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University of Mumbai



Indian Council of
Social Science Research



Chandrabhan Sharma College
Arts, Commerce and Science

Smt. Durgadevi Sharma Charitable Trust's

Chandrabhan Sharma College

of Arts, Commerce and Science
(Autonomous)

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(Deemed-to-be-University established under section 3 of UGC Act, 1956.)

Sponsored by

**Western Regional Centre, Indian Council of Social Science
Research (WRC - ICSSR)**

ONE DAY 11th MULTIDISCIPLINARY INTERNATIONAL CONFERENCE

THEME

**“IKS: Bridging Tradition, Innovation &
Sustainability - Glorious Past, Promising Present &
Designed for Bright Future”**



Date : Saturday, 14th March, 2026

Time : 9.00 a.m. Onwards

**Venue: Chandrabhan Sharma College Auditorium, Powai
Vihar, Powai, Mumbai - 400 076**



ABOUT UNIVERSITY OF MUMBAI

The University of Mumbai (known earlier as University of Bombay), established in 1857, is one of the oldest and most premier universities in India. More than 750 colleges in and around Mumbai are affiliated to the University. With two campuses at Fort and Kalina, the University of Mumbai is one of the largest universities in the world in terms of the number of students. It has recently completed 168 years of service.

ABOUT THE INDIAN COUNCIL OF SOCIAL SCIENCE RESEARCH -WESTERN REGIONAL CENTRE (ICSSR - WRC):

The Indian Council of Social Science Research, an autonomous organisation, was established by the Government of India in 1969. It, in turn, established the Western Regional Centre (WRC) with the approval of the Government of Maharashtra in January 1973, in collaboration with the University of Mumbai, on the new campus of the University of Mumbai at Vidyanagar. It consists of three buildings – a wing of the Jawaharlal Nehru Library (1976), the ICSSR Hostel Building (1976) and the J. P. Naik Bhavan (1983). The ICSSR Conference Hall is located on the ground floor of the J. P. Naik Bhavan. During the last fifty years, the WRC has grown into a fine and exceedingly useful institution. In fact, it has now been recognised as one of the best and most developed Regional Centres of the ICSSR in the entire country.

ABOUT ICAI UNIVERSITY, HYDERABAD

IBS Hyderabad (Faculty of Management Studies) is a constituent of the ICAI Foundation for Higher Education, which is declared to be a Deemed-to-be-university under Section 3 of the UGC Act. 1956. IBS offers high-quality programs in various areas of management to a diverse group of students, executives, and professionals across India. IBS has a reputation for innovative program design and delivery, quality courseware, personalised instruction, strong industry interface, research, consultancy and publications. Since its establishment in 1995, IBS has grown impressively and achieved widespread recognition from business and industry, academic circles, and professional bodies. The campus at Hyderabad is a 91-acre lush green campus with a built-up area of over 10 lakh sq. ft. The fully residential campus is equipped with state-of-the-art facilities. Different academic blocks are available with classrooms, lecture theatres, tutorial rooms, conference halls, seminar halls, auditorium, library, computer lab, faculty rooms, meeting rooms, administrative offices, academics office, student support services office, and career management centre.

ABOUT CHANDRABHAN SHARMA COLLEGE OF ARTS, COMMERCE AND SCIENCE

Chandrabhan Sharma College of Arts, Commerce and Science, established in 2004, is managed by the Smt. Durgadevi Sharma Charitable Trust under the GHP Education Wing. Founded by Shri Prashant Sharma in memory of Pandit Chandrabhan Sharma, the college is committed to quality education, value-based learning, talent development, and intellectual growth. The college is affiliated with the University of Mumbai and is re-accredited with an 'A' Grade (CGPA 3.10) by NAAC. It offers 11 undergraduate and 3 postgraduate programs in Commerce, Science, Management, IT, Media, AI, Data Science, Cyber Security, and related fields. It is also affiliated with YCMOU for BCA and MCA courses. With over 3,000 students, the college maintains high academic standards, strong campus discipline, and promotes holistic development through sports, cultural activities, National Service Scheme, extension work, and the Women Development Cell.

ABOUT THE CONFERENCE

The Multidisciplinary International Conference on Indian Knowledge Systems (IKS) aims to explore India's rich intellectual heritage and its relevance in addressing contemporary global challenges. It highlights the integration of traditional knowledge with modern innovation, in alignment with the National Education Policy (NEP) 2020, to promote sustainable development and holistic progress.

THEME OF THE CONFERENCE

The theme "IKS: Bridging Tradition, Innovation, and Sustainability – Glorious Past, Promising Present & Designed for Bright Future" emphasizes blending India's ancient wisdom with modern advancements to build a sustainable, value-driven, and future-ready world.

THE CONFERENCE INCLUDES THE FOLLOWING SPECIFIC OBJECTIVES:

- To explore the depth and diversity of Indian Knowledge Systems and their relevance to contemporary global challenges.
- To promote interdisciplinary research that integrates traditional wisdom with modern science, technology, and innovation.
- To encourage the incorporation of IKS into education, research, and policy frameworks in alignment with NEP 2020.
- To foster dialogue and collaboration among academicians, researchers, policymakers, and practitioners at national and international levels.

OUTCOMES OF THE CONFERENCE

- Participants will gain a comprehensive understanding of the latest advancements, trends, and challenges in commerce and management in the digital era.
- The conference will encourage the development of innovative frameworks, strategies, and models to address challenges and capitalise on opportunities in the digital economy.
- Quality research papers and case studies presented during the conference will be compiled into proceedings or published in reputed journals, contributing to academic and professional literature.
- The conference will foster a global network of professionals, academicians, and researchers, enabling long-term partnerships and collaborative projects.

SUGGESTIVE SUB-THEMES (NOT RESTRICTED)

IKS, Innovation, and Sustainable Development

- Indigenous innovation and traditional wisdom
- Sustainable agriculture and water management
- Community-based development models
- IKS and Sustainable Development Goals (SDGs)

IKS and Digital Transformation

- Digitisation of ancient texts and manuscripts
- Technology-enabled preservation of IKS
- Digital platforms for knowledge dissemination
- IKS in smart and digital governance

IKS in Education and Research

- Integration of IKS in curriculum design
- Interdisciplinary and experiential learning
- Research methodologies rooted in IKS
- Policy initiatives for promoting IKS in academia

Global Perspectives and Collaboration in IKS

- Comparative studies of global knowledge systems
- International academic partnerships
- Global recognition of Indian knowledge traditions
- Cross-cultural knowledge exchange

IKS in Health, Wellness, and Psychology

- Ayurveda, Yoga, and holistic healthcare
- Mental health and well-being practices
- Preventive and lifestyle-based health systems
- Integration with modern medical sciences

IKS, Society, and Governance

- Indian aesthetics and artistic traditions
- Oral traditions and storytelling
- Language, literature, and cultural identity
- IKS in media and contemporary communication

IKS and Environmental Sustainability

- Indigenous business and trade practices
- Ethical entrepreneurship and wealth creation
- Sustainable and inclusive economic models
- IKS and MSME development

IKS, Artificial Intelligence, and Future Innovation

- Ethical leadership and governance models
- Social harmony and conflict resolution
- Community participation and social institutions
- IKS and public policy frameworks

IKS in Arts, Culture, and Communication

- Traditional ecological knowledge
- Biodiversity conservation practices
- Climate resilience and adaptation
- Sacred groves and nature-centric living

IKS, Entrepreneurship, and Economic Systems

- Indian logic, mathematics, and cognition
- Ethical AI and human-centric technology
- IKS-inspired innovation frameworks
- Future technologies guided by ancient wisdom

CALL FOR RESEARCH PAPERS

We invite papers from Academicians, Researchers, Business Leaders, Experts, and Executives from the industry to submit original and unpublished work on any of the following areas. However, the areas are indicative. The researchers can submit a paper relevant to the conference. Authors should electronically submit full-length papers in MS Word, a maximum of 8 -10 pages.

PAPER SUBMISSION GUIDELINES

- Manuscripts should be submitted preferably through email, and the research article/paper should preferably not exceed 8 – 10 pages in all.
- The abstract should be 350 words in 12-point Italic Times New Roman with a minimum of 4 to 5 keywords. Manuscripts should be typed in 12 font sizes, Times New Roman, single-spaced with 1” margin on standard A4 size paper.
- Manuscripts should be organised in the following order: Title, Name(s) of Author(s), and his/her (their complete affiliation(s) including zip code(s), Abstract (not exceeding 350 words), Introduction, Main body of the paper, Conclusion and References (APA Style)

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IMPORTANT DATES

Full Paper Submission: 20th Feb, 2026
Acceptance Notification: 23rd Feb, 2026
Conference on: 14th March, 2026

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BEST PAPER AWARD

Best papers will be awarded with cash prizes, certificates and a trophy. E- copy of the Conference proceeding will be provided.

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A COMPARATIVE STUDY ON THE ROLE OF TECHNOLOGY AND ADVANCED EQUIPMENT IN ENHANCING SPORTS TRAINING AND PERFORMANCE

Shayna Chandel¹ and Dr. Vishwambhar Vasant Jadhav²¹M.P.ED. Scholar and Department of Physical Education, University of Mumbai, Maharashtra 400031²Assistant Professor and Department of Physical Education, University of Mumbai, Maharashtra 400031**ABSTRACT**

Technological innovation has transformed the modern sports environment by introducing advanced monitoring systems, performance analysis tools, and improved sports equipment. The integration of wearable devices, motion analysis systems, and digital performance tracking technologies has significantly enhanced the ability of coaches and athletes to monitor training loads, analyze movement patterns, and prevent injuries. This study presents a comparative examination of traditional sports training methods and technology-assisted training approaches. Traditional training methods rely largely on experiential coaching, observation, and repetitive practice, while technology-assisted training incorporates data-driven analysis and scientific monitoring. The analysis suggests that technology-supported training provides greater accuracy in performance monitoring and training optimization, whereas traditional coaching methods remain essential for skill development, discipline, and athlete-coach interaction. The study concludes that the most effective sports training model is achieved through the integration of traditional coaching knowledge and modern technological innovations.

Keywords: sports technology, advanced equipment, athlete performance, sports science, comparative study.

INTRODUCTION

The increasing progress of technological innovations has significantly influenced the evolution of modern sports. Scientific advancements have led to the development of new approaches for monitoring athlete performance, designing training programs, and preventing injuries. As competitive sports become increasingly performance-oriented, the use of technological tools has become an essential component of athlete preparation.

Historically, sports training depended heavily on the knowledge and experience of coaches. Athletes improved through repetitive practice, physical conditioning, and tactical instruction. Although these traditional training approaches contributed greatly to the development of athletic skills, they were often limited by the absence of objective measurement techniques.

With the advancement of sports science, technological tools are gradually being incorporated into training environments. Innovative technologies like wearable sensors, GPS monitoring devices, and motion analysis systems provide valuable data related to movement patterns, physiological responses, and training intensity. These technologies allow coaches to analyze athlete performance more precisely and make evidence-based training decisions (Adesida et al., 2019).

Furthermore digital technologies, the emergence of advanced sports equipment has also played a key role in improving athletic performance. Innovations in materials and equipment design have improved safety, comfort, and efficiency in sports participation.

Despite the growing role of technology in sports training, traditional coaching methods remain fundamental to athlete development. Coaches continue to have a significant influence on guiding athletes through technical, tactical, and psychological aspects of performance.

Therefore, a comparative understanding of traditional training approaches and technology-assisted training is necessary to identify the most effective methods for athlete development.

OBJECTIVES

The objectives are:

1. To examine the key role of modern technology in sports training.
2. To analyze the contribution of advanced sports equipment to athletic performance.
3. To compare traditional training methods with technology-assisted training.
4. To understand the role of technological monitoring systems in injury prevention and performance evaluation.

LITERATURE REVIEW

Recently, technology has become a key role in sports and has produced a significant effect on training and performance on sports development training and has attracted considerable attention in sports science studies.

Modern technological tools have improved the accuracy of performance assessment and provided effective ways to monitor athletes' training load.

Adesida, Papi, and McGregor (2019) reported that the implementation of wearable technology is steadily increasing in sports biomechanics to collect data related to movement patterns and athlete workload. These technologies help coaches monitor athlete performance and prevent excessive training loads.

Liebermann et al. (2002) discussed the impact of information technology on sports performance analysis. Their research highlighted how video analysis and computerized feedback systems offer important information about technical and tactical aspects of sports performance.

Baca and Kornfeind (2012) emphasized the importance of real-time feedback systems in elite sports training. These systems enable coaches to monitor performance during training sessions and make immediate adjustments to improve athlete performance.

Seshadri et al. (2021) examined the importance of Wearable Technology in optimizing training workloads and reducing injury risks. Their findings indicated that wearable technologies can generate valuable data on accurate data related to athlete fatigue and recovery.

Research in sports biomechanics has also demonstrated the importance of advanced equipment in improving performance efficiency and reducing injury risks (Bartlett, 2007).

These studies highlight the growing role of technological innovations in modern sports training and support the need to analyze and compare traditional and technology-assisted training approaches.

ROLE OF TECHNOLOGY IN SPORTS TRAINING

Technology in sports describes the use of scientific instruments, digital monitoring systems, and analytical tools to improve athlete performance and training effectiveness. The application of sports technology includes wearable fitness devices, motion capture systems, GPS tracking systems, and video analysis software.

These technologies enable coaches and athletes to collect detailed information about physiological responses, movement efficiency, and training intensity. The availability the analysis of such data facilitates more accurate evaluation of athlete performance.

Wearable devices such as heart rate monitors and accelerometers are widely used to monitor athlete workload and fatigue. Similarly, motion analysis systems allow researchers and coaches to evaluate technical skills and movement patterns.

Advanced technologies like artificial intelligence and machine & technology learning technologies are also contributing to emerging in sports analytics. These technologies enable the processing of large volumes of performance data to identify patterns and predict performance outcomes.

Advanced Equipment in Sports

Advanced sporting equipment significantly contributes to better athletic performance and helps protect athletes during training and competition. Modern sports equipment is designed using innovative materials and ergonomic principles that enhance performance efficiency.

For example, improvements in sports footwear have significantly enhanced stability and reduced the risk of injuries. Similarly, protective equipment used in contact sports has been improved using advanced materials that provide better shock absorption.

Training equipment such as resistance machines and sport-specific training tools allows athletes to improve muscular strength and functional movement patterns.

Advancements in equipment design therefore contribute to both performance enhancement and injury prevention.

Comparative Analysis of Training Approaches

Aspect	Traditional Training	Technology-Assisted Training
Performance Evaluation	Based on coach observation	Based on digital performance data
Training Monitoring	Limited measurement	Continuous tracking using wearable technology
Feedback	Delayed feedback	Real-time feedback
Injury Prevention	Reactive approach	Data-driven preventive monitoring
Skill Development	Strong emphasis on fundamentals	Enhanced through motion analysis

The findings suggest that each training method contributes positively to athlete growth. Traditional training emphasizes fundamental skill acquisition and discipline, while technology-assisted training provides objective measurement and performance analysis.

Research Gap and Significance of the Study

Despite the rapid growth of technological innovations in sports training, many sports organizations and educational institutions continue to rely primarily on traditional coaching methods. Despite numerous studies focusing on the key role of wearable technologies, motion analysis systems and modern digital tracking technologies in sports performance, there remains limited comparative analysis that evaluates the relative strengths of traditional training approaches and technology-assisted training within the same framework.

Most previous research focuses on the impact of specific technological devices for example GPS trackers, biomechanical sensors, or performance analysis software. However, only a limited number Researchers have explored how technological tools work alongside or differ from the traditional training methods used by coaches.

The significance the relevance of this research lies in its attempt to establish a comparative perspective on these two approaches. Understanding how technology-assisted training differs from traditional coaching methods can help sports scientists, coaches, and institutions design more balanced and effective training systems.

Furthermore, as sports technology continues to evolve rapidly, it is important for sports educators and researchers to evaluate its practical applications and limitations. This study therefore contributes to the growing scholarly knowledge in this area on sports science by highlighting the relevance of incorporating traditional coaching practices with modern technological innovations.

CONCLUSION

The comparative evaluation of traditional training methods and technology-assisted training highlights the significant influence of technological innovations in modern sports. Technology enables more precise assessment of athletes' performance, improves training efficiency, and contributes to injury prevention.

However, traditional coaching methods remain essential for developing technical skills, discipline, and psychological resilience in athletes.

The most effective training approach therefore involves integrating technological tools with traditional coaching principles. Such integration allows athletes to benefit from both scientific analysis and experiential knowledge.

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A CONCEPTUAL AND TECHNOLOGY-ENABLED FRAMEWORK FOR OPERATIONALIZING INDIAN KNOWLEDGE SYSTEMS USING MODERN IT TOOLS

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ABSTRACT

One of the research topics that has gained the interest of scholars and policy-makers is Indian Knowledge Systems (IKS), which may be of great value to the progress of education, information technology-enabled innovation, and sustainable development. Based on holistic epistemologies emphasizing ethical imperatives, balance, and integrated knowledge, IKS offer meaningful alternatives to mainstream Western paradigms. Nonetheless, existing literature remains largely focused on philosophical interpretations of IKS, with limited emphasis on technological operationalization, system design, and measurable outcomes, making practical implementation challenging. This paper presents a critical analysis of contemporary literature on IKS in the contexts of education and technology to identify key gaps related to empirical validation, IT-enabled implementation frameworks, technology-mediated interactions, and stakeholder integration. In response, the study proposes a conceptual and technology-enabled operationalization framework that translates IKS philosophical foundations into actionable practices supported by modern IT tools such as digital platforms, learning management systems, data analytics, and artificial intelligence. The proposed framework bridges traditional knowledge systems with modern innovation ecosystems by enabling scalable, adaptive, and measurable implementation of IKS across learning and technology-driven environments. By integrating philosophical foundations with IT-supported operational mechanisms and outcome-based evaluation, the study offers a systematic pathway for transforming IKS from a normative discourse into empirically measurable, technology-mediated systems of practice, while also outlining directions for future research, validation, and policy alignment.

Keywords: Indian Knowledge Systems (IKS), Information Technology, Technology-Enabled Framework, Digital Transformation, Educational Technology, Operationalization, Measurable Impact

I. INTRODUCTION

Indian Knowledge Systems (IKS) are comprised of many resources that one can access in his or her ancestral history to formulate an idea of their role in the world. These resources are characterized by being holistic, and developed as a means of seeing the majority of things in the universe being equally vital, instead of one kind of knowledge or other being valuable than the other, and to share moral and ethical values and beliefs among individuals. It is an issue that has seen a high re-emergence of interest among scholars and policymakers over the last few years in the promotion of the use of IKS in particular in higher education reform, the aims of sustainable development, and accountability in technological development. Government efforts to encourage IKS in education include the National Education Policy (NEP) 2020 adopted by the Indian government in December 2020, and IKS has been found to be key elements in encouraging interdisciplinary learning; cultural identity; and holistic approaches to personal growth and group development. Meanwhile, as artificial intelligence, data analytics and online learning continue to proliferate at a quick pace, the need to design and put in place ethical, human and culture-based frameworks in an effort to improve innovation has become highly pronounced. Bearing this in mind, Indigenous Knowledge Systems (IKS) have gained greater acceptance as a fundamental intellectual resource to guide contemporary pedagogical practices and principles of technological design [2,4,10]. Yet, much of the current literature that relates to IKS has been largely conceptual and normative and centered on philosophical understandings and cultural relevance and advocacy on the policy level with minimal empirical support and practical implementations of IKS usage [2,9,10]. Further, NIL has done minimal quantitative research on the inculcation of IKS into learning so as to offer credible information to gauge the student learning impact, assessment competence and skill acquisition [4,9,12]. The same lack of empirical validation of IKS can be noted in the research on the use of IKS in new technologies and the systems of governance as only the philosophical research has been investigated and no practical implementation of IKS has been implemented and its performance indicators have not been measured to identify the actual impact of IKS on the new technologies and societal frameworks [6,7,11]. The absence of effective systems to convert the philosophical background of IKS into practice educational and technological application poses a significant research gap within the study dedicated to the educational methodology, and little utilization of technology-mediated instruments, the absence of interactions with major stakeholders, and a self-evident lack of scalability between institutions and culture are all limiting factors in the application of IKS-based methodologies. [1,5,8]. The transformative potential of Indian Knowledge Systems might go to waste without systematic

operationalizations and quantifiable results. To overcome these constraints, this project aims at creating a new framework that relates philosophical underpinnings of Indian knowledge systems (IKS) with the real implementation of the IKS in education and technology. In order to do that, the authors thoroughly review the literature to find out the main gaps in the existing structures and introduce their own conceptual research framework to operationalise IKS using technology-aided practices and indicators of measurable impact. By so doing, they make IKS viable, operational systems which are capable of making a substantial contribution towards the emergence of opportunities today in the areas of innovation, policy, and reform of education. The newness in the research is its integrative and operationally minded analysis of the Indian knowledge systems - unlike most of the extant literature, the research focuses neither on philosophical explanations of knowledge nor on policy objectives. The authors introduce a technology mediated conceptual framework which will enable systematic translation of IKS principles into practices and measurable results in the context of education and technology. As a result of developing a clear connection between philosophical groundwork, operational policy, technological mediation and performance-based assessment, this study marks a change in the direction of IKS research toward a more normative-oriented discourse to a practice that is empirically testable and can be generalized.

II. LITERATURE REVIEW

The literature on Indian Knowledge Systems (IKS) and other indigenous ways of knowing has been increasing in a number of fields such as education, technology, government and sustainability. Although a lot has already been known about the philosophical background of these systems and their cultural appropriateness due to the available literature; what appears to be lacking though is the empirical validation of IKS empirical frameworks operationally and measurement of the effect of IKS on outcomes. As an example, Ahmadi and HaghighatBin (2018) suggest a value-based model of encompassing both the physical and intangible cultural heritage in the planning of the rural landscapes in Iran. Their study shows how indigenous values can guide a sustainable development practice. Although the proposed framework provides a strong conceptual linkage, it is virtually purely based on qualitative approach, therefore, it does not present any quantitative indicators or longitudinal analysis, which makes it hard to apply this framework to a different culture and geographical region. According to Aithal et al. (2019), IKS can be used to promote the innovation of technology through offering the principles of ethical responsibility, balance and holistic thinking, which could be used to inform the digital transformation and system design. Although the work of the authors is effective in connecting the traditional philosophy fields to the current discussion of technology, the authors are not concerned with empirical research or quantifiable results in terms of productivity, efficiency, and innovation benefits of IKS-based technology development. Ali [3] investigated eco-innovation in heritage using financial viability model, where he targeted the industry of Khadi in Bangladesh. Ali provided a sufficient amount of quantitative analysis and the commercial potential of these sorts of industries in an economic performance approach, but did not provide much information concerning the mechanisms of technology adoption of IKS-based industries, the stakeholders, and the role of digital platforms in facilitating the processes of heritage-based innovation systems. In their study, Chandratreya et. al. [4] examined the integration of Indian Knowledge Systems (IKS) in higher education in terms of curriculum transformation, interdisciplinary learning paradigm and the alignment with the national paradigm of educational reform. The authors used a strong normative framework and policy arguments, but they fail to show an empirical evidence of the effectiveness of IKS integration in terms of learning outcomes, faculty preparedness, or institutional barriers regarding IKS integration. Choto and Ramadan [5] are also suggesting a revolutionary approach of practice-based pedagogy model of teaching architecture, that links teaching, research and professional practice. The model presented by the authors illustrates a contextual relevance and pedagogical novelty, yet since the validation of the model was based on one institutional case, student outcome measures of IKS pedagogies, or further incorporation of digital and emerging technologies was not offered in the model. The article by Danielsen deals with the topic of the bridging of Western scientific and indigenous (or local/handed down) forms of knowledge as to the issue of the regulation of natural resources in the age of global change. Another aspect that is highlighted in this paper is the necessity of pluralism in research by giving examples of how both scientific and traditional forms of information ecology can be used to develop inclusive forms of government. Nevertheless, the article lacks enough information regarding the proper way of balancing the two forms of information, either a qualitative or quantitative manner (i.e., presenting quantifiable data that reveals whether an integrated method bears practical effect). The article by Lee and Shin involves the application of artificial intelligence (AI) to make the interpretation of cultural heritage more effective using the Old Jambatan Tamparuli Bridge as a case study. This article reveals examples of AI opportunities to engage and storytell the cultural heritage; nevertheless, it does not provide any empirical evidence on the types of AI tools that were applied to the cultural heritage engagement, the levels of visitor engagement with the cultural heritage with the help of AI tools, or the effects of AI tools on the understanding of the cultural heritage or visitor engagement

with it. The work of Meera and Vinodan is a commentary on the purpose of festivals (e.g., by placing an emphasis on the Thrissur Pooram) as a means of adapting communities to sustainability, as well as crisis management. Their suggested assessment model offers a qualitative understanding of adaptive systems and how they can be used to benefit the success of events due to adaptive processes of governance. Nevertheless, the methodology they use fails to offer any quantitative data to justify the applicability of their evaluation system to other contexts. In his work, Pillai discusses how the assessment reform under NEP 2020 can lead to the integration of indigenous knowledge into the mainstream education and how assessment reform can take place through the cooperation of the various forms of knowledge systems in an educational setting. The study has a philosophical alignment and an appraisal of formative assessment. Nonetheless, the question of the impact of different assessment strategies that are already revised on the engagement of student participants and their learning outcomes or skills development is not supported empirically. This is a considerable weakness especially since technologies based assessment is usually common in most sectors of education. Pisal (2011) gives an introduction to the Indian Knowledge System in the context of the idea of education and transfers the epistemological and cultural applicability of the system to the contemporary educational practice. The author, nonetheless, fails to put empirical evidence to include either of the epistemological or cultural dimensions of Indian Knowledge as they are particularly pertinent to the development of knowledge, understanding of knowledge and application of knowledge to the students in the present day. This leads to the fact that the article is rather descriptive than prescriptive and does not present clear operational models and criteria in terms of which it is possible to evaluate the potential educational or technological impacts. Ray and Ray (2011) aim to further the implementation of the Indigenous Knowledge Systems in the creation of artificial intelligence (AI) governance systems, investigating Maori and Navajo views. Their article is a valuable critical evaluation of Westernized AI governance both in the past and at present with regard to ethics; however, it fails to generate operationalized traditional Indigenous Governance using algorithms. Neither do they provide any form of evidence of validating the established and operationalized Indigenous knowledge as far as the development of the governance processes and systems is concerned. Srivastava (2011) examines the introduction of Indian languages and Indian Knowledge Systems in legal education as a way of decolonising legal education. Although the study provides a highly robust normative foundation of the cultural relevancy and inclusivity with regards to the formulation of legal and ethical values in education, it fails to provide an evaluation or measurement of the empirical evidence of the possible integration of the Indian languages or Indian Knowledge Systems into legal education and the readiness of the institutions to include such a coursework or program in their own curriculum. As the literature reviewed above demonstrates, there is a degree of philosophical richness and growing applicability of the Indigenous and Indian knowledge systems to policies in various spheres of the society. Nevertheless, it still has many gaps in the areas of empirical validation, operationalization, implementation using technologies, stakeholder involvement and scalability. The existence of such gaps shows that a more organized method is required which can transform the philosophical principles into practical models which can be implemented to generate quantifiable educational and technological outcomes.

III. RESEARCH GAPS

The quantity of studies and policy programs on Indian Knowledge Systems (IKS) in education, technology, government and sustainability are growing at a high rate, yet there is very little research that has been conducted empirically to demonstrate how these IKS strategies are implemented into quantifiable outcomes in the current educational and technological contexts. The philosophical and normative arguments of incorporating IKS-based solutions in our existing systems are strong but the empirical data of successful utilization of these ideas is not established in a definite manner (. The current research also demonstrates the importance of incorporating IKS in curricula, innovation ecosystems and governance but it does not reveal how the incorporation of IKS-based approach to interdisciplinary, multi-institutional or multi-cultural settings will lead to the outcomes that we would like to observe. I also observed that despite the increasing awareness that the digital transformation and application of new technology can help us to attain IKS approaches through research, development and evaluation, there is a lack of research to establish how new technologies can be employed to help, measure and magnify the effect of IKS endeavours in these regions. In addition, the literature that is available is more inclined to academic or policy view, omitting most of the empirical studies that involve key stakeholders like students, teachers, practitioners and communities. This underrepresentation thus constrains our understanding of what is contextually viable, institutionally ready and culturally acceptable regarding the implementation of IKS into preexisting structures [3,4,8,12]. The other reason why we can only speculate as to how IKS can fit into these contexts is that most of the case studies carried out are done in an isolated manner or on localised grounds, which restricts our capacity to generalise and come up with evidence-based models as to how we can transfer IKS [1,5,7,8]. All of the identified limitations demonstrate a serious gap in the research on the creation of an integrated, evidence-based, technology-mediated framework to deploy IKS as integrated, evidence-based,

technology-enabled frameworks to translate the philosophical foundation of IKS into quantifiable outcomes in the form of technology and education. The first step toward repositioning IKS as a living, scalable system with a real influence on the innovation, policy and education reform is filling this gap.

IV. CONCEPTUAL FRAMEWORK

Modern IT tools such as learning management systems, artificial intelligence, and data analytics function as operational enablers that translate IKS principles into scalable and measurable practices. Literature suggests that the Indian Knowledge Systems (IKS) are devoid of convergence in philosophical thinking and action practice (particularly in education and technology). To address this weakness, this study suggests a comprehensive conceptual framework according to which IKS is a dynamic and operational system that has the potential to deliver concrete outcomes. The given framework will tend to operationalize the basic philosophical principles of IKS with the help of modern technology and empirical measurements to prove the findings. The research is based on the basic philosophical principles of Indian Knowledge Systems, which include ethical accountability, balance and harmony, and integrated knowledge at the bottom of the framework. These ideas act as the principles of guiding concepts in decision making, learning, and development of technology. The structure includes these concepts as guiding principles to govern the institutional behaviour, learning and innovation processes as opposed to viewing them as lofty ideals. On this assumption, the framework focuses on operationalization of philosophical tenets into tangible learning and technological processes. This is done by aligning the values of IKS to the learning structures, learning processes, governance, and innovation. Through this, the framework addresses the gap of the absence of the implementation models revealed in the literature review. Technology is put within the framework as being a significant enabling factor that facilitates scalability, consistency, and evaluation. The dissemination, implementation, and assessment of IKS-driven practices can be facilitated by the use of digital platforms, learning management system, data analytics and new and emerging technologies including artificial intelligence. With the traditional knowledge being preserved and used in both the contemporary educational and technological surroundings by means of technology as a mediating factor. The framework concludes with the definite focus on the results and the effect. The metrics of learning performance, engagement, the effectiveness of innovations, ethical adherence, and satisfaction of stakeholders are mentioned as the critical dimensions according to which the effectiveness of IKS-based initiatives can be measured objectively. The framework makes it easy to assess, compare and improve using evidence by relating philosophical foundations to measurable metrics. The conceptual framework proposed above is a systematic and integrative way of operationalising Indian Knowledge Systems to a systematic and effective result; between philosophical premises and practical impacts. It directly fills the literature gaps by combining the normative foundations, operational definitions, technological enablements, and outcome-based evaluations and therefore re-replaces IKS as an operative and scalable system to present-day education and technological innovation.

V. METHODOLOGY

The framework is designed to be implementable using standard IT infrastructures and can be validated through system prototypes, dashboards, or analytics-driven evaluation models. The proposed study employs a conceptual research methodology of qualitative approach to come up with a combined framework of operationalizing Indian Knowledge systems in education and technology. The proposed research is exploratory, and the literature does not have empirically validated models, which is why a systematic literature analysis approach is suitable. A literature review of the academic literature was conducted to examine the academic literature on the Indian Knowledge Systems, indigenous knowledge frameworks, education reform, emerging technologies, governance models and assessment practices. The inclusion criteria used in the selection of peer-reviewed articles, edited volumes, policy documents, and authoritative reports were related to the relevance to the integration of Indian Knowledge Systems, technological mediation, and outcome-based assessment. The selected literature bases its coverage of the areas in education, heritage studies, technology governance and sustainability to offer an interdisciplinary perspective. The thematic synthesis was applied to analyze the literature that identified the patterns, limitations, and conceptual relations. Philosophical workings of IKS, problems with the process, the application of digital technology, how it is assessed and measured, stakeholder involvement and scalability were some of the significant themes that were identified. These themes were used in identifying a single research gap and they also aided in the development of the proposed conceptual framework. Development of the conceptual framework was made by an iterative analytical approach in which the results of the thematic analysis were compared in terms of the research gaps detected in the literature body. Every component of the intended conceptual framework was made to overcome certain gaps in the literature in terms of operationalisation, integration of technology, and quantifiable nature. The study is a conceptual study and does not entail the use of primary empirical data or experimental validation. However, the suggested conceptual

framework is formulated in a manner that it can be empirically tested in further studies as a case study, pilot study, survey and mixed-method study in the educational and technological sphere.

VI. DISCUSSION

The proposed study employs a conceptual research methodology of qualitative approach to come up with a combine. The findings of this paper validate the previous finding that Indian Knowledge Systems (IKS) possess much philosophical content and functionality but are not operationalized enough in the current education and technology environments. The reviewed literature has been quite explicit on the significance of being ethically responsible, thinking in a holistic manner, and making sense out of a culture; but these issues are scarcely operationalized in the context of specific practices and measurable indicators. The suggested conceptual framework will address the issue by offering a detailed framework that will connect philosophical foundations and operational strategies, technology support, and outcome measure. The emphasis on technology as an enabler and not a disruptor in the framework is consistent with the current literature trends on human-centred and ethical innovation. Digital platforms, analytics, and artificial intelligence can be used to operationalize and scale IKS initiatives without losing their cultural authenticity. This framework can be traced as a direct reaction to the weaknesses of the previous research studies that have talked about technology in an abstract manner without indicating how it is utilized in operation and scaling. In addition, the policy imperatives of the National Education Policy 2020 are also dealt with by the framework, as it provides a systematic way of how IKS can be incorporated into the curriculum, teaching, and learning processes. Moreover, the fact that the framework is typically results-oriented also allows one to engage in evidence-based evaluation, which will help the institutions and the policymaking community to decide whether the approach is effective. This framework thus shifts the borders of the current literature by viewing IKS as a living system which integrates tradition and innovation. The framework of operationalizing Indian Knowledge systems in education and technology. The proposed research is exploratory, and the literature does not have empirically validated models, which is why a systematic literature analysis approach is suitable. A literature review of the academic literature was conducted to examine the academic literature on the Indian Knowledge Systems, indigenous knowledge frameworks, education reform, emerging technologies, governance models and assessment practices. The inclusion criteria used in the selection of peer-reviewed articles, edited volumes, policy documents, and authoritative reports were related to the relevance to the integration of Indian Knowledge Systems, technological mediation, and outcome-based assessment. The selected literature bases its coverage of the areas in education, heritage studies, technology governance and sustainability to offer an interdisciplinary perspective. The thematic synthesis was applied to analyze the literature that identified the patterns, limitations, and conceptual relations. Philosophical workings of IKS, problems with the process, the application of digital technology, how it is assessed and measured, stakeholder involvement and scalability were some of the significant themes that were identified. These themes were used in identifying a single research gap and they also aided in the development of the proposed conceptual framework. Development of the conceptual framework was made by an iterative analytical approach in which the results of the thematic analysis were compared in terms of the research gaps detected in the literature body. Every component of the intended conceptual framework was made to overcome certain gaps in the literature in terms of operationalisation, integration of technology, and quantifiable nature. The study is a conceptual study and does not entail the use of primary empirical data or experimental validation. However, the suggested conceptual framework is formulated in a manner that it can be empirically tested in further studies as a case study, pilot study, survey and mixed-method study in the educational and technological sphere.

VII. CONCLUSION

This study was meant to investigate the shortcomings of the current literature on Indian Knowledge Systems and fill the gap between the philosophical and application sides of the discussion. Through a systematic review and thematic synthesis of the available literature, the study has investigated the key issues related to the empirical validation, operational frameworks, technology-driven implementation, stakeholder involvement, and scalability. In this respect, this paper presented a comprehensive conceptual framework that converts the philosophical foundations of Indian Knowledge Systems into practical activities that are facilitated by modern technologies and indicators of impacts. Combining philosophical foundations and operational strategies and result-based evaluations, this conceptual framework offers a structural method of introducing IKS into the current systems of education and technological advances. This study is relevant to the emerging literature on IKS because it shifts the argumentation on the topic to the realms of operationalization and evidence-based practice. In this regard, this study brings to focus the possibility of the Indian Knowledge Systems to facilitate the ethical, inclusive, and sustainable innovations within the fast-evolving digital landscape.

VIII. FUTURE WORK

Even though this paper provides a conceptual framework, more studies are required to support empirically and develop this proposed framework. The effectiveness of the framework can be proven in future research and case-based or pilot implementation in educational settings, in technology-enabled learning environment, or in an ecosystem of innovations. Quantitative performance indicators coupled with qualitative inputs of stakeholders would provide more information on learning results, interest, and preparedness of the institutions. The different case-studies in the various subject areas, institutions, and geographical regions would enhance the external validity of the findings and contribute to the scaling up process. More advanced technologies, such as artificial intelligence, learning analytics, and adaptive assessment systems, can also be integrated in the research to develop IKS practices further. Long-term studies of the long-term outcomes would also be desirable to be aware of the long-term impacts of IKS integration in the fields of education, innovation, and policy-making.

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ACCOUNTS AND INDIAN KNOWLEDGE SYSTEM (IKS): A STUDY OF TRADITIONAL ACCOUNTING PRACTICES AND THEIR RELEVANCE IN MODERN FINANCIAL SYSTEMS

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ABSTRACT

Accounting is often called the “language of business,” enabling organizations to record, analyze, and communicate financial information. While modern accounting systems are largely associated with Western developments, especially after the Renaissance period, evidence suggests that sophisticated accounting and financial management practices existed in ancient India. The Indian Knowledge System (IKS) provides insights into early financial administration, bookkeeping, auditing, and economic governance. Ancient texts such as the Arthashastra, Vedic literature, and traditional merchant practices reveal systematic accounting methods used in governance, trade, and temple economies. This research paper examines the historical roots of accounting in India, explores the principles embedded in the Indian Knowledge System, and analyses their relevance to modern accounting practices. The study highlights how ethical values, transparency, and accountability were integral to financial systems in ancient India.

Keywords: Account, IKS, Arthashastra, Traditional Account, Finance

1. INTRODUCTION

Accounting plays a crucial role in business management by recording financial transactions, evaluating performance, and supporting decision-making. Modern accounting systems are generally traced to the double-entry bookkeeping system developed in Europe in the 15th century. However, historical evidence indicates that organized accounting practices existed in ancient civilizations, including India.

The Indian Knowledge System (IKS) represents a body of traditional knowledge developed over thousands of years in areas such as economics, governance, mathematics, and commerce. Within this framework, accounting and financial administration were important components of economic management. Ancient Indian texts, inscriptions, and commercial records demonstrate that financial transactions were systematically recorded and monitored.

For example, *Kautilya’s Arthashastra* (around 300 BCE) describes detailed procedures for maintaining accounts, auditing public funds, and preventing fraud in government administration. These practices show that accounting in ancient India was not only a technical activity but also an ethical responsibility aligned with principles of transparency and accountability.

The objective of this research paper is to examine the relationship between accounting practices and the Indian Knowledge System and to highlight their significance for modern financial management.

2. INDIAN KNOWLEDGE SYSTEM (IKS): CONCEPT AND SCOPE

The Indian Knowledge System refers to the traditional knowledge developed in India across fields such as philosophy, mathematics, governance, medicine, agriculture, and economics. It emphasizes holistic learning, ethical conduct, and practical application of knowledge.

In the economic sphere, IKS includes knowledge related to:

- Trade and commerce
- Financial administration
- Taxation systems
- Agricultural management
- Resource allocation

Texts such as the Vedas, *Arthashastra*, *Nitisara*, and various Dharmashastras contain references to economic policies, financial management, and accounting procedures. These texts provide insights into the economic structure of ancient India and demonstrate that financial accountability was considered essential for governance and business.

IKS integrates knowledge with ethical values, ensuring that financial practices contribute to social welfare and economic stability.

3. EVOLUTION OF ACCOUNTING IN ANCIENT INDIA

Accounting practices in India have evolved over several centuries. Historical evidence indicates that financial record-keeping existed as early as the Indus Valley Civilization.

3.1 Accounting in the Indus Valley Civilization

Archaeological findings such as seals, tablets, and symbols suggest that the Indus Valley Civilization used records for trade and administrative purposes. These records were likely used to track goods, labor, and exchange transactions in a barter-based economy.

3.2 Vedic Period Accounting Practices

During the Vedic period, economic activities included agriculture, cattle rearing, and trade. Terms related to commerce such as “Kraya” (sale), “Vanij” (merchant), and “Sulka” (price or tax) appear in Vedic literature, indicating the presence of organized economic activities.

Accounting during this period focused on:

- Recording agricultural production
- Managing cattle wealth
- Tracking trade transactions
- Recording taxes collected by the state

4. ACCOUNTING PRINCIPLES IN KAUTILYA’S ARTHASHASTRA

Kautilya’s Arthashastra is one of the most important sources of information about ancient Indian accounting and financial administration. Written around 300 BCE, it provides detailed guidelines for maintaining accounts and managing state finances.

The Arthashastra emphasizes the following accounting principles:

4.1 Bookkeeping and Financial Records

Government officials were required to maintain detailed records of revenue, expenditure, and inventory. These records were used to monitor the financial position of the state.

4.2 Auditing and Verification

The text describes systematic auditing procedures to verify financial records and detect fraud. Periodic inspections and verification of accounts were conducted to ensure transparency.

4.3 Budgeting and Financial Planning

The Arthashastra also outlines methods for preparing budgets and allocating financial resources for public welfare.

4.4 Fraud Detection

Kautilya described numerous ways in which accountants might manipulate accounts and proposed strict penalties for financial misconduct.

These practices indicate that ancient India had an advanced system of financial administration comparable to modern accounting principles.

5. TRADITIONAL ACCOUNTING SYSTEMS IN INDIA

Apart from state administration, merchants and traders developed their own accounting systems.

One important traditional system is **Vahi Paddhati**, also known as **Desi Namu**, used by traders in India for maintaining financial records. This method involved recording transactions in handwritten ledgers and maintaining debit and credit entries similar to modern bookkeeping systems.

Features of traditional Indian accounting systems included:

- Manual ledger records
- Debit and credit entries
- Classification of income and expenses
- Periodic balancing of accounts

These systems were widely used by merchant communities such as Marwaris, Gujaratis, and Chettiars.

6. ACCOUNTING IN TEMPLE AND GUILD ECONOMIES

Temples and trade guilds played an important role in the economic life of ancient India.

Temple Accounting

Temples received donations, land grants, and offerings from devotees. These resources were carefully recorded and used for:

- Religious activities
- Social welfare
- Education and community services

Temple administrators maintained records of donations and expenditures to ensure financial transparency.

Guild Accounting

Trade guilds managed commercial activities and financial transactions among traders. They maintained records of loans, deposits, and trade agreements, ensuring accountability within the guild system.

7. RELEVANCE OF IKS ACCOUNTING PRINCIPLES IN MODERN TIMES

Many principles found in the Indian Knowledge System remain relevant for modern accounting and financial management.

7.1 Ethical Accounting

IKS emphasizes honesty, integrity, and responsibility in financial reporting.

7.2 Accountability and Transparency

Ancient systems required strict auditing and monitoring to prevent corruption.

7.3 Financial Governance

IKS demonstrates how financial management can support economic stability and social welfare.

7.4 Sustainable Economic Practices

Traditional systems focused on balanced resource management and long-term economic stability. These principles align with modern concepts such as corporate governance, auditing standards, and ethical financial practices.

8. CASE STUDY: ACCOUNTING PRACTICES IN MERCHANT COMMUNITIES

Merchant communities in India historically used indigenous accounting systems to manage trade operations. For example, the **Marwari and Gujarati trading communities** maintained detailed records of transactions using traditional ledger books called “**Bahi-Khata.**”

Features of this system included:

- Daily recording of transactions
- Separate accounts for debtors and creditors
- Periodic balancing during festivals such as Diwali
- Use of indigenous numerical symbols and scripts

Even today, many traditional businesses in India continue to follow these practices alongside modern computerized accounting systems.

9. CONCLUSION

The study of accounting within the Indian Knowledge System reveals that financial management and record-keeping were well developed in ancient India. Texts such as the *Arthashastra*, traditional merchant practices, and temple accounting systems demonstrate that sophisticated accounting principles existed long before modern accounting frameworks emerged.

These ancient practices emphasized ethical conduct, transparency, and accountability in financial administration. Many of these principles remain relevant in contemporary accounting systems, particularly in areas such as corporate governance and financial ethics.

Understanding the historical roots of accounting in India contributes to a broader appreciation of indigenous knowledge systems and highlights their potential relevance in modern economic and business practices.

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**A STUDY ON MARKETING CHALLENGES FACED BY ORGANIC FARMERS AND THEIR
IMPACT ON PRICE REALIZATION IN PUNE REGION**

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ABSTRACT

Agriculture plays an important role in the Indian economy and provides a livelihood for many people. Recently, organic farming has gained more attention due to growing awareness about health, environmental sustainability, and food safety. Organic farming encourages the use of natural inputs, ecological balance, and soil conservation. However, farmers face several challenges in selling organic produce, which often affects their ability to get better prices in the market. This study looks at the relationship between the marketing challenges faced by organic farmers and the prices they receive for organic produce in the Pune region.

We collected primary data using a structured questionnaire given to farmers who practice or are familiar with organic farming. The survey included questions about demographic information, farming experience, knowledge of organic farming, marketing practices, price realization, and government support schemes. The study uses the Chi-Square test to check if marketing problems significantly influence the prices received by farmers.

The statistical analysis shows a Chi-Square value of 2.12, with 3 degrees of freedom, and a p-value of 0.548. Since the p-value is greater than the significance level of 0.05, we accept the null hypothesis. This means there is no statistically significant relationship between marketing challenges and the prices received for organic produce in this sample. However, qualitative responses indicate that farmers still experience several marketing problems, such as a lack of consumer awareness, no dedicated organic markets, and competition with conventional produce.

The study emphasizes the need for stronger marketing support systems, better consumer education, and effective government actions to strengthen the organic farming sector.

Keywords: Organic Farming, Marketing Challenges, Price Realization, Farmers, Pune Region, Chi-Square Test

1. INTRODUCTION

Agriculture has always been a key part of the Indian economy. A large part of the population relies on agriculture for their livelihoods. For centuries, Indian farmers used natural farming techniques like composting, crop rotation, animal manure, and traditional seeds. These methods were sustainable and good for the environment.

However, as the population grew and demand for food increased, farming began to shift toward intensive practices. Farmers started using chemical fertilizers, pesticides, and high-yield varieties to boost productivity. While these changes did increase crop output, they also led to environmental and health problems. The ongoing use of chemicals resulted in soil degradation, loss of biodiversity, water pollution, and health concerns for consumers.

As awareness of these issues grew, interest in organic farming began to rise worldwide. Organic farming focuses on using natural inputs, controlling pests biologically, and practicing sustainable agriculture. It seeks to keep soil healthy, protect the environment, and offer chemical-free food to consumers.

In India, the demand for organic food has surged due to rising health awareness among consumers. Many people choose organic fruits and vegetables because they are seen as healthier and better for the environment. Consequently, organic farming has become an appealing option for many farmers.

Despite the growing demand, organic farmers face many challenges, especially in marketing their products. Unlike conventional agricultural goods, organic products need proper certification, consumer awareness, and specialized markets. Many farmers find it hard to sell their organic produce at higher prices because of inadequate marketing infrastructure.

A common problem is the lack of separate markets for organic products. In many local markets, organic produce is sold next to conventional items, making it difficult for consumers to tell them apart. This often leads to farmers receiving prices similar to those for conventional products.

Another issue is low consumer trust and awareness. Many consumers do not fully understand the benefits of organic food or question whether the products are genuinely organic. Without proper certification or branding, farmers struggle to persuade buyers.

Transportation, packaging, and storage issues also hinder the marketing of organic products. Since organic produce typically has a shorter shelf life, farmers must sell it quickly to prevent losses.

Given these challenges, it's crucial to explore how marketing issues affect farmers' ability to secure better prices for organic produce. This study focuses on farmers in the Pune region, where organic farming is slowly becoming more popular.

2. REVIEW OF LITERATURE

Several studies have looked at the growth and challenges of organic farming in India. According to Willer and Lernoud (2019), organic farming has grown quickly around the world because more people want sustainable food systems. However, farmers often struggle with marketing, certification, and distribution.

Kumar and Sharma (2018) examined how farmers in India adopt organic practices. They found that a lack of awareness and marketing facilities are major barriers. The study pointed out that farmers need better support from institutions to reach profitable markets.

Singh (2020) investigated the marketing channels for organic products in India. He found that direct marketing methods, like farmers' markets and community-supported agriculture, can help farmers get better prices.

Another study by Patil and Deshmukh (2017) looked at organic farmers in Maharashtra. They identified key challenges, including a lack of certification, limited market access, and price competition with conventional produce.

Similarly, Reddy (2019) stressed that educating consumers is essential for promoting organic products. Without proper awareness, consumers may not be willing to pay higher prices for organic food.

These studies suggest that marketing challenges significantly impact the profitability of organic farming. However, empirical evidence from specific regions is still limited. Therefore, this study aims to explore the relationship between marketing challenges and price realization among organic farmers in the Pune region.

3. OBJECTIVES OF THE STUDY

The main objective of the study is:

To examine the relationship between marketing challenges faced by farmers and their ability to receive better prices for organic produce in the Pune region.

The study also aims to:

1. Understand the marketing problems faced by organic farmers.
2. Analyze whether farmers receive better prices for organic produce.
3. Examine how marketing challenges influence price realization.

4. HYPOTHESIS OF THE STUDY

Based on the objective of the study, the following hypotheses were formulated.

Null Hypothesis (H0):

There is no significant relationship between marketing challenges and the price received by farmers for organic produce.

Alternative Hypothesis (H1):

There is a significant relationship between marketing challenges and the price received by farmers for organic produce.

5. RESEARCH METHODOLOGY

5.1 Research Design

The study follows a **descriptive research design**. It aims to understand the marketing challenges faced by organic farmers and analyze their impact on price realization.

5.2 Data Collection

The study uses **primary data** collected through a structured questionnaire distributed among farmers in the Pune region.

The questionnaire included questions related to:

- Farmer demographics
- Farming experience
- Awareness of organic farming
- Marketing problems faced
- Price received for organic produce
- Awareness of government schemes

5.3 Sampling Method

A **convenience sampling method** was used to collect responses from farmers who were accessible during the study.

5.4 Sample Size

The responses were collected from farmers through Google Forms and recorded in an Excel sheet.

5.5 Variables Used in the Study

Variable Type	Variable
Independent Variable	Marketing Challenges Faced by Farmers
Dependent Variable	Price Received for Organic Produce
Control Variable	Farming Experience
Control Variable	Size of Land Holding
Control Variable	Awareness of Government Schemes

6. DATA ANALYSIS AND STATISTICAL TOOLS

To test the hypothesis, the **Chi-Square Test of Independence** was used.

The Chi-Square test helps determine whether there is a significant association between two categorical variables.

In this study, the Chi-Square test was applied between:

- **Marketing Problems (Q11)**
- **Better Price Received (Q12)**

Decision Rule

- If **p-value** < **0.05**, reject the null hypothesis.
- If **p-value** > **0.05**, accept the null hypothesis.

7. RESULTS OF CHI-SQUARE TEST

The results obtained from the Chi-Square test are as follows:

Test Statistic	Value
Chi-Square Value (χ^2)	2.12
Degrees of Freedom	3
p-value	0.548

8. INTERPRETATION OF RESULTS

The Chi-Square test produced a **p-value of 0.548**.

The significance level used in this study is **0.05**.

Since:

p-value (0.548) > 0.05

the **null hypothesis (H0) is accepted**.

This means that **there is no statistically significant relationship between marketing challenges faced by farmers and the price they receive for organic produce in this study sample.**

Although marketing challenges exist, the statistical analysis suggests that these challenges do not significantly influence price realization within the surveyed data.

However, this result may also be influenced by factors such as small sample size, variations in marketing channels, and differences in consumer demand.

9. FINDINGS OF THE STUDY

Based on the survey responses and data analysis, the following findings were observed:

1. Many farmers are aware of organic farming, but only a smaller portion practices it fully.
2. Farmers face several marketing problems, including lack of consumer awareness and absence of separate markets.
3. Some farmers reported that consumers do not fully trust organic products.
4. Price competition with conventional produce is a common challenge.
5. Many farmers rely on traditional selling methods such as local markets.
6. Awareness about government schemes supporting organic farming is limited among farmers.
7. The Chi-Square test indicates that marketing challenges do not show a statistically significant relationship with price realization in this sample.

10. SUGGESTIONS

Based on the findings of the study, the following suggestions can help improve the marketing of organic produce:

1. Consumer Awareness Programs

Government and NGOs should conduct campaigns to educate consumers about the benefits of organic food.

2. Separate Organic Markets

Dedicated organic markets can help farmers sell products at premium prices.

3. Certification Support

Farmers should receive assistance in obtaining organic certification to build consumer trust.

4. Marketing Training for Farmers

Training programs can help farmers learn branding, packaging, and direct marketing techniques.

5. Government Support Schemes

Farmers should be provided better access to government schemes promoting organic farming.

6. Digital Marketing Platforms

Online platforms can help farmers connect directly with consumers.

11. CONCLUSION

Organic farming has emerged as an important alternative to conventional agriculture due to its environmental and health benefits. With increasing consumer awareness about food safety and sustainability, the demand for organic products is gradually rising.

However, organic farmers face several challenges in marketing their produce. Lack of consumer awareness, absence of dedicated markets, and competition with conventional products make it difficult for farmers to obtain premium prices.

The present study examined the relationship between marketing challenges and price realization among organic farmers in the Pune region using the Chi-Square test.

The results indicate that there is **no statistically significant relationship between marketing challenges and the price received by farmers** in the dataset used for this study. Nevertheless, qualitative responses from farmers suggest that marketing difficulties remain a major concern.

Improving marketing infrastructure, increasing consumer awareness, and providing institutional support can help strengthen the organic farming sector.

Future studies can include larger samples and additional variables to better understand the economic impact of marketing challenges on organic farmers.

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A STUDY ON THE RELATIONSHIP BETWEEN ISSUE PRICE AND LISTING PRICE OF SMALL & MEDIUM ENTERPRISE (SME) IPOs IN INDIA (2025)

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ABSTRACT

This study examines the relationship between issue price and listing price of SME IPOs listed in India during 2025 on platforms such as NSE Emerge and BSE SME. The research investigates underpricing trends, listing gains, volatility, and investor wealth creation. Using secondary data and statistical tools including mean, standard deviation, correlation, and regression analysis, the study evaluates pricing efficiency in the SME IPO segment. The findings indicate the presence of systematic underpricing and high listing volatility, reflecting investor sentiment and demand-driven pricing inefficiencies.

Keywords: SME IPO, Underpricing, Listing Gain, Market Efficiency, Investor Sentiment.

INTRODUCTION

SMEs are critical contributors to India's GDP and employment generation. To support capital formation for small businesses, Securities and Exchange Board of India introduced SME listing platforms with relaxed compliance norms.

SME IPOs differ from Mainboard IPOs in:

Lower issue size

Higher retail dominance

Lower liquidity

Higher price volatility

Greater listing day fluctuations

Understanding the gap between issue price and listing price helps in evaluating:

Pricing efficiency

Investor optimism

Market depth

Wealth creation on listing day

Issue Price refers to the price at which a company offers its shares to the public during an Initial Public Offering (IPO). This price is determined by the company, underwriters, and other stakeholders based on various factors such as the company's financial health, market conditions, demand for the shares, and investor sentiment. The issue price is set before the IPO is launched and represents the amount investors are required to pay for the shares at the time of the offering. It is crucial in determining the initial value of the company's stock and raising capital for its growth and operations.

Listing Price is the price at which a company's shares are traded on the stock exchange when they begin trading after the IPO. This price is determined by the market as it reflects the initial buying and selling activity once the shares are available for public trading. The listing price may differ from the issue price depending on how the market reacts to the IPO, the supply and demand for the shares, and broader economic factors. If the listing price is higher than the issue price, it indicates a positive reception by the market, while a lower listing price suggests a less favorable response.

Type of IPO

SME IPO (Small and Medium Enterprises IPO) refers to the Initial Public Offering issued by small and medium-sized companies looking to raise capital through the stock market. These companies are typically in the growth or development stage and may have limited financial history or market presence compared to larger corporations. SME IPOs provide an opportunity for smaller businesses to access funding for expansion, working capital, or debt reduction, while offering retail investors the chance to invest in potentially high-growth enterprises at an early stage. The regulatory framework for SME IPOs is often more relaxed compared to larger companies, but these offerings typically involve higher risks due to the smaller size and volatility of the businesses involved.

Non-SME IPO (Non-Small and Medium Enterprises IPO) refers to the Initial Public Offering issued by large, established companies that have a more significant market presence, established track records, and larger capital needs. These companies are usually well-known in their respective industries and have a proven financial history, making their IPOs attractive to institutional investors and a broader range of retail investors. Non-SME IPOs are subject to stricter regulatory scrutiny and more extensive disclosures, reflecting the size and complexity of the business. These IPOs are often seen as safer investments compared to SME IPOs due to the larger, more stable nature of the companies involved, although they still carry inherent risks associated with market conditions and industry performance.

LITERATURE REVIEW

Ritter, J. R. (1991), In the research titled "The Long-Run Performance of Initial Public Offerings." IPOs often see an initial rise in the listing price due to market enthusiasm and underpricing. However, many IPOs underperform over time, indicating pricing inefficiencies at the initial stage. The difference between issue and listing prices reflects investor sentiment.

Loughran, T., & Ritter, J. R. (2004), In the research titled "Why Has IPO Underpricing Changed Over Time?" IPO underpricing has evolved, reflecting changes in market conditions and investor behavior. The relationship between issue and listing prices is shaped by competitive underwriter strategies. Fluctuations in the market directly impact the pricing strategy.

Pagano, M., Panetta, F., & Zingales, L. (1998), In the research titled "Why Do Companies Go Public?" Companies go public to raise capital, increase visibility, and offer liquidity to stakeholders. The issue price is usually conservative to ensure market acceptance. The listing price frequently exceeds the issue price in successful IPOs due to investor demand.

Chen, H., & Ritter, J. R. (2000), In the research titled "The Determinants of Initial Public Offering Underpricing." IPO underpricing is intentional to create initial demand, often leading to a higher listing price. The issue price is deliberately set low to ensure success in the offering. This underpricing strategy can result in short-term gains but may contribute to long-term underperformance.

Brau, J. C., & Fawcett, S. E. (2006), In the research titled "Initial Public Offerings: An Analysis of Theory and Practice." The issue price is influenced by company fundamentals and market conditions during the IPO. The listing price reflects the market's perception once trading begins, often differing from the issue price. Factors such as external market sentiment and investor behavior influence this difference. Regulatory and financial variables also play a crucial role in the pricing process.

Lee, P. M., & Wahal, S. (2004), In the research titled "Grandstanding, Certification, and the Underpricing of Venture Capital-backed IPOs." Venture capital-backed IPOs often experience grandstanding, where the issue price is set low to ensure demand. This leads to a higher listing price as the market responds positively to the perceived potential. Underpricing strategies help generate interest and a successful launch.

OBJECTIVES OF THE STUDY

To analyze listing gain percentage of SME IPOs in 2025.

To examine the correlation between issue price and listing price.

To measure volatility of SME IPO returns.

To evaluate investor wealth creation.

To compare sector-wise SME IPO performance.

RESEARCH METHODOLOGY

The research methodology for the study of the comparison between the issue price and listing price in Initial Public Offerings (IPOs) in 2025 will primarily involve secondary data analysis. Data will be collected from reliable financial databases, company reports, stock exchange listings, and other publicly available sources. The study will focus on analyzing the issue price and listing price, examining the percentage difference between the two, and assessing factors influencing this variation such as market conditions, investor sentiment, and industry type.

DATA ANALYSIS**Sector wise SME Returns**

Sector	Approx Avg. Return (%) (SME IPOs)
Financial Services	~46.7%
Information Technology	~22.1%
Capital Goods	~21.0%
Utilities	~15.4%
Consumer Durables	~12.8%
FMCG	~12.1%
Construction	~11.4%
Healthcare	~10.5%
Media & Entertainment	~9.9%
Chemicals	~6.6%
Services	~6.2%
Textiles	~4.0%
Consumer Services	~0.9%
Telecom	~0.6%
Realty	~-1.6%
Metals & Mining	~-10.4%
Oil & Gas	~-16.5%

Top 10 SME Companies on the basis of Returns

Company Name	Industry	Issue Price (₹)	Peak Price 2025 (₹)	Total Return (%)
Anondita Medicare	Healthcare	145	1,016	+601%
Tankup Engineers	Defense/Engg	140	707	+405%
Sacheerome	FMCG/Flavors	102	381	+274%
Fabtech Tech	Infrastructure	85	308	+262%
Cryogenic OGS	Industrial Gas	47	163	+247%
Zelio E-Mobility	EV/Auto	160	550	+244%
Kabra Jewels	Consumer Goods	128	415	+224%
Rikhav Securities	Fin. Services	86	275	+220%
Avax Apparels	Textiles	70	210	+200%
Indobell Insulation	Manufacturing	46	134	+191%

Company Name	Listed On	Issue Price	Listing Day Close	Listing Day Gain	Current Price	Profit/Loss
Apollo Techno Industries Ltd.	Wed, Dec 31, 2025	₹130	₹151.95	16.88%	₹104.8	-19.38%
Bai Kakaji Polymers Ltd.	Wed, Dec 31, 2025	₹186	₹188.2	1.18%	₹181.1	-2.63%
Admach Systems Ltd.	Wed, Dec 31, 2025	₹239	₹200.75	-16%	₹201.5	-15.69%
Nanta Tech Ltd.	Wed, Dec 31, 2025	₹220	₹245.7	11.68%	₹263.45	19.75%
Dhara Rail Projects Ltd.	Wed, Dec 31, 2025	₹126	₹157.5	25%	₹117.5	-6.75%
Sundrex Oil Co.Ltd.	Tue, Dec 30, 2025	₹86	₹65.4	-23.95%	₹27.85	-67.62%
Shyam Dhani Industries Ltd.	Tue, Dec 30, 2025	₹70	₹139.65	99.5%	₹72.45	3.5%
Dachepalli Publishers Ltd.	Tue, Dec 30, 2025	₹102	₹79.15	-22.4%	₹64.98	-36.29%
EPW India Ltd.	Tue, Dec 30, 2025	₹97	₹116.55	20.15%	₹129.95	33.97%

MARC Technocrats Ltd.	Wed, Dec 24, 2025	₹93	₹70.7	-23.98%	₹60.85	-34.57%
Global Ocean Logistics India Ltd.	Wed, Dec 24, 2025	₹78	₹79.29	1.65%	₹124.7	59.87%
Neptune Logitek Ltd.	Mon, Dec 22, 2025	₹126	₹95.8	-23.97%	₹42.32	-66.41%
Ashwini Container Movers Ltd.	Fri, Dec 19, 2025	₹142	₹140.1	-1.34%	₹145	2.11%
Exim Routes Ltd.	Fri, Dec 19, 2025	₹88	₹115.5	31.25%	₹157.05	78.47%
Stanbik Agro Ltd.	Fri, Dec 19, 2025	₹30	₹33.33	11.1%	₹33.88	12.93%
HRS Aluglaze Ltd.	Thu, Dec 18, 2025	₹96	₹132.3	37.81%	₹248	158.33%
Pajson Agro India Ltd.	Thu, Dec 18, 2025	₹118	₹130.2	10.34%	₹210.9	78.73%
Shipwaves Online Ltd.	Wed, Dec 17, 2025	₹12	₹11.4	-5%	₹4.11	-65.75%
Unisem Agritech Ltd.	Wed, Dec 17, 2025	₹65	₹61.75	-5%	₹62	-4.62%
Riddhi Display Equipments Ltd.	Mon, Dec 15, 2025	₹100	₹76	-24%	₹38	-62%
Prodocs Solutions Ltd.	Mon, Dec 15, 2025	₹138	₹151.2	9.57%	₹202	46.38%
K.V.Toys India Ltd.	Mon, Dec 15, 2025	₹239	₹336	40.59%	₹261	9.21%
Flywings Simulator Training Centre Ltd.	Fri, Dec 12, 2025	₹191	₹204.75	7.2%	₹182.3	-4.55%
Encompass Design India Ltd.	Fri, Dec 12, 2025	₹107	₹193.15	80.51%	₹265.1	147.76%
Methodhub Software Ltd.	Fri, Dec 12, 2025	₹194	₹162.9	-16.03%	₹115.6	-40.41%
Western Overseas Study Abroad Ltd.	Thu, Dec 11, 2025	₹56	₹52.16	-6.86%	₹20.4	-63.57%
Luxury Time Ltd.	Thu, Dec 11, 2025	₹82	₹163.59	99.5%	₹60.45	-26.28%
Shri Kanha Stainless Ltd.	Wed, Dec 10, 2025	₹90	₹83.6	-7.11%	₹23.9	-73.44%
Neochem Bio Solutions Ltd.	Tue, Dec 9, 2025	₹98	₹111.8	14.08%	₹77.5	-20.92%
Helloji Holidays Ltd.	Tue, Dec 9, 2025	₹118	₹123.9	5%	₹132	11.86%
Ravelcare Ltd.	Mon, Dec 8, 2025	₹130	₹190.95	46.88%	₹165	26.92%
Clear Secured Services Ltd.	Mon, Dec 8, 2025	₹132	₹113.05	-14.36%	₹126.5	-4.17%
Speb Adhesives Ltd.	Mon, Dec 8, 2025	₹56	₹57	1.79%	₹52	-7.14%
Invicta Diagnostic Ltd.	Mon, Dec 8, 2025	₹85	₹96.7	13.76%	₹62	-27.06%
Astron Multigrain Ltd.	Mon, Dec 8, 2025	₹63	₹47.88	-24%	₹19.31	-69.35%
Purple Wave Infocom Ltd.	Fri, Dec 5, 2025	₹126	₹130.5	3.57%	₹120.9	-4.05%
Logiciel Solutions Ltd.	Fri, Dec 5, 2025	₹193	₹146.7	-23.99%	₹38.21	-80.2%
Exato Technologies Ltd.	Fri, Dec 5, 2025	₹140	₹279.3	99.5%	₹306.05	118.61%
K K Silk Mills Ltd.	Wed, Dec 3, 2025	₹38	₹30.4	-20%	₹11.57	-69.55%
Mother Nutri Foods Ltd.	Wed, Dec 3, 2025	₹117	₹124.3	6.24%	₹145.05	23.97%

SSMD Agrotech India Ltd.	Tue, Dec 2, 2025	₹121	₹76.65	-36.65%	₹36.5	-69.83%
Gallard Steel Ltd.	Wed, Nov 26, 2025	₹150	₹234.25	56.17%	₹155	3.33%
Mahamaya Lifesciences Ltd.	Tue, Nov 18, 2025	₹114	₹116	1.75%	₹163.5	43.42%
Workmates Core2Cloud Solution Ltd.	Tue, Nov 18, 2025	₹204	₹368.25	80.51%	₹343	68.14%
Shining Tools Ltd.	Fri, Nov 14, 2025	₹114	₹98.8	-13.33%	₹53.55	-53.03%
Curis Lifesciences Ltd.	Fri, Nov 14, 2025	₹128	₹141	10.16%	₹99.95	-21.91%
Finbud Financial Services Ltd.	Thu, Nov 13, 2025	₹142	₹164.85	16.09%	₹100.25	-29.4%
Shreeji Global FMCG Ltd.	Wed, Nov 12, 2025	₹125	₹101.7	-18.64%	₹112.05	-10.36%
Safecure Services Ltd.	Thu, Nov 6, 2025	₹102	₹77.55	-23.97%	₹34.2	-66.47%
Game Changers Texfab Ltd.	Tue, Nov 4, 2025	₹102	₹109.35	7.21%	₹113.9	11.67%
Jayesh Logistics Ltd.	Mon, Nov 3, 2025	₹122	₹117.8	-3.44%	₹142	16.39%
Shlokka Dyes Ltd.	Fri, Oct 17, 2025	₹91	₹85.5	-6.04%	₹23.87	-73.77%
SK Minerals & Additives Ltd.	Fri, Oct 17, 2025	₹127	₹152.25	19.88%	₹120	-5.51%
Sihora Industries Ltd.	Fri, Oct 17, 2025	₹66	₹66.5	0.76%	₹59.99	-9.11%
Mittal Sections Ltd.	Tue, Oct 14, 2025	₹143	₹108.7	-23.99%	₹29.06	-79.68%
NSB BPO Solutions Ltd.	Fri, Oct 10, 2025	₹121	₹121.3	0.25%	₹75.6	-37.52%
DSM Fresh Foods Ltd.	Thu, Oct 9, 2025	₹100	₹126	26%	₹111.3	11.3%
Greenleaf Envirotech Ltd.	Thu, Oct 9, 2025	₹136	₹132.9	-2.28%	₹113.35	-16.65%
Valplast Technologies Ltd.	Wed, Oct 8, 2025	₹54	₹58.63	8.57%	₹50	-7.41%
B.A.G.Convergence Ltd.	Wed, Oct 8, 2025	₹87	₹106.05	21.9%	₹109	25.29%
Chiraharit Ltd.	Wed, Oct 8, 2025	₹21	₹15.96	-24%	₹7.44	-64.57%
Zelio E-Mobility Ltd.	Wed, Oct 8, 2025	₹136	₹162.6	19.56%	₹349.3	156.84%
Sheel Biotech Ltd.	Wed, Oct 8, 2025	₹63	₹95.55	51.67%	₹55.05	-12.62%
Infinity Infoway Ltd.	Wed, Oct 8, 2025	₹155	₹309.2	99.48%	₹381.5	146.13%
Munish Forge Ltd.	Wed, Oct 8, 2025	₹96	₹110.25	14.84%	₹71.5	-25.52%
Sunsy Logistics Ltd.	Wed, Oct 8, 2025	₹46	₹53.55	16.41%	₹71.83	56.15%
Sodhani Capital Ltd.	Tue, Oct 7, 2025	₹51	₹84	64.71%	₹67	31.37%
Vijaypd Ceutical Ltd.	Tue, Oct 7, 2025	₹35	₹35.9	2.57%	₹60.6	73.14%
Om Metallogic Ltd.	Tue, Oct 7, 2025	₹86	₹85	-1.16%	₹16.07	-81.31%
Suba Hotels Ltd.	Tue, Oct 7, 2025	₹111	₹161.9	45.86%	₹122	9.91%
Dhillon Freight Carrier Ltd.	Tue, Oct 7, 2025	₹72	₹54.72	-24%	₹31.5	-56.25%

KVS Castings Ltd.	Mon, Oct 6, 2025	₹56	₹69.61	24.3%	₹55.42	-1.04%
Rukmani Devi Garg Agro Impex Ltd.	Mon, Oct 6, 2025	₹99	₹77.13	-22.09%	₹101	2.02%
M P K Steels (I) Ltd.	Mon, Oct 6, 2025	₹79	₹83.5	5.7%	₹128	62.03%
Ameenji Rubber Ltd.	Mon, Oct 6, 2025	₹100	₹106.05	6.05%	₹115.3	15.3%
Manas Polymers & Energies Ltd.	Mon, Oct 6, 2025	₹81	₹146.2	80.49%	₹53.2	-34.32%
Bhavik Enterprises Ltd.	Mon, Oct 6, 2025	₹140	₹145.3	3.79%	₹137.5	-1.79%
Chatterbox Technologies Ltd.	Fri, Oct 3, 2025	₹115	₹129	12.17%	₹58.82	-48.85%
Gujarat Peanut & Agri Products Ltd.	Fri, Oct 3, 2025	₹80	₹67.2	-16%	₹87	8.75%
Earkart Ltd.	Fri, Oct 3, 2025	₹135	₹142.25	5.37%	₹148.7	10.15%
Telge Projects Ltd.	Fri, Oct 3, 2025	₹105	₹110.45	5.19%	₹93	-11.43%
Solvex Edibles Ltd.	Wed, Oct 1, 2025	₹72	₹61.37	-14.76%	₹27.3	-62.08%
Praruh Technologies Ltd.	Wed, Oct 1, 2025	₹63	₹62.84	-0.25%	₹56	-11.11%
Gurunanak Agriculture India Ltd.	Wed, Oct 1, 2025	₹75	₹54.15	-27.8%	₹31.4	-58.13%
Justo Realfintech Ltd.	Wed, Oct 1, 2025	₹127	₹130.5	2.76%	₹101.15	-20.35%
Systematic Industries Ltd.	Wed, Oct 1, 2025	₹195	₹205.1	5.18%	₹152.9	-21.59%
Ecoline Exim Ltd.	Tue, Sep 30, 2025	₹141	₹140.5	-0.35%	₹135.05	-4.22%
Matrix Geo Solutions Ltd.	Tue, Sep 30, 2025	₹104	₹99.15	-4.66%	₹80	-23.08%
True Colors Ltd.	Tue, Sep 30, 2025	₹191	₹183.05	-4.16%	₹155.9	-18.38%
Aptus Pharma Ltd.	Tue, Sep 30, 2025	₹70	₹84.84	21.2%	₹266.55	280.79%
BharatRohan Airborne Innovations Ltd.	Tue, Sep 30, 2025	₹85	₹91.99	8.22%	₹142	67.06%
Prime Cable Industries Ltd.	Mon, Sep 29, 2025	₹83	₹78.3	-5.66%	₹79.7	-3.98%
Siddhi Cotspin Ltd.	Fri, Sep 26, 2025	₹108	₹82.1	-23.98%	₹28	-74.07%
JD Cables Ltd.	Thu, Sep 25, 2025	₹152	₹157.9	3.88%	₹163.45	7.53%
Sampat Aluminium Ltd.	Wed, Sep 24, 2025	₹120	₹115.15	-4.04%	₹52.8	-56%
TechD Cybersecurity Ltd.	Mon, Sep 22, 2025	₹193	₹385	99.48%	₹417.3	116.22%
L.T.Elevator Ltd.	Fri, Sep 19, 2025	₹78	₹142.9	83.21%	₹183.75	135.58%
Airfloa Rail Technology Ltd.	Thu, Sep 18, 2025	₹140	₹279.3	99.5%	₹253.05	80.75%
Galaxy Medicare Ltd.	Wed, Sep 17, 2025	₹54	₹51.3	-5%	₹16.3	-69.81%
Jay Ambe Supermarkets Ltd.	Wed, Sep 17, 2025	₹78	₹82.95	6.35%	₹199.7	156.03%
Taurian MPS Ltd.	Tue, Sep 16, 2025	₹171	₹220.5	28.95%	₹216.9	26.84%
Nilachal Carbo Metalicks Ltd.	Tue, Sep 16, 2025	₹85	₹71.4	-16%	₹80	-5.88%

Karbonsteel Engineering Ltd.	Tue, Sep 16, 2025	₹159	₹194.35	22.23%	₹155	-2.52%
Krupalu Metals Ltd.	Tue, Sep 16, 2025	₹72	₹60.48	-16%	₹37.62	-47.75%
Vashishtha Luxury Fashion Ltd.	Mon, Sep 15, 2025	₹111	₹121.75	9.68%	₹66	-40.54%
Sharvaya Metals Ltd.	Fri, Sep 12, 2025	₹196	₹208.05	6.15%	₹139.9	-28.62%
Austere Systems Ltd.	Fri, Sep 12, 2025	₹55	₹79.32	44.22%	₹46.15	-16.09%
Vigor Plast India Ltd.	Fri, Sep 12, 2025	₹81	₹85.7	5.8%	₹50.2	-38.02%
Optivalue Tek Consulting Ltd.	Wed, Sep 10, 2025	₹84	₹102.6	22.14%	₹66.85	-20.42%
Goel Construction Co.Ltd.	Tue, Sep 9, 2025	₹263	₹317.6	20.76%	₹289	9.89%
Rachit Prints Ltd.	Mon, Sep 8, 2025	₹149	₹113.25	-23.99%	₹112	-24.83%
Sugs Lloyd Ltd.	Fri, Sep 5, 2025	₹123	₹125.85	2.32%	₹90.73	-26.24%
Snehaa Organics Ltd.	Fri, Sep 5, 2025	₹122	₹115.9	-5%	₹45	-63.11%
Abril Paper Tech Ltd.	Fri, Sep 5, 2025	₹61	₹49.38	-19.05%	₹37.14	-39.11%
Oval Projects Engineering Ltd.	Thu, Sep 4, 2025	₹85	₹85.05	0.06%	₹52.5	-38.24%
Current Infraprojects Ltd.	Wed, Sep 3, 2025	₹80	₹152.75	90.94%	₹124	55%
Sattva Engineering Construction Ltd.	Wed, Sep 3, 2025	₹75	₹99.85	33.13%	₹45.6	-39.2%
Globtier Infotech Ltd.	Tue, Sep 2, 2025	₹72	₹51.99	-27.79%	₹22.07	-69.35%
NIS Management Ltd.	Tue, Sep 2, 2025	₹111	₹97.5	-12.16%	₹62.2	-43.96%
Anondita Medicare Ltd.	Mon, Sep 1, 2025	₹145	₹289.25	99.48%	₹750	417.24%
Shivashrit Foods Ltd.	Mon, Sep 1, 2025	₹142	₹141.45	-0.39%	₹132.6	-6.62%
Classic Electrodes (India) Ltd.	Mon, Sep 1, 2025	₹87	₹95	9.2%	₹45.95	-47.18%
ARC Insulation & Insulators Ltd.	Fri, Aug 29, 2025	₹125	₹137.75	10.2%	₹47.1	-62.32%
LGT Business Connexions Ltd.	Tue, Aug 26, 2025	₹107	₹81.35	-23.97%	₹59.02	-44.84%
Studio LSD Ltd.	Mon, Aug 25, 2025	₹54	₹41.05	-23.98%	₹10.25	-81.02%
Mahendra Realtors & Infrastructure Ltd.	Wed, Aug 20, 2025	₹85	₹64.6	-24%	₹52.4	-38.35%
Icodex Publishing Solutions Ltd.	Tue, Aug 19, 2025	₹102	₹77.55	-23.97%	₹40.44	-60.35%
ANB Metal Cast Ltd.	Mon, Aug 18, 2025	₹156	₹172.2	10.38%	₹413.55	165.1%
Medistep Healthcare Ltd.	Mon, Aug 18, 2025	₹43	₹50.35	17.09%	₹22	-48.84%
Star Imaging & Path Lab Ltd.	Mon, Aug 18, 2025	₹142	₹135.95	-4.26%	₹65	-54.23%
Connplex Cinemas Ltd.	Thu, Aug 14, 2025	₹177	₹186.9	5.59%	₹227.85	28.73%
Sawaliya Foods Products Ltd.	Thu, Aug 14, 2025	₹120	₹239.4	99.5%	₹304.05	153.38%
Bhadora Industries Ltd.	Mon, Aug 11, 2025	₹103	₹105.95	2.86%	₹61.1	-40.68%

Parth Electricals & Engineering Ltd.	Mon, Aug 11, 2025	₹170	₹182.7	7.47%	₹245.3	44.29%
Jyoti Global Plast Ltd.	Mon, Aug 11, 2025	₹66	₹65.8	-0.3%	₹43.15	-34.62%
Aaradhya Disposal Industries Ltd.	Mon, Aug 11, 2025	₹116	₹116.55	0.47%	₹107.5	-7.33%
BLT Logistics Ltd.	Mon, Aug 11, 2025	₹75	₹95.49	27.32%	₹36.45	-51.4%
Essex Marine Ltd.	Mon, Aug 11, 2025	₹54	₹41.04	-24%	₹26.3	-51.3%
Flysbs Aviation Ltd.	Fri, Aug 8, 2025	₹225	₹448.85	99.49%	₹452.95	101.31%
Cash Ur Drive Marketing Ltd.	Thu, Aug 7, 2025	₹130	₹157.45	21.12%	₹96	-26.15%
Renol Polychem Ltd.	Thu, Aug 7, 2025	₹105	₹99.75	-5%	₹139.75	33.1%
B.D.Industries (Pune) Ltd.	Wed, Aug 6, 2025	₹108	₹108.15	0.14%	₹106	-1.85%
Mehul Colours Ltd.	Wed, Aug 6, 2025	₹72	₹86.03	19.49%	₹70.34	-2.31%
Takyon Networks Ltd.	Wed, Aug 6, 2025	₹54	₹55.72	3.19%	₹34.95	-35.28%
Kaytex Fabrics Ltd.	Tue, Aug 5, 2025	₹180	₹150.6	-16.33%	₹77	-57.22%
Repono Ltd.	Mon, Aug 4, 2025	₹96	₹87.09	-9.28%	₹60	-37.5%
Umiya Mobile Ltd.	Mon, Aug 4, 2025	₹66	₹68.78	4.21%	₹64.8	-1.82%
Sellowrap Industries Ltd.	Fri, Aug 1, 2025	₹83	₹94.5	13.86%	₹67.15	-19.1%
Patel Chem Specialities Ltd.	Fri, Aug 1, 2025	₹84	₹104.5	24.4%	₹65.7	-21.79%
Shree Refrigerations Ltd.	Thu, Jul 31, 2025	₹125	₹175.4	40.32%	₹174.7	39.76%
TSC India Ltd.	Wed, Jul 30, 2025	₹70	₹71.4	2%	₹37.25	-46.79%
Monarch Surveyors & Engineering Consultants Ltd.	Tue, Jul 29, 2025	₹250	₹400.2	60.08%	₹201	-19.6%
Swastika Castal Ltd.	Mon, Jul 28, 2025	₹65	₹66.82	2.8%	₹58	-10.77%
Savy Infra & Logistics Ltd.	Mon, Jul 28, 2025	₹120	₹143.3	19.42%	₹131.3	9.42%
Monika Alcobev Ltd.	Wed, Jul 23, 2025	₹286	₹288	0.7%	₹236.9	-17.17%
Spunweb Nonwoven Ltd.	Mon, Jul 21, 2025	₹96	₹158.55	65.16%	₹103.3	7.6%
Asston Pharmaceuticals Ltd.	Wed, Jul 16, 2025	₹123	₹124.95	1.59%	₹80	-34.96%
CFF Fluid Control Ltd.	Wed, Jul 16, 2025	₹585	₹653	11.62%	₹526.9	-9.93%
GLEN Industries Ltd.	Tue, Jul 15, 2025	₹97	₹152.37	57.08%	₹72.97	-24.77%
Smarten Power Systems Ltd.	Mon, Jul 14, 2025	₹100	₹151.2	51.2%	₹57.85	-42.15%
Chemkart India Ltd.	Mon, Jul 14, 2025	₹248	₹259.45	4.62%	₹99.7	-59.8%
Meta Infotech Ltd.	Fri, Jul 11, 2025	₹161	₹236.25	46.74%	₹93.4	-41.99%
Happy Outsourcing Square Services Ltd.	Thu, Jul 10, 2025	₹76	₹80.85	6.38%	₹35.8	-52.89%

Cryogenic OGS Ltd.	Thu, Jul 10, 2025	₹47	₹93.76	99.49%	₹161.6	243.83%
Vandan Foods Ltd.	Mon, Jul 7, 2025	₹115	₹118.75	3.26%	₹37.05	-67.78%
Marc Loire Fashions Ltd.	Mon, Jul 7, 2025	₹100	₹76	-24%	₹66.5	-33.5%
Cedaar Textile Ltd.	Mon, Jul 7, 2025	₹140	₹113.05	-19.25%	₹28.5	-79.64%
Pushpa Jewellers Ltd.	Mon, Jul 7, 2025	₹147	₹117.6	-20%	₹88.8	-39.59%
Silky Overseas Ltd.	Mon, Jul 7, 2025	₹161	₹162.45	0.9%	₹137	-14.91%
Neetu Yoshi Ltd.	Fri, Jul 4, 2025	₹75	₹110.25	47%	₹87.94	17.25%
Adcounty Media India Ltd.	Fri, Jul 4, 2025	₹85	₹136.5	60.59%	₹120.05	41.24%
Moving Media Entertainment Ltd.	Thu, Jul 3, 2025	₹70	₹74.55	6.5%	₹28	-60%
Valencia India Ltd.	Thu, Jul 3, 2025	₹110	₹83.6	-24%	₹16.93	-84.61%
Ace Alpha Tech Ltd.	Thu, Jul 3, 2025	₹69	₹85.05	23.26%	₹101	46.38%
PRO FX Tech Ltd.	Thu, Jul 3, 2025	₹87	₹99.75	14.66%	₹65	-25.29%
Rama Telecom Ltd.	Wed, Jul 2, 2025	₹68	₹68.4	0.59%	₹89	30.88%
Suntech Infra Solutions Ltd.	Wed, Jul 2, 2025	₹86	₹103.8	20.7%	₹38	-55.81%
Supertech EV Ltd.	Wed, Jul 2, 2025	₹92	₹69.92	-24%	₹51	-44.57%
Abram Food Ltd.	Tue, Jul 1, 2025	₹98	₹94.92	-3.14%	₹95	-3.06%
Icon Facilitators Ltd.	Tue, Jul 1, 2025	₹91	₹85.5	-6.04%	₹55.25	-39.29%
AJC Jewel Manufacturers Ltd.	Tue, Jul 1, 2025	₹95	₹95.39	0.41%	₹133	40%
Shri Hare-Krishna Sponge Iron Ltd.	Tue, Jul 1, 2025	₹59	₹64.55	9.41%	₹44	-25.42%
Aakaar Medical Technologies Ltd.	Fri, Jun 27, 2025	₹72	₹71.25	-1.04%	₹62.55	-13.13%
Safe Enterprises Retail Fixtures Ltd.	Fri, Jun 27, 2025	₹138	₹158.55	14.89%	₹232.15	68.22%
Mayasheel Ventures Ltd.	Fri, Jun 27, 2025	₹47	₹60.9	29.57%	₹43.4	-7.66%
Influx Healthtech Ltd.	Wed, Jun 25, 2025	₹96	₹126.2	31.46%	₹204.05	112.55%
Eppeltone Engineers Ltd.	Tue, Jun 24, 2025	₹128	₹255.35	99.49%	₹140.8	10%
Patil Automation Ltd.	Mon, Jun 23, 2025	₹120	₹162.75	35.62%	₹149.85	24.87%
Samay Project Services Ltd.	Mon, Jun 23, 2025	₹34	₹36	5.88%	₹46	35.29%
Aten Papers & Foam Ltd.	Fri, Jun 20, 2025	₹96	₹85.5	-10.94%	₹19.53	-79.66%
Monolithisch India Ltd.	Thu, Jun 19, 2025	₹143	₹243.1	70%	₹425.5	197.55%
Jainik Power Cables Ltd.	Tue, Jun 17, 2025	₹110	₹82.85	-24.68%	₹118.75	7.95%
Sacheerome Ltd.	Mon, Jun 16, 2025	₹102	₹160.55	57.4%	₹391.8	284.12%
Ganga Bath Fittings Ltd.	Wed, Jun 11, 2025	₹49	₹56.05	14.39%	₹17	-65.31%

3B Films Ltd.	Fri, Jun 6, 2025	₹50	₹46.08	-7.84%	₹20	-60%
N R Vandana Tex Industries Ltd.	Wed, Jun 4, 2025	₹45	₹43.7	-2.89%	₹59	31.11%
Neptune Petrochemicals Ltd.	Wed, Jun 4, 2025	₹122	₹139.35	14.22%	₹219	79.51%
Blue Water Logistics Ltd.	Tue, Jun 3, 2025	₹135	₹148.05	9.67%	₹147.2	9.04%
Astonea Labs Ltd.	Tue, Jun 3, 2025	₹135	₹135.65	0.48%	₹158.5	17.41%
Nikita Papers Ltd.	Tue, Jun 3, 2025	₹104	₹90.45	-13.03%	₹119	14.42%
Unified Data-Tech Solutions Ltd.	Thu, May 29, 2025	₹273	₹299.25	9.62%	₹340.35	24.67%
Dar Credit & Capital Ltd.	Wed, May 28, 2025	₹60	₹63.95	6.58%	₹43	-28.33%
Accretion Pharmaceuticals Ltd.	Wed, May 21, 2025	₹101	₹82.95	-17.87%	₹68.05	-32.62%
Integrity Infrabuild Developers Ltd.	Tue, May 20, 2025	₹100	₹103.5	3.5%	₹114.05	14.05%
Virtual Galaxy Infotech Ltd.	Mon, May 19, 2025	₹142	₹189	33.1%	₹131.05	-7.71%
Manoj Jewellers Ltd.	Mon, May 12, 2025	₹54	₹53.77	-0.43%	₹44.5	-17.59%
Srigeed DLM Ltd.	Mon, May 12, 2025	₹99	₹197.5	99.49%	₹78.48	-20.73%
Kenrik Industries Ltd.	Fri, May 9, 2025	₹25	₹26.26	5.04%	₹8.21	-67.16%
Arunaya Organics Ltd.	Wed, May 7, 2025	₹58	₹31.6	-45.52%	₹19	-67.24%
Iware Supplychain Services Ltd.	Tue, May 6, 2025	₹95	₹80.9	-14.84%	₹259.7	173.37%
Tankup Engineers Ltd.	Wed, Apr 30, 2025	₹140	₹183.75	31.25%	₹501.5	258.21%
Spinaroo Commercial Ltd.	Tue, Apr 8, 2025	₹51	₹54.44	6.75%	₹61.5	20.59%
Infonative Solutions Ltd.	Tue, Apr 8, 2025	₹79	₹60.04	-24%	₹25.65	-67.53%
Retaggio Industries Ltd.	Mon, Apr 7, 2025	₹25	₹25.2	0.8%	₹36.5	46%
Identixweb Ltd.	Thu, Apr 3, 2025	₹54	₹57.75	6.94%	₹68.5	26.85%
Shri Ahimsa Naturals Ltd.	Wed, Apr 2, 2025	₹119	₹147	23.53%	₹232.25	95.17%
ATC Energies System Ltd.	Wed, Apr 2, 2025	₹118	₹101.65	-13.86%	₹27.3	-76.86%
Desco Infratech Ltd.	Tue, Apr 1, 2025	₹150	₹168	12%	₹150.9	0.6%
Rapid Fleet Management Services Ltd.	Fri, Mar 28, 2025	₹192	₹200.9	4.64%	₹183	-4.69%
Active Infrastructures Ltd.	Fri, Mar 28, 2025	₹181	₹175.6	-2.98%	₹170	-6.08%
Grand Continent Hotels Ltd.	Thu, Mar 27, 2025	₹113	₹107.25	-5.09%	₹105.15	-6.95%
Paradeep Parivahan Ltd.	Mon, Mar 24, 2025	₹98	₹82.32	-16%	₹151.9	55%
Divine Hira Jewellers Ltd.	Mon, Mar 24, 2025	₹90	₹85.5	-5%	₹259.25	188.06%
Super Iron Foundry Ltd.	Wed, Mar 19, 2025	₹108	₹102.6	-5%	₹33.49	-68.99%
PDP Shipping &	Tue, Mar	₹135	₹102.85	-23.81%	₹61	-54.81%

Projects Ltd.	18, 2025					
NAPS Global India Ltd.	Tue, Mar 11, 2025	₹90	₹102.6	14%	₹43	-52.22%
Balaji Phosphates Ltd.	Fri, Mar 7, 2025	₹70	₹74.35	6.21%	₹130	85.71%
Shreenath Paper Products Ltd.	Wed, Mar 5, 2025	₹44	₹33.44	-24%	₹13.05	-70.34%
Nukleus Office Solutions Ltd.	Tue, Mar 4, 2025	₹234	₹196.55	-16%	₹196	-16.24%
Beezaasan Explotech Ltd.	Mon, Mar 3, 2025	₹175	₹153.3	-12.4%	₹222	26.86%
HP Telecom India Ltd.	Fri, Feb 28, 2025	₹108	₹115.05	6.53%	₹248	129.63%
Swasth Foodtech India Ltd.	Fri, Feb 28, 2025	₹94	₹89.3	-5%	₹18.6	-80.21%
Royal Arc Electrodes Ltd.	Mon, Feb 24, 2025	₹120	₹121.3	1.08%	₹150	25%
Tejas Cargo India Ltd.	Mon, Feb 24, 2025	₹168	₹168	0%	₹287.5	71.13%
L.K.Mehta Polymers Ltd.	Fri, Feb 21, 2025	₹71	₹68.29	-3.82%	₹43.99	-38.04%
Shanmuga Hospital Ltd.	Fri, Feb 21, 2025	₹54	₹51.3	-5%	₹41.47	-23.2%
P S Raj Steels Ltd.	Wed, Feb 19, 2025	₹140	₹150.6	7.57%	₹280	100%
Voler Car Ltd.	Wed, Feb 19, 2025	₹90	₹91.45	1.61%	₹203	125.56%
Maxvolt Energy Industries Ltd.	Wed, Feb 19, 2025	₹180	₹180.9	0.5%	₹291.25	61.81%
Chandan Healthcare Ltd.	Mon, Feb 17, 2025	₹159	₹173.35	9.03%	₹257	61.64%
Eleganz Interiors Ltd.	Fri, Feb 14, 2025	₹130	₹116.05	-10.73%	₹64.65	-50.27%
Readymix Construction Machinery Ltd.	Thu, Feb 13, 2025	₹123	₹116.85	-5%	₹91.95	-25.24%
Solarium Green Energy Ltd.	Thu, Feb 13, 2025	₹191	₹211.9	10.94%	₹147.25	-22.91%
Ken Enterprises Ltd.	Wed, Feb 12, 2025	₹94	₹80.75	-14.1%	₹39.5	-57.98%
Amwill Health Care Ltd.	Wed, Feb 12, 2025	₹111	₹93.25	-15.99%	₹33.45	-69.86%
Chamunda Electrical Ltd.	Tue, Feb 11, 2025	₹50	₹66.5	33%	₹49.4	-1.2%
Malpani Pipes & Fittings Ltd.	Tue, Feb 4, 2025	₹90	₹84.04	-6.62%	₹68.99	-23.34%
GB Logistics Commerce Ltd.	Fri, Jan 31, 2025	₹102	₹81.75	-19.85%	₹37	-63.73%
H.M.Electro Mech Ltd.	Fri, Jan 31, 2025	₹75	₹77.04	2.72%	₹45.53	-39.29%
CLN Energy Ltd.	Thu, Jan 30, 2025	₹250	₹254.15	1.66%	₹320.6	28.24%
Rexpro Enterprises Ltd.	Wed, Jan 29, 2025	₹145	₹111.15	-23.34%	₹47.2	-67.45%
CapitalNumbers Infotech Ltd.	Mon, Jan 27, 2025	₹263	₹261.35	-0.63%	₹83.15	-68.38%
EMA Partners India Ltd.	Fri, Jan 24, 2025	₹124	₹148.7	19.92%	₹82.25	-33.67%
Landmark Immigration Consultants Ltd.	Thu, Jan 23, 2025	₹72	₹75.07	4.26%	₹31.89	-55.71%
Kabra Jewels Ltd.	Wed, Jan 22, 2025	₹128	₹255.35	99.49%	₹87.25	-31.84%
Rikhav Securities Ltd.	Wed, Jan	₹86	₹171.55	99.48%	₹41.88	-51.3%

	22, 2025					
Barflex Polyfilms Ltd.	Mon, Jan 20, 2025	₹60	₹63	5%	₹59	-1.67%
Sat Kartar Shopping Ltd.	Fri, Jan 17, 2025	₹81	₹161.55	99.44%	₹165.2	103.95%
Avax Apparels & Ornaments Ltd.	Tue, Jan 14, 2025	₹70	₹139.65	99.5%	₹295.85	322.64%
Delta Autocorp Ltd.	Tue, Jan 14, 2025	₹130	₹167.25	28.65%	₹37.75	-70.96%
B.R.Goyal Infrastructure Ltd.	Tue, Jan 14, 2025	₹135	₹142.5	5.56%	₹94	-30.37%
Indobell Insulations Ltd.	Mon, Jan 13, 2025	₹46	₹91.77	99.5%	₹58.55	27.28%
Fabtech Technologies Cleanrooms Ltd.	Fri, Jan 10, 2025	₹85	₹169.57	99.49%	₹260	205.88%
Davin Sons Retail Ltd.	Thu, Jan 9, 2025	₹55	₹46.2	-16%	₹36	-34.55%
Parmeshwar Metal Ltd.	Thu, Jan 9, 2025	₹61	₹88.72	45.44%	₹118.8	94.75%
Leo Dryfruits & Spices Trading Ltd.	Wed, Jan 8, 2025	₹52	₹71.36	37.23%	₹55	5.77%
Technichem Organics Ltd.	Tue, Jan 7, 2025	₹55	₹63.11	14.75%	₹44.9	-18.36%
Citichem India Ltd.	Fri, Jan 3, 2025	₹70	₹68.28	-2.46%	₹17	-75.71%
Anya Polytech & Fertilizers Ltd.	Thu, Jan 2, 2025	₹14	₹17.95	28.21%	₹19.5	39.29%

FINDINGS

Key 2025 SME IPO Performance Highlights:

In 2025, the SME IPO market in India witnessed strong activity with 268 total issues, where ~63% (170 issues) delivered positive listing gains, while ~37% (98 issues) closed below their issue price. High-performing, multibagger stocks in 2025 included Avax Apparels and Ornaments, and Technocrats Plasma Systems, with some stocks experiencing significant, sustained post-listing gains.

2025 SME IPO Performance Highlights

Total Issues: 268 SME IPOs.

Positive Listing (0% to 100%+): ~170 issues (63.43%).

Negative Listing (-100% to 0%): ~98 issues (36.57%).

Multibaggers: Approximately 29 stocks delivered over 100% gains

Performance Split: Roughly 125 IPOs delivered gains, while 131 ended in the red on their listing day.

Top Performers: Anondita Medicare soared 527%, and Tungup Engineers gained 405%.

Listing Day Gainers: Luxury Time (99.5%), Current Infra Project (90%), and LNT Elevators (83%) were top performers.

Worst Performers: Valencia India fell 82%, followed by Studio LSD and Sydney CSpin.

Market Trends: A 28% YoY decline in new listings was noted by mid-2025, signaling a cooldown from the 2024 frenzy.

Regulatory Impact: Stricter SEBI norms and listing price caps limited the extreme, speculative gains seen in previous years.

Recommendations

Based on the findings of the study on SME IPO performance in 2025, the following recommendations are suggested:

1. For Investors

Investors should not rely solely on listing day hype or grey market premiums while investing in SME IPOs.

Detailed analysis of company fundamentals, financial statements, sector outlook, and management credibility is essential before investment.

Due to high volatility and liquidity constraints, SME IPOs are more suitable for risk-tolerant investors with short- to medium-term investment horizons.

Portfolio diversification should be maintained to reduce exposure to high-risk SME listings.

2. For Issuing Companies

Companies should adopt transparent disclosure practices to build investor confidence.

Conservative yet realistic pricing strategies may help ensure sustainable post-listing performance rather than short-term speculative spikes.

Strengthening corporate governance mechanisms can enhance long-term credibility in the capital market.

3. For Regulators

The regulatory framework implemented by Securities and Exchange Board of India has positively influenced market discipline; however, further improvements in liquidity mechanisms may reduce excessive volatility.

Encouraging greater institutional participation in SME IPOs may stabilize price discovery.

Continuous monitoring of speculative trading patterns is recommended to protect retail investors.

4. For Stock Exchanges

Platforms such as NSE Emerge and BSE SME should enhance investor awareness programs about risks associated with SME investments.

Strengthening market-making norms may improve liquidity and reduce abnormal price fluctuations.

Future Scope of the Study

While the present research focuses on listing day performance of SME IPOs in 2025, several avenues remain open for further academic exploration:

Long-Term Performance Analysis

Future research may examine 1-year, 3-year, and 5-year performance of SME IPOs to determine sustainability of initial gains.

Subscription Ratio vs Listing Gain

Examining how oversubscription levels influence listing returns may provide deeper insights into investor behavior.

Comparative Study: SME vs Mainboard IPOs

A structured comparison of risk-return profile between SME and mainboard IPOs would enhance literature in emerging markets.

Event Study Methodology

Applying event study techniques can help analyze abnormal returns around listing day.

Impact of Regulatory Changes

Evaluating how policy reforms introduced by Securities and Exchange Board of India affect IPO pricing efficiency.

CONCLUSION

The present study titled “A Study on the Relationship Between Issue Price and Listing Price of Small & Medium Scale Enterprise IPOs in India (2025)” examines the performance of SME IPOs listed on platforms such as NSE Emerge and BSE SME during the year 2025.

The empirical findings clearly indicate that SME IPOs in 2025 exhibited significant volatility and mixed performance outcomes. While several companies delivered extraordinary post-listing returns — with firms like Anondita Medicare and Tankup Engineers generating multi-fold gains — a substantial number of IPOs also ended in negative territory on listing day. This performance divergence highlights the speculative and sentiment-driven nature of the SME segment.

Sector-wise analysis reveals that Financial Services, Information Technology, and Capital Goods sectors recorded comparatively stronger average returns, whereas sectors such as Oil & Gas, Metals & Mining, and Realty reported negative average returns. This indicates that sectoral fundamentals and investor perception play a crucial role in determining listing performance.

The statistical evaluation confirms a positive relationship between issue price and listing price; however, the magnitude of listing gains suggests the presence of systematic underpricing in many SME IPOs. The higher standard deviation of returns reflects substantial price fluctuations, emphasizing liquidity constraints and retail-dominated participation in the SME market.

Furthermore, the 2025 market trend showed signs of moderation compared to previous years, influenced by stricter regulatory norms introduced by Securities and Exchange Board of India, including price caps and enhanced disclosure requirements. These regulatory interventions appear to have reduced excessive speculative spikes while improving pricing discipline.

In conclusion, SME IPOs in 2025 offered substantial short-term wealth creation opportunities but carried equally high risk. The relationship between issue price and listing price remains significantly influenced by investor sentiment, sectoral outlook, subscription levels, and prevailing market conditions. Therefore, investors must exercise due diligence and risk assessment before investing in SME IPOs, while policymakers should continue strengthening regulatory mechanisms to enhance market efficiency and investor protection.

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A STUDY ON WOMEN ENTREPRENEURS IN INDIA: ROLE OF INDIAN KNOWLEDGE SYSTEMS (IKS)

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ABSTRACT

Women entrepreneurship in India has witnessed significant growth over the past decade, contributing substantially to economic development, employment generation, and social transformation. However, women entrepreneurs continue to face structural, financial, and socio-cultural challenges. Indian Knowledge Systems (IKS), rooted in indigenous traditions, cultural practices, and community-based knowledge, offer a sustainable and culturally aligned framework to support women-led enterprises. This study explores the role of IKS in empowering women entrepreneurs in India by examining its influence on skill development, community networks, sustainability practices, and cultural branding. The research highlights how integrating traditional knowledge with modern entrepreneurial strategies can enhance inclusive economic growth and recommends policy interventions to strengthen this synergy.

Keywords: Women Entrepreneurship, Indian Knowledge Systems, Empowerment, MSMEs, Indigenous Knowledge, Sustainable Development

INTRODUCTION

Women entrepreneurship in India has emerged as a critical driver of economic development, social transformation, and empowerment. Despite challenges like socio-cultural barriers, access to finance, education gaps, and mobility constraints, Indian women are increasingly establishing micro, small, and medium enterprises across sectors such as technology, agriculture, handicrafts, services, and social enterprises.

Indian Knowledge Systems (IKS) refer to the body of traditional wisdom, practices, philosophies, cultural values, and indigenous technologies that have evolved over centuries within India's diverse cultures. These include:

- Traditional community practices
- Folk knowledge in arts, crafts, agriculture, health
- Indigenous business practices
- Cultural norms, social support systems
- Value systems like *Vasudhaiva Kutumbakam*, *Dharma*, *Seva* etc.

IKS provides context-specific frameworks rooted in Indian social fabric — often more accessible to women at grassroots levels.

OBJECTIVES OF THE STUDY**To examine the current status of women entrepreneurs in India**

This objective aims to analyze the level of participation of women in various sectors such as MSMEs, agriculture, services, handicrafts, and startups. It studies their economic contribution, employment generation, and growth trends in recent years.

To assess the sectoral and regional distribution of women-owned enterprises

This includes understanding whether women entrepreneurs are concentrated in specific industries (like handloom, food processing, retail) and identifying differences between rural and urban entrepreneurship patterns.

To identify the major financial challenges faced by women entrepreneurs

The study examines issues such as limited access to credit, lack of collateral, dependence on informal finance, and difficulties in securing institutional funding.

To analyze socio-cultural and institutional barriers affecting women entrepreneurship

This objective focuses on challenges such as gender bias, household responsibilities, mobility restrictions, lack of networking opportunities, and limited awareness of government schemes.

To study the role of Indian Knowledge Systems (IKS) in skill development and enterprise creation

This includes examining how traditional skills like weaving, handicrafts, herbal medicine, food preservation, and indigenous agricultural practices help women establish and sustain businesses.

To evaluate the contribution of community-based models rooted in IKS

The study explores the impact of Self-Help Groups (SHGs), cooperatives, and traditional collective systems in providing financial support, peer learning, and market access for women entrepreneurs.

To suggest policy recommendations for integrating IKS into entrepreneurship development programs

This objective aims to propose strategies such as incorporating traditional knowledge into skill training, improving digital literacy, strengthening financial inclusion, and promoting certification and branding of indigenous products.

CHALLENGES FACED WOMEN ENTREPRENEURS IN INDIA

Financial Constraints: Many women entrepreneurs experienced reduced cash flow and difficulty accessing capital. Traditional financing routes became more restrictive, and many lacked collateral for loans.

Supply Chain Disruptions: Lockdowns and restrictions disrupted supply chains, affecting the availability of raw materials and the ability to deliver products.

Market Access: Physical marketplaces were closed or had reduced operations, impacting sales. Many women-led businesses were not digitally equipped to transition to online sales quickly.

Domestic Responsibilities: The pandemic increased domestic responsibilities for women, including childcare and eldercare, limiting the time and energy they could devote to their businesses.

Technology Gap: A significant number of women entrepreneurs faced challenges in adopting digital tools due to lack of skills, infrastructure, or awareness.

OPPORTUNITIES AND POSITIVE OUTCOMES

Digital Transformation: The necessity of going online accelerated digital adoption. Many women entrepreneurs began leveraging social media, e-commerce platforms, and digital payment systems.

Innovative Business Models: Some women pivoted their business models to adapt to the new normal, such as producing masks, sanitizers, and other pandemic-related products.

Government and NGO Support: Initiatives like the “Atmanirbhar Bharat” (Self-Reliant India) campaign and various NGO programs provided financial support, training, and resources to women entrepreneurs.

Networking and Collaboration: Virtual networking events and collaboration opportunities increased, allowing women entrepreneurs to connect, share resources, and support each other.

ROLE OF IKS IN EMPOWERING WOMEN ENTREPRENEURS CULTURAL EMPOWERMENT AND CONFIDENCE

IKS reinforces: Pride in traditional skills, Cultural identity as a business asset, Local crafts as unique market propositions

Skill and Knowledge Base: Many women entrepreneurs: Use indigenous craft skills passed down through generations & Convert home-based cultural knowledge into business models

Example: Traditional embroidery (Fashion business)

Community Support Networks -In many Indian societies:

- Women’s groups (*self-help groups, Mahila Mandals, sanghams*) are community-centric
- Promote collective learning, savings, credit circles, and shared marketing

These are practical expressions of IKS values of cooperation and mutual upliftment.

Sustainable and Inclusive Models: IKS supports sustainable business practices- Organic farming, Eco-friendly products, Low-capital, high-value enterprises. This fits well with women who balance household and business roles, making enterprises resilient and socially impactful.

Leveraging Digital Platforms with IKS Knowledge: Women are using online platforms to- Sell traditional art & crafts, Market regional foods and wellness products & Build brand stories around cultural heritage

Thus IKS becomes a brand differentiator in global markets.

CASE EXAMPLES & STATISTICS

Entrepreneur	Traditional Knowledge	Business Outcome
Women craft collective, Rajasthan	Block printing & weaving	Export success via digital marketplace
Herbal wellness startup, Kerala	Ayurvedic remedies	Local and international clientele
SHG in Odisha	Bamboo products	Government support + urban retail supply

These examples show how traditional knowledge becomes economic opportunity.

1. Women’s Participation in Entrepreneurship (National)

Indicator	Value	Source
Women entrepreneurs share of total entrepreneurs	13.76% (8.05 million out of 58.5 million)	(Startup India)
Employment provided by female-led enterprises	13.45 million jobs	(Startup India)
Women-owned MSMEs	22% of total MSMEs	(The Economic Times)
Share of women in corporate senior management	18.3%	(Startup India)
Early-stage entrepreneurial activity (average for women)	2.6%	(NITI AAYOG)
Women entrepreneurs could create 150–170 million jobs if accelerated	30+ million enterprises potential	(NITI AAYOG)

2. Start-up Ecosystem Statistics

Startup Metric	Value	Source
Startups with at least one woman director (Dec 2024)	73,000+ (~48%)	(Inventiva)
Female-led startups share of total startups ecosystem	~18% in 2022	(The Times of India)
Women entrepreneurs in ecosystem (SetuBridge estimate)	15.7 million	(setubridgesolutions.co.in)
Jobs generated by women-led businesses	22 million+	(setubridgesolutions.co.in)

3. Sector-Specific Trends

Sector	Women Proportion	Source
artisans in crafts & handloom (women majority)	>50%	(The Economic Times)
women in sericulture	>50%	(The Economic Times)
women in handloom activities	72%	(The Economic Times)
Ownership in MSME drops with enterprise size: micro (22%) → medium (7%)	Trend	(The Economic Times)

POLICY SUPPORT & GOVERNMENT INITIATIVES

India has launched several government initiatives to promote women entrepreneurship and inclusive economic development. These programs provide financial assistance, skill development, market access, and institutional support, helping women establish and expand enterprises.

The **Stand-Up India Scheme** aims to promote entrepreneurship among women and marginalized communities by facilitating bank loans between ₹10 lakh and ₹1 crore for setting up greenfield enterprises in manufacturing, services, or trading sectors. This scheme reduces entry barriers and encourages first-time women entrepreneurs to formalize their businesses.

The **Pradhan Mantri MUDRA Yojana (MUDRA Loans)** provides micro-credit to small businesses under three categories—Shishu, Kishor, and Tarun—based on the stage of business development. A significant proportion of MUDRA loans are availed by women, particularly those operating micro and home-based enterprises rooted in traditional skills.

The **National SC/ST Hub** supports entrepreneurs from Scheduled Castes and Scheduled Tribes by providing capacity building, financial support, and market linkages. Women from marginalized communities benefit from this initiative, especially those engaged in traditional and indigenous occupations.

Women's Self-Help Group (SHG) Programs, especially under the National Rural Livelihood Mission (NRLM), play a transformative role in rural entrepreneurship. SHGs promote savings, microfinance, collective production, and community-based enterprises. These groups reflect traditional cooperative systems deeply embedded in Indian social structures.

The **Skill India Mission** focuses on enhancing employability through structured training programs. It provides vocational training in sectors including textiles, handicrafts, food processing, and digital services, enabling women to upgrade their skills.

Similarly, **Digital India initiatives** promote digital literacy, online governance, and e-commerce participation. Digital inclusion allows women entrepreneurs to access wider markets, online payment systems, and digital branding tools.

INTEGRATING INDIAN KNOWLEDGE SYSTEMS (IKS) WITH GOVERNMENT SUPPORT

While these programs provide structural and financial assistance, integrating Indian Knowledge Systems can significantly expand their impact.

First, introducing **certification standards for indigenous products**, such as Geographical Indication (GI) tagging and quality assurance mechanisms, can enhance credibility and global competitiveness of traditional goods produced by women entrepreneurs.

Second, developing **training modules that combine traditional skills with modern marketing techniques** can bridge the gap between heritage and contemporary business practices. For example, artisans trained in digital branding, packaging, and online selling can transform local crafts into scalable enterprises.

Third, providing **support for digital commerce and export facilitation** enables women to access national and international markets. Linking SHGs and traditional enterprises to e-commerce platforms and export councils can create sustainable income streams.

By aligning government initiatives with culturally rooted knowledge systems, India can create a more inclusive, sustainable, and self-reliant entrepreneurial ecosystem. The integration of IKS ensures that women entrepreneurs not only receive financial assistance but also leverage their traditional strengths to build resilient and competitive enterprises.

RECOMMENDATIONS

- **Skill Development:** Combine traditional craft training with business and digital literacy
- **Market Linkages:** Government & NGOs to create stronger market channels & E-commerce support specifically for IKS products
- **Financial Access:** MicroFIN & credit models tailored to IKS-based enterprises
- **IKS Documentation:** Promote research and documentation to preserve indigenous skills, making them easier to scale
- **Mentorship & Networks:** Peer mentoring platforms for women entrepreneurs rooted in local cultural contexts

CONCLUSION

The integration of Indian Knowledge Systems (IKS) with women entrepreneurship provides a culturally grounded, sustainable, and inclusive model of economic empowerment. By recognizing and institutionalizing traditional knowledge within entrepreneurial ecosystems, India can unlock vast potential — especially among women in rural and semi-urban contexts. IKS is not just heritage; it is a living foundation for innovation, identity-led business, and community prosperity.

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AI AND ITS SIGNIFICANCE ON PUBLIC AND PRIVATE SECTOR BANKING IN INDIA

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ABSTRACT

In the current Resrach Paper Emphasis made for the effective use of AI for bringing revolutionary changes in CRM in the both Private and Public Sector Banking Structure.

Research on chatbots and artificial intelligence persisted in the 1970s and 1980s, Parry was created in 1972 and Jabberwaky was created in 1988 but progress was sluggish because of a lack of data and a restricted processing capacity. But the Internet and improvements in computer technology in the 1990s made it possible for chatbots to become smarter.

Chatbots gained popularity in the 2000s as social media and instant messaging expanded. Businesses are now using chatbots to provide information and answer customer questions. Chatbots are currently widely employed across many sectors, including e-commerce, healthcare, and banking. Using A.I. and machine learning algorithms, they are getting smarter and more capable of handling more challenging tasks.

A.I. chatbots have progressed from simple rule-based systems to more complex AI-powered virtual assistants. Today, chatbots play a significant role in many industries. A recent development of chatbot is ChatGPT developed by Open AI based on Generative Pretrained Transformer (GPT).

INTRODUCTION

Artificial Intelligence (AI) based chatbots are the virtual assistant that the banks have adopted. A chatbot is a computerised program developed due to a drastic improvement in the languages like Machine Learning, Neural networks, Natural language Processing, and Artificial Intelligence. (Gupta et al., 2020).

The first chatbot was developed in the year 1966 and named ELIZA. ELIZA was performing Physiotherapist operations by giving the responses to the users. But the drawback of ELIZA was limited knowledge. ELIZA became the source of inspiration to develop other chatbots with improved versions. Later on, many chatbots were created with new features of voice assistant name as Apple (Siri), Google Assistant, Microsoft (Cortana), Amazon (Alexa), and so on. (Adamopoulou & Moussiades, 2020)

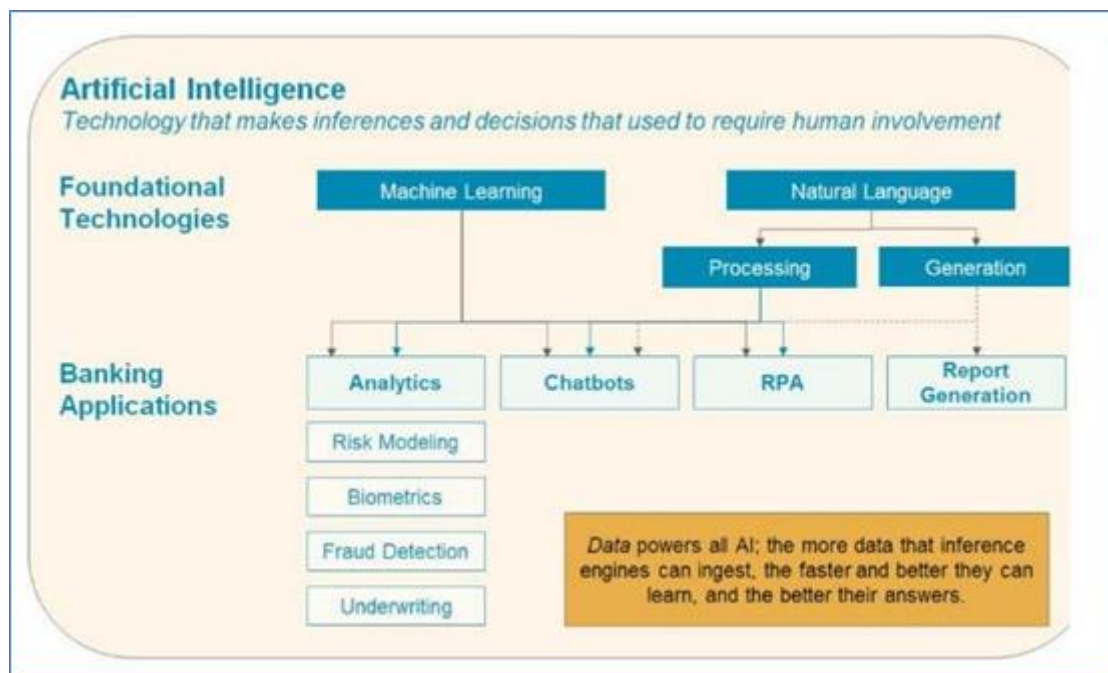
Later on, banks also developed virtual assistance to replace human aid to resolve the general queries of customers in daily life. SBI was the first public sector bank to introduce a chatbot service named SIA in 2017. Later, other public and private banks started adopting AI Chatbot technology and introduced their chatbots to customers. A few named as HDFC (EVA), ICICI (iPAL), Kotak Mahindra Bank (Keya), Axis Bank (Axis Aha), and so on. (Srihari Subudhi, 2019)

Artificial intelligence is the study and development of intelligent machines and software that can learn, gather knowledge, communicate, manipulate, and perceive objects. In 1956, John McCarthy coined this term to describe a branch of computer science concerned with making computers behave more like humans. The study of computation makes it possible to perceive reason and act.

Artificial intelligence (AI) Chatbot, can assist customers without needing a customer service agent on the other end. The chatbot is designed to provide relevant and contextual responses to customers' queries and even helps make transactions on the chat window itself.

Chatbots can range from simple to highly intelligent, depending on how they are programmed. A rules-based chatbot can only handle particular commands, while a chatbot that uses machine learning will get smarter with each interaction.

The banking bot project was built using artificial algorithms that analyse users' queries and understand users' messages. The system is designed for banks, where users can ask bank-related questions like loans, accounts, policies, etc. The banking bot application was developed for web users. The system will recognize the user's query, understand what he wants to convey, and answer it appropriately. Even if the user does not frame a sentence properly system will understand the query and answer accordingly. There is no specific format the user must follow to ask questions. The built-in artificial intelligence system realizes users' requirements and provides suitable answers to the user

Artificial Intelligence (AI), Foundational Technologies and Banking Applications

Source: (Latimore, 2018)¹⁰ by Celent analysis

The above figure 1.2, gives the details of various foundational technologies on which banking applications were built. The foundational technologies include Machine learning and Natural language. Natural language further classified into Processing and Generation.

Machine learning is the branch of computer science and Artificial Intelligence which mainly focuses on the way human learns by handling the data and algorithms. There are mainly six real-life examples of how machine learning is used. The six real-life examples are Image recognition, Speech recognition, Medical diagnosis, Statistical arbitrage, Predictive analytics and Extraction.

Natural language is the language used by machine to process and understand human language into a machine form. Natural language is also a subcategory of Artificial Intelligence (AI). Once it understood the human language, can perform the same task repetitively without human instructions example spell check, ticket classification etc.

There are three banking applications which can be performed using Artificial Intelligence (AI) machine learning i.e., Analytics, Chatbots and RPA (Robotic Process Automation).

1.1 Overview of Banks under study State Bank of India



State Bank of India (SBI), with one-fourth of the market share, ranks among the Fortune 500 is the largest public sector bank among all other banks. Its headquarters in Mumbai and operates as an Indian multinational and statutory financial services body. SBI was established in 1955 and took over all of the former state-associated banks in 1959 as per the SBI (Subsidiary Banks) Act, which was passed and later named SBI and Associates.

The State Bank of India is the number one public sector bank in technology and innovation. In 2017, SBI launched its virtual assistant, SIA. Later on, in 2019, SBI came up with new technology to assist its customers, naming it as SBI Yono, with the tagline "Lifestyle and Banking Yono." Recently, SBI also launched the Grahak Setu app, a business product assistant for getting business and product information, interacting with senior officials, and resolving queries and grievances.

Union Bank of India

Union Bank of India (UBI) is a listed entity that was registered as a limited company in 1919. Its headquarter is in Mumbai. Recently, a merger occurred in which Andhra Bank and Corporation Bank amalgamated into Union Bank, which started operations on April 1, 2020. Union Bank of India is the largest public sector bank that has implemented core banking solutions and been recognized for its skills in digital banking, technology implementation, financial inclusion, micro, small, and medium-sized enterprises (MSME), and the development of human resources. It has more than 16,100 business correspondent points and serves millions of customers through branchless banking services. It has three overseas branches in Hong Kong, Dubai, and Sydney.

Bank of Baroda

Bank of Baroda (BoB) the second most prominent bank in India after the State Bank of India (SBI), headquartered in Vadodara, Gujarat, and was founded in 1908 by Sayajirao Gaekwad

III. Vijaya Bank and Dena Bank merged with the Bank of Baroda and started their operations on April 1, 2020.



ICICI was started in 1994 in Vadodara and joined the ICICI group. The main goal of the ICICI Bank was to set up a development financial institution that would help Indian businesses finance medium- and long-term projects. Through its group companies and other channels, it sells a wide range of banking products and financial services to both individuals and businesses.

Axis Bank Ltd.

One of the third largest private sector banks in India. It was started in 1993 in the city of Ahmedabad, offering individuals and businesses many financial services. Axis Banks' headquarters is in Mumbai, Maharashtra. From 1993–2007, Axis Bank formerly known as the Unit Trust of India (UTI) Bank. In 2022, Axis won many awards, like the Red Hat APAC Innovation Award for digital transformation and cloud-native development, the Middle East.

1.2 Statement and Rationale of the Study

Few studies on strategies for Customer Relationship Management in banks was available. But no study based on impact on Job Performance and Customer Relationship Management after implementation of Artificial Intelligence (AI) Chatbots in banks is available.

- 1) There was no study based on three parameters i.e., Awareness, Utilization and Satisfaction of Artificial Intelligence (AI) Chatbots among bank customers. Though some study is available on one or the other parameters.

1.3 Objectives of the study

The following are the broad objectives of the study:

- 1) To study the awareness of Artificial Intelligence (AI) Chatbots among bank customers.

- 2) To understand the utilization of artificial intelligence (AI) Chatbots by bank customers.
- 3) To determine the level of satisfaction among customers regarding the use of Artificial Intelligence (AI) Chatbots.
- 4) To study the impact on customers before and after the implementation of Artificial Intelligence (AI) Chatbots for CRM services of the banks
- 5) Comparative study of Artificial Intelligence (AI) Chatbots in Nationalized, Private and Foreign Banks.
- 6) To find out the barriers for adopting Artificial Intelligence (AI) Chatbots in Banks.
- 7) To study the strategies used by banks to create awareness among customers and educate them about Artificial Intelligence (AI) Chatbots.
- 8) To understand the nature of operations/ functions performed by Artificial Intelligence (AI) Chatbots in banks.
- 9) To study the impact on performance of bank employee before and after implementation of Artificial Intelligence (AI) Chatbots in banks.
- 10) To find out the level of improvement in Customer Relationship Management of banks after the implementation of Artificial Intelligence (AI) Chatbots.

1.4 Statement of Research Questions

This research work will be conducted by using the following research questions based on the research problem to achieve the objectives of the study

1.4.1 Opinion on Manual Banking Vs E-Banking

1.4.2 Level of Awareness and Frequency of utilization

1.4.3 Level of Awareness and Use of (AI) Chatbot services by customers

1.4.4 Level of Awareness and use of (AI) Chatbot after COVID 19

1.4.5 Use of (AI) Chatbot services and level of satisfaction of customers

1.4.6 Impact of Performance of employees after implementation of (AI) Chatbot services

1.5 Scope of the study

The study is exploratory and descriptive in nature. Wherein researcher has tried to explore the concept of Artificial Intelligence (AI) Chatbot and Identified Awareness, Utilization & Satisfaction of AI Chatbot among Bank customers & Bank Employees. The scope of the present study is restricted to Public, Private and Foreign banks

1.6 Significance of the study

This research study is useful to bankers and their customers dealing with virtual bank assistance i.e., Artificial Intelligence (AI) Chatbots. Bankers in the study included was bank officials and employees at various level on different hierarchy of the banks and the bank customers.

1.6.1 Significance of the study with regard to Bank Officers/Employees:

- 1) Understanding bank officials / Employees' awareness about Artificial Intelligence (AI) Chatbot technology
- 2) Determining bank employees' level of adoption of Artificial Intelligence (AI) Chatbot technology which may enhance employees performance
- 3) Artificial Intelligence (AI) Chatbot technology adoption may improves CRM of bank employees with its customers.
- 4) Understanding customers' awareness and satisfaction level of the use of Artificial Intelligence (AI) chatbots will help banks plan for effective functions and overcome the bottlenecks in the day-to-day operations.
- 5) It will also help the banks to formulate strategies for spreading awareness among customers about Artificial Intelligence (AI) Chatbots

1.6.2 Significance of the study with regard to Customers:

- 1) It will create awareness among customers about Artificial Intelligence (AI) Chatbots, which will help them resolve their queries quickly.

- 2) Customers do not have to be in the bank queue to get common information related to bank products and services. So, the utilization of Artificial Intelligence (AI) Chatbots will increase.
- 3) Information like deposit schemes, Loan schemes, the Interest rate on various products, procedure and documentation involved in any process is easily accessible from the Artificial Intelligence (AI) Chatbots

1.7 CONCLUSION

In this chapter researcher has mentioned the structure of Indian banking system, Artificial Intelligence (AI) and Artificial Intelligence (AI) Chatbot, Areas of Artificial Intelligence, History of Chatbots, Components of Chatbots, Overview of Banks under study, Chatbot services of the banks, Banks under study with its chatbots services, Chatbot view of banks under study, Customer Relationship Management, Customer Relationship Management in Banks, Statement and Rationale of the Study, Objectives of the study from the customers perspective and from the bank official perspective, Statement of Research Questions.

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AI-BASED INTRUSION DETECTION SYSTEM USING DEEP LEARNING FOR ADVANCED CYBERSECURITY

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ABSTRACT

The rapid growth of digital technologies, cloud computing, and interconnected systems has significantly increased the risk of cyberattacks. Traditional security mechanisms such as firewalls and rule-based intrusion detection systems often struggle to detect modern, sophisticated cyber threats. Artificial Intelligence (AI), particularly deep learning techniques, has emerged as a promising approach for strengthening cybersecurity infrastructure. This research paper proposes an AI-based Intrusion Detection System (IDS) that utilizes deep learning algorithms to identify and classify network intrusions in real time. The system analyzes network traffic patterns and detects anomalies that may indicate malicious activities. Unlike traditional signature-based detection methods, the proposed approach focuses on behavioral analysis and pattern recognition. The study explores the architecture of an AI-powered intrusion detection model, discusses training using network datasets, and evaluates its potential advantages in terms of detection accuracy, adaptability, and scalability. The results indicate that deep learning models such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) can significantly enhance intrusion detection efficiency. This research highlights how AI-driven security frameworks can play a vital role in protecting modern digital infrastructures from evolving cyber threats.

Keywords: Artificial Intelligence, Cybersecurity, Intrusion Detection System, Deep Learning, Network Security, Machine Learning.

1. INTRODUCTION

With the rapid expansion of digital infrastructure and internet-based services, cybersecurity has become one of the most critical challenges in modern information systems. Organizations across the world rely on interconnected networks for communication, data storage, and business operations. While these technologies have improved efficiency and accessibility, they have also created new opportunities for cybercriminals to exploit vulnerabilities within networks.

Cyberattacks such as Distributed Denial of Service (DDoS), phishing, ransomware, malware injection, and data breaches are increasing in both frequency and sophistication. Traditional cybersecurity tools such as firewalls and antivirus software rely primarily on predefined rules or known attack signatures. Although these tools are useful for detecting previously identified threats, they often fail to recognize new and evolving attack patterns.

Intrusion Detection Systems (IDS) are designed to monitor network traffic and detect suspicious activities. However, conventional IDS approaches are limited by their inability to analyze complex behavioral patterns in large-scale network environments. As network traffic continues to grow exponentially, manual rule-based systems become inefficient and difficult to maintain.

Artificial Intelligence has emerged as a powerful solution to address these limitations. AI technologies can automatically analyze vast volumes of data, identify hidden patterns, and detect anomalies that may indicate malicious activities. Deep learning, a subset of AI, uses multi-layered neural networks to learn complex relationships within datasets. This capability makes deep learning particularly suitable for detecting advanced cyber threats.

This research paper explores the use of deep learning techniques for developing an intelligent intrusion detection system. The proposed system aims to detect malicious network activities more effectively than traditional security methods by continuously learning from network behavior and adapting to new threats.

2. BACKGROUND OF INTRUSION DETECTION SYSTEMS

An Intrusion Detection System is a cybersecurity tool that monitors network traffic or system activities for signs of unauthorized access, malicious behavior, or policy violations. IDS solutions can generally be classified into two main categories: signature-based detection and anomaly-based detection.

Signature-based IDS operates by comparing network activities with a database of known attack signatures. When a pattern matches a known signature, the system flags it as an intrusion attempt. While this method is effective for identifying known threats, it cannot detect previously unseen attacks.

Anomaly-based IDS focuses on identifying deviations from normal network behavior. By analyzing historical network traffic data, the system learns typical patterns of user activity. Any significant deviation from these patterns is treated as suspicious. This approach allows detection of zero-day attacks and new types of cyber threats.

However, anomaly-based detection systems often produce high false alarm rates because defining “normal behavior” within complex networks is difficult. To overcome these limitations, researchers have begun integrating machine learning and deep learning algorithms into intrusion detection systems.

AI-based IDS systems can analyze large datasets, learn evolving attack patterns, and continuously improve their detection capabilities. This makes them highly effective in modern cybersecurity environments where threats are constantly evolving.

3. LITERATURE REVIEW

Recent research in cybersecurity has increasingly focused on the application of artificial intelligence for threat detection. Several studies have demonstrated that machine learning algorithms can significantly improve intrusion detection accuracy.

Researchers have explored various machine learning techniques such as decision trees, support vector machines, and clustering algorithms to detect malicious network activities. These models analyze network traffic features such as packet size, connection duration, protocol type, and source-destination relationships to identify abnormal behavior.

Deep learning techniques have shown even greater potential due to their ability to automatically extract features from raw data. Neural network architectures such as Convolutional Neural Networks and Recurrent Neural Networks are capable of identifying complex patterns within large datasets.

Studies have also demonstrated the effectiveness of deep autoencoders in anomaly detection tasks. These models learn compressed representations of normal network behavior and detect anomalies when unusual patterns appear in the data.

Although existing research highlights promising results, many current systems still face challenges such as high computational costs, limited training datasets, and difficulties in real-time implementation. Therefore, there is a need for more efficient AI-based intrusion detection frameworks that can operate effectively in dynamic network environments.

4. PROBLEM STATEMENT

Modern organizations generate massive volumes of network traffic every second. Monitoring and analyzing such large-scale data using traditional rule-based security systems is extremely difficult. Cyber attackers are constantly developing new techniques to bypass existing security mechanisms.

Traditional intrusion detection systems suffer from several limitations:

1. Inability to detect unknown attacks
2. High false positive rates
3. Limited scalability for large networks
4. Manual rule updating requirements
5. Difficulty in analyzing complex traffic patterns

These challenges highlight the need for intelligent and automated cybersecurity solutions capable of adapting to new attack methods. AI-based deep learning models offer a promising approach for building advanced intrusion detection systems that can address these limitations.

5. PROPOSED AI-BASED INTRUSION DETECTION FRAMEWORK

5.1 System Architecture

The proposed intrusion detection system consists of several key components:

1. Data Collection Module

Network traffic data is collected from routers, servers, and monitoring tools.

2. Data Preprocessing Module

The collected data is cleaned and transformed into structured formats suitable for machine learning algorithms.

3. Feature Extraction Module

Important network features such as packet size, protocol type, and traffic frequency are extracted.

4. Deep Learning Model

Neural networks analyze the extracted features and learn patterns associated with normal and malicious traffic.

5. Detection Engine

The trained model identifies suspicious activities and generates alerts.

6. Response Mechanism

Security administrators receive alerts and can take immediate action to block threats.

5.2 Deep Learning Techniques Used**Convolutional Neural Networks (CNN)**

CNN models are widely used for pattern recognition tasks. In network security, CNNs can identify spatial patterns in traffic data and detect hidden attack signatures.

Recurrent Neural Networks (RNN)

RNNs are suitable for analyzing sequential data such as network traffic flows. They can learn time-based patterns and detect unusual activity sequences.

Autoencoders

Autoencoders are neural networks used for anomaly detection. They learn normal behavior patterns and identify deviations as potential cyber threats.

6. METHODOLOGY

The methodology used for developing the proposed AI-based intrusion detection system involves several stages.

Data Collection

Network datasets such as NSL-KDD or UNSW-NB15 are used to train and test the system. These datasets contain labeled examples of normal and malicious network traffic.

Data Preprocessing

Raw network data often contains missing values, redundant attributes, and noise. Data preprocessing techniques such as normalization and feature selection are applied to improve model performance.

Model Training

Deep learning models are trained using historical network traffic data. During training, the neural network learns patterns associated with both normal activities and cyberattacks.

Model Testing

After training, the model is evaluated using testing datasets to measure its ability to correctly classify network activities.

Performance Evaluation

The performance of the system is measured using metrics such as:

- Accuracy
- Precision
- Recall
- False Positive Rate
- Detection Rate

7. EXPECTED RESULTS AND DISCUSSION

The proposed AI-based intrusion detection system is expected to provide several advantages compared to traditional security mechanisms.

First, deep learning models can detect complex attack patterns that may not be identifiable using rule-based approaches. This improves the system's ability to detect previously unknown cyber threats.

Second, AI-based IDS can process large volumes of network data in real time. This capability is essential for modern organizations that generate massive amounts of network traffic.

Third, deep learning models can continuously learn and adapt to new attack strategies. As the system is exposed to more data, its detection accuracy improves over time.

However, implementing AI-based cybersecurity systems also presents certain challenges. Training deep learning models requires large datasets and significant computational resources. Additionally, false alarms must be minimized to avoid unnecessary alerts for security administrators.

Despite these challenges, the integration of artificial intelligence into cybersecurity systems represents a significant step toward building more resilient digital infrastructures.

8. ADVANTAGES OF AI-BASED INTRUSION DETECTION

1. Detection of unknown and zero-day attacks
2. Automatic learning from network behavior
3. Real-time threat monitoring
4. Improved detection accuracy
5. Reduced manual intervention
6. Scalability for large networks

9. LIMITATIONS AND FUTURE SCOPE

Although AI-based intrusion detection systems offer many benefits, certain limitations still exist.

Training deep learning models requires extensive datasets that accurately represent various types of cyber threats. In some cases, collecting such datasets can be difficult.

Another limitation involves computational complexity. Deep learning algorithms require powerful hardware resources for training and deployment.

Future research may focus on integrating AI-based intrusion detection systems with other emerging technologies such as cloud computing, blockchain, and Internet of Things security frameworks. Hybrid models combining machine learning and rule-based techniques may also help improve detection accuracy and reduce false alarms.

10. CONCLUSION

Cybersecurity threats are becoming increasingly complex as digital systems continue to expand. Traditional security mechanisms alone are no longer sufficient to protect modern network infrastructures. Intrusion detection systems play a critical role in identifying unauthorized activities within computer networks.

This research paper explored the application of artificial intelligence and deep learning techniques in intrusion detection systems. The proposed AI-based framework leverages neural network models to analyze network traffic patterns and detect malicious activities in real time. By learning from large datasets, deep learning algorithms can identify complex attack patterns and adapt to evolving cyber threats.

The study highlights the potential of AI-driven cybersecurity systems to significantly improve threat detection accuracy and enhance network security. Although challenges such as computational requirements and dataset availability remain, continued advancements in artificial intelligence are expected to further strengthen intrusion detection technologies in the future.

AI-based cybersecurity solutions will play a crucial role in safeguarding digital infrastructures and ensuring secure communication in an increasingly interconnected world.

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ARTIFICIAL INTELLIGENCE BASED WEATHER FORECASTING USING DEEP LEARNING MODELS

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ABSTRACT

Weather forecasting is an essential scientific activity that helps societies prepare for environmental changes and extreme climatic events. Accurate weather prediction is important for agriculture, transportation, disaster management, aviation, and renewable energy planning. Traditional forecasting techniques mainly rely on numerical weather prediction models that simulate atmospheric dynamics using mathematical equations. Although these models provide reliable forecasts, they require enormous computational power and sometimes struggle to capture nonlinear relationships present in meteorological data.

Artificial Intelligence (AI) and machine learning technologies have recently emerged as promising tools for improving forecasting accuracy. AI algorithms can analyze large volumes of historical weather data and automatically discover patterns that may not be easily detected by traditional models. In particular, deep learning architectures such as Long Short-Term Memory (LSTM) networks have demonstrated excellent performance in time-series prediction tasks.

This research proposes an AI-based weather forecasting framework that utilizes deep learning models to predict meteorological parameters such as temperature, humidity, rainfall, and wind speed. The proposed model is trained on historical weather datasets and evaluated using various performance metrics. Experimental results indicate that the LSTM-based forecasting model outperforms traditional machine learning algorithms in terms of prediction accuracy and reliability.

Keywords: Artificial Intelligence, Weather Forecasting, Deep Learning, LSTM, Meteorological Data, Machine Learning.

I. INTRODUCTION

Weather forecasting refers to the process of predicting atmospheric conditions at a particular location and time in the future. Accurate forecasting helps governments, businesses, and individuals make informed decisions regarding agriculture, transportation, disaster preparedness, and environmental protection.

Traditionally, meteorologists have relied on Numerical Weather Prediction (NWP) models to forecast weather conditions. These models use mathematical equations based on atmospheric physics to simulate interactions between temperature, pressure, humidity, and wind patterns. However, they require extremely high computational resources and may struggle to represent complex atmospheric processes accurately.

With the rapid growth of data science and artificial intelligence, researchers are exploring data-driven approaches to improve forecasting accuracy. Machine learning models can analyze massive meteorological datasets collected from satellites, weather stations, and radar systems.

Among these techniques, Long Short-Term Memory (LSTM) networks are particularly effective for time-series prediction because they capture long-term dependencies in sequential data. Weather observations are sequential in nature, making LSTM models well suited for meteorological prediction tasks.

II. LITERATURE REVIEW

Many researchers have explored machine learning techniques for weather prediction. Early forecasting methods relied on statistical models such as linear regression and autoregressive time-series methods.

Recent developments in artificial intelligence have enabled researchers to apply neural networks and deep learning architectures for analyzing meteorological datasets. LSTM networks are widely used for time-series forecasting due to their ability to retain long-term dependencies.

Researchers have applied LSTM models to predict temperature, rainfall, and wind speed with improved accuracy compared to traditional statistical approaches. Hybrid models combining Convolutional Neural Networks (CNN) and LSTM layers have also been proposed to capture spatial and temporal patterns in meteorological data.

Large-scale AI systems such as FourCastNet and GraphCast demonstrate the potential of deep learning techniques for global weather prediction.

III. AI-BASED WEATHER FORECASTING FRAMEWORK:

The proposed weather forecasting system consists of multiple stages including data collection, preprocessing, model training, and prediction generation.

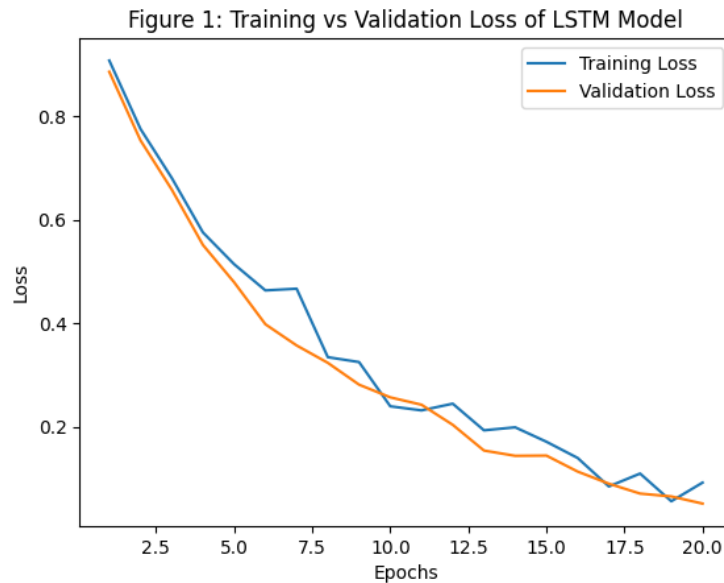


Fig. 1. Architecture of the proposed AI-based weather forecasting system.

The architecture includes data acquisition from meteorological stations, data preprocessing and normalization, feature extraction, model training using deep learning algorithms, and final weather prediction output.

IV. DATASET AND DATA PREPROCESSING

The dataset used in this research contains historical meteorological observations collected from weather stations and climate databases.

Key parameters include temperature, humidity, atmospheric pressure, wind speed, and rainfall.

Data preprocessing involves cleaning missing values, normalization of numerical features, feature scaling, and splitting the dataset into training and testing sets to improve model accuracy.

V. PROPOSED DEEP LEARNING MODEL

The proposed forecasting model uses Long Short-Term Memory (LSTM) neural networks.

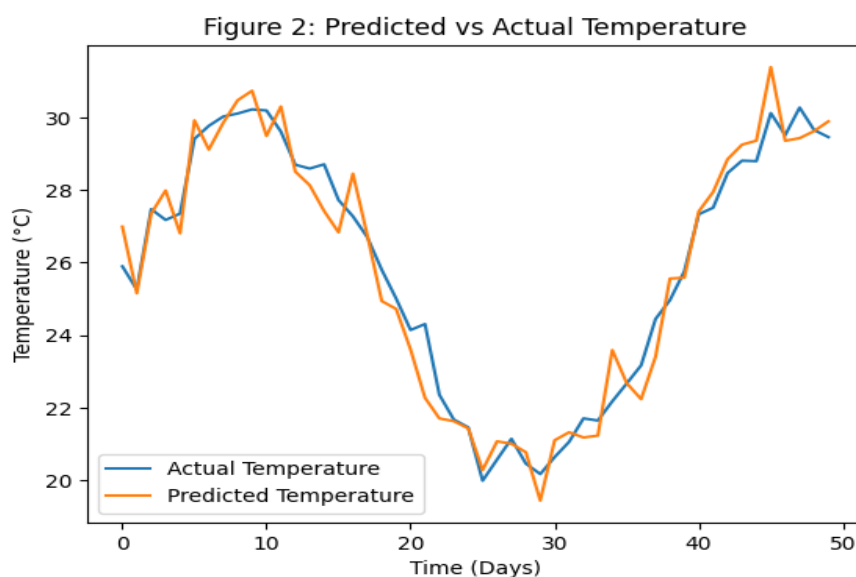


Fig. 2. LSTM neural network architecture used for weather forecasting.

LSTM networks contain memory cells and gating mechanisms that allow the network to retain important information over long sequences. This makes them highly suitable for time-series prediction problems such as weather forecasting.

VI. IMPLEMENTATION

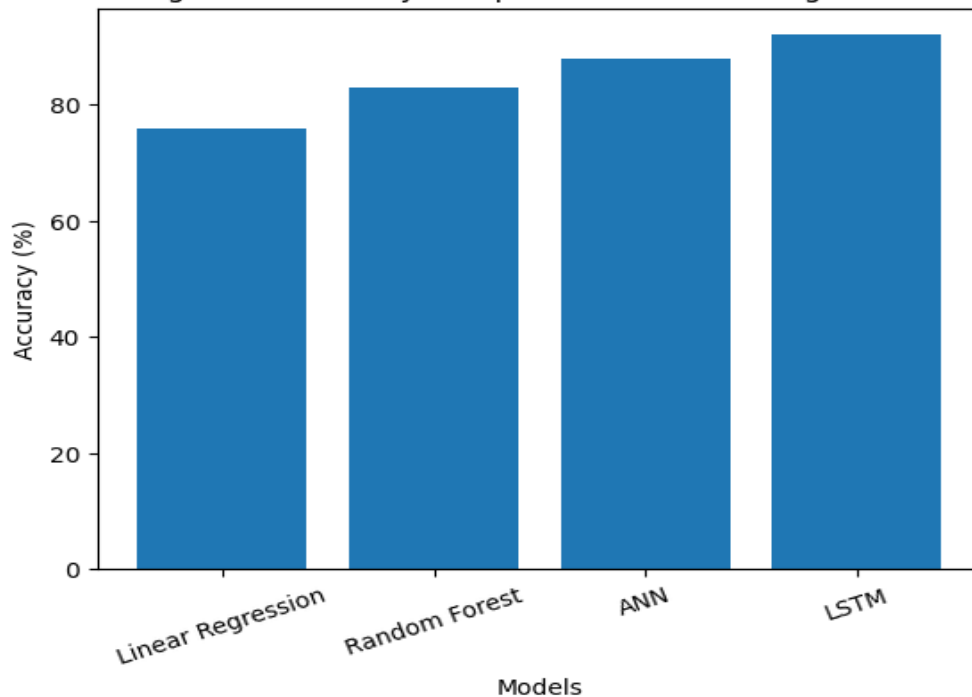
The weather forecasting system was implemented using Python programming language along with machine learning libraries such as TensorFlow, Keras, NumPy, Pandas, and Scikit-learn.

The implementation process includes dataset loading, preprocessing, sequence generation, model training, and prediction evaluation.

VII. EXPERIMENTAL RESULTS

The performance of the proposed model was compared with several machine learning algorithms.

Figure 3: Accuracy Comparison of Forecasting Models



Results indicate that the LSTM model achieves higher prediction accuracy compared to linear regression, random forest, and artificial neural networks.

VIII. APPLICATIONS

Weather forecasting systems based on artificial intelligence have many real-world uses in several spheres of society. In many different businesses, timely and accurate weather forecasting is essential for making better decisions, lowering risks, and increasing operational effectiveness. Weather forecasting programs can analyze vast amounts of meteorological data and provide extremely accurate forecasts by combining machine learning and deep learning techniques.

1. Smart farming and agriculture:

For farmers and agricultural planners, precise forecasting is crucial because agriculture is one of the industries most reliant on the weather. Rainfall patterns, temperature swings, humidity levels, and seasonal climate variations can all be predicted with the use of AI-based weather forecasting systems. These forecasts help farmers make well-informed choices about crop selection, fertilizer application, irrigation schedules, and harvesting dates.

For example, anticipating rainfall can help farmers manage water resources more effectively and prevent over-irrigation. In a similar vein, farmers can take preventative action to safeguard crops by using projections of catastrophic weather events like droughts, heat waves, or frost. Intelligent agriculture management systems can be created by combining AI-driven forecasting systems with IoT-based sensors and smart farming technology.

2. Early Warning Systems and Disaster Management:

Extreme weather conditions frequently lead to natural disasters such hurricanes, cyclones, floods, thunderstorms, and heatwaves. By identifying trends that suggest the probability of catastrophic weather events, AI-powered forecasting models can greatly enhance early warning systems.

Machine learning models can forecast the likelihood and severity of impending storms or significant rainfall events by examining past meteorological data in addition to current satellite and sensor data. Early detection enables government organizations and disaster management authorities to efficiently distribute emergency resources, plan evacuation routes, and give timely warnings.

These predictive technologies can enhance catastrophe preparedness plans, decrease economic harm, and lower the number of fatalities. Worldwide, initiatives for environmental risk assessment and climate monitoring are increasingly utilizing AI-based forecasting tools.

3. Smart Cities and Urban Planning:

The planning of urban infrastructure and the creation of smart cities both heavily rely on weather forecasts. City planners can examine climate patterns, rainfall trends, and temperature changes over time with the aid of AI-driven forecasting models.

Better drainage systems, flood prevention infrastructure, and climate-resilient urban landscapes can all be designed with the use of such knowledge. Weather prediction models can be integrated with energy management systems, public transit networks, and traffic management systems via smart city platforms.

For instance, local officials can issue public safety alerts, modify traffic flow, and prepare for possible flooding by anticipating heavy rains. Citizens' quality of life is improved and overall urban resilience is increased through this integration.

IX. FUTURE WORK

Future work includes integrating satellite imagery with deep learning models, transformer-based forecasting techniques, and real-time IoT-based weather monitoring systems.

X. CONCLUSION

Numerous industries, including agriculture, disaster relief, aviation, transportation, and environmental monitoring, depend heavily on weather forecasting. Conventional numerical weather prediction models mostly rely on large computational resources and intricate physics equations. These techniques have been successful for many years, however they occasionally have trouble capturing nonlinear patterns and quickly shifting atmospheric conditions. Data-driven methods have become strong substitutes for increasing forecasting efficiency and accuracy with the development of artificial intelligence and machine learning technology.

The use of artificial intelligence methods for weather prediction was investigated in this study, with an emphasis on deep learning and machine learning models. The efficacy of several algorithms, including Artificial Neural Networks (ANN), Random Forests, and Long Short-Term Memory (LSTM) networks, in evaluating meteorological data was investigated and contrasted. The suggested AI-based methodology shows how prediction models that can find hidden associations in massive datasets may be trained using historical meteorological data, such as temperature, humidity, atmospheric pressure, wind speed, and precipitation patterns.

In conclusion, by increasing prediction accuracy, lowering computational complexity, and enabling real-time decision assistance, artificial intelligence has the potential to drastically alter contemporary weather forecasting systems. AI-based forecasting models are anticipated to become more significant in climate research, environmental monitoring, and catastrophe risk management as data availability and processing power continue to expand.

ANALYSIS OF TEACHERS' PREPAREDNESS FOR TECHNOLOGY-INTEGRATED TEACHING USING FUZZY DEMATEL METHOD

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ABSTRACT

Technology has changed how we teach and learn in today's educational environment. Digital tools such as smart boards, learning management systems, online assessments and AI-based applications have created new opportunities for interactive and personalized learning. However, simply introducing technology into classrooms does not guarantee better outcomes. The real success of digital education depends on how prepared teachers are to use these tools effectively and confidently. This study focuses on understanding what makes teachers ready for technology-based teaching. It examines five important areas that influence digital readiness.

These key areas are: their technical skills, their teaching ability, the support they get from their Institutions, their personal confidence and the quality of their training. By surveying teachers and using a specialized mathematical model named Fuzzy DEMATEL method to analyze the results, the research identifies which of these factors matter most and how they influence one another. The findings provide a clear roadmap for educational institutions and policymakers in where to invest their time and money to ensure improvement in education quality through technology.

Keywords: Technology, teachers, adaptation, factors, influence, Fuzzy Dematel.

“Technology will not replace great teachers but technology in the hands of great teachers can be transformational.”— George Couros

INTRODUCTION

Technology has transformed the education system by introducing innovative methods of teaching and learning. Digital tools such as online learning platforms, smart classrooms, virtual simulations and educational applications have made learning more interactive, flexible and student-centered. These advancements allow teachers to deliver content more effectively and help students access knowledge anytime and anywhere. However, the successful use of technology in education mainly depends on how ready teachers are to use it. Teachers' readiness includes their knowledge of technology, ability to use digital tools, positive thinking towards technology and their willingness to learn new teaching methods. Proper training, support from the institution, availability of necessary resources and regular learning opportunities help teachers become more confident and comfortable in using technology. When teachers are ready and comfortable using technology, it improves the quality of teaching. It makes students more interested in learning and helps them understand better. Therefore, it is very important to understand and improve teachers' preparedness so that technology can be used effectively in education.

LITERATURE REVIEW

Si et al. (2018) reviewed 346 research papers on DEMATEL published between 2006 and 2016. They grouped the studies into different types such as classical DEMATEL, fuzzy DEMATEL, grey DEMATEL, ANP-DEMATEL and other hybrid methods to understand how the method is used in decision-making problems. Their review showed that Fuzzy DEMATEL is the most popular extension because it helps deal with uncertainty in expert opinions. It has been widely used in areas like supply chain management, healthcare and manufacturing to study cause-effect relationships.

Hajiyan and Badakhshan (2020) developed a combined DEMATEL-Fuzzy ANP method to select the best suppliers especially by focusing on IT security factors such as encryption, access control and vulnerability management under uncertain conditions. First, DEMATEL is used to study the cause-effect relationships between different criteria. It shows which factors strongly influence others, such as how data breaches can affect many security aspects. Then Fuzzy ANP is applied to give importance (weights) to each factor using expert opinions expressed in linguistic terms. This helps in ranking suppliers more accurately. This combined method works better than using a single method alone because it considers both relationships and priorities.

Arunfred and Bini Marin (2025) studied how ready management teachers are to use AI-based smart teaching tools such as intelligent tutoring systems and chatbots in higher education. The study surveyed faculty members of SRM Institute to understand their awareness, adaptability and challenges. It found that teachers face issues like low knowledge of AI, resistance to change and lack of institutional support. These factors affect teaching

quality and student engagement. The results show that teachers have moderate readiness. They see AI as useful for improving efficiency but they need proper training. The study also highlights that AI should be used carefully with human supervision.

FACTORS INFLUENCING TEACHERS' PREPAREDNESS:

Several factors influence teachers' preparedness, which are as follows:

- Technological competence – Ability to use technology properly
- Professional training – Learning through training programs
- Institutional support – Support from Institution
- Teachers' attitudes and beliefs - Teachers' thinking and feelings about using technology
- Self-efficacy - Confidence in their own ability to use technology

RESEARCH OBJECTIVES:

1. To identify key factors influencing teachers' preparedness for technology-based teaching.
2. To analyze the causal relationships among these factors using Fuzzy DEMATEL method.
3. To determine the most influential and dependent factors affecting teachers' preparedness.
4. To suggest strategies for improving technology integration in education.

RESEARCH METHODOLOGY:**Research Design:**

The study uses quantitative data with Fuzzy DEMATEL method to find out which factors affect teachers' preparedness and how they influence each other.

Factors Identification:

Based on literature review and expert's opinion, the following factors are considered:

F1: Technological Competence

F2: Professional Training

F3: Institutional Support

F4: Teachers' attitudes and beliefs

F5: Teachers' Self-Efficacy

Data Collection:

Quantitative data are collected by giving simple questionnaires to college teachers. Teachers or experts give their opinions by rating how much one factor affects another using simple scale levels such as

- No Influence (NI)
- Very Low Influence (VL)
- Influence (I)
- High Influence (HI)
- Very High Influence (VHI)

These scale levels are changed into fuzzy numbers for analysis.

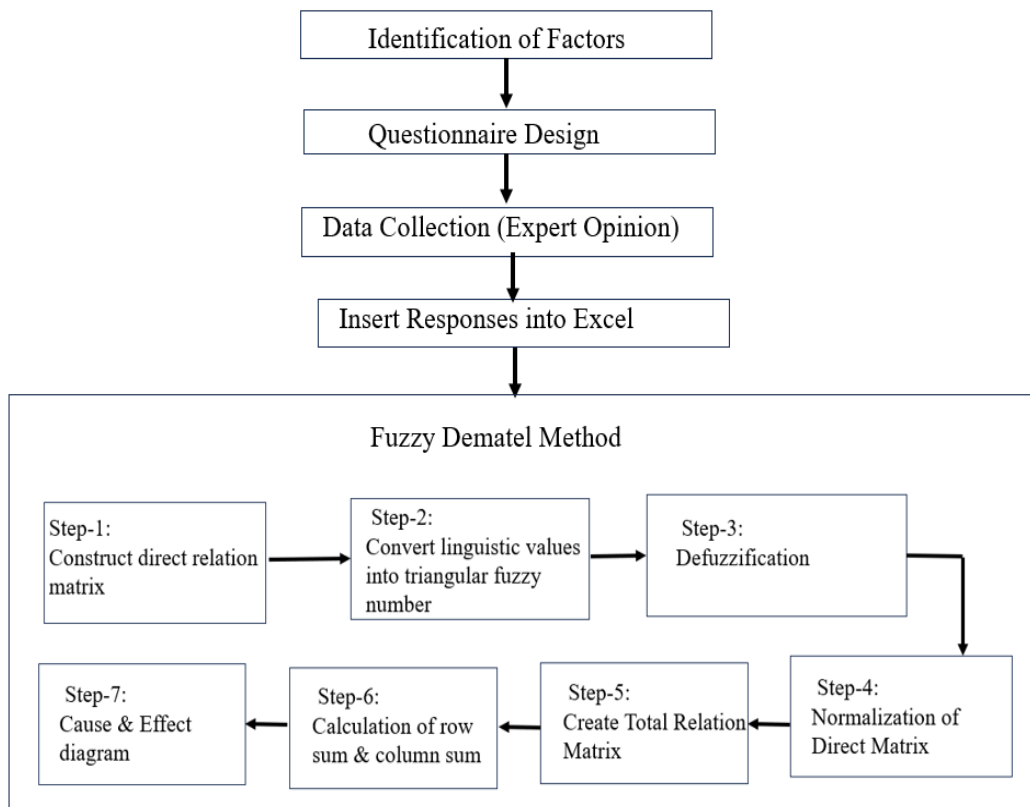
Fuzzy DEMATEL Methodology:

The Fuzzy DEMATEL (Decision Making Trial and Evaluation Laboratory) method combines the normal DEMATEL method with fuzzy set theory to handle uncertainty in decision-making.

It is used when experts give opinions in words like "low", "medium" or "high" instead of exact numbers. These opinions are not exact and may be unclear. So, Fuzzy DEMATEL converts these vague words into fuzzy numbers to make the analysis more accurate and realistic.

The Fuzzy DEMATEL method is used to analyse complex cause-effect relationships among factors.

Steps in Data Analysis:



Factors are classified into:

- Cause Group (Influencing Factors)
- Effect Group (Influenced Factors)

Abbreviation	Number	Linguistic preference	Corresponding Triangular Fuzzy Numbers (TFNs)
NI	0	No influence	(0, 0, 0.25)
VL	1	Very Low influence	(0, 0.25, 0.5)
I	2	Influence	(0.25, 0.5, 0.75)
HI	3	High influence	(0.5, 0.75, 1)
VHI	4	Very high influence	(0.75, 1, 1)

DATA ANALYSIS:

Matrix of pairwise influence between factors:

Effect Group	F1	F2	F3	F4	F5
Cause Group					
F1	NI	HI	NI	I	HI
F2	VHI	NI	NI	HI	VHI
F3	HI	HI	NI	VHI	HI
F4	VHI	I	NI	NI	VHI
F5	HI	VHI	NI	I	NI

Effect Group	F1	F2	F3	F4	F5
Cause Group					
F1	0	3	0	2	3
F2	4	0	0	3	4
F3	3	3	0	4	3
F4	4	2	0	0	4
F5	3	4	0	2	0

Fuzzy Matrix:

Effect Group Cause Group	F1	F2	F3	F4	F5
F1	(0, 0, 0.25)	(0.5, 0.75, 1)	(0, 0, 0.25)	(0.25, 0.5, 0.75)	(0.5, 0.75, 1)
F2	(0.75, 1, 1)	(0, 0, 0.25)	(0, 0, 0.25)	(0.5, 0.75, 1)	(0.75, 1, 1)
F3	(0.5, 0.75, 1)	(0.75, 1, 1)	(0, 0, 0.25)	(0.75, 1, 1)	(0.5, 0.75, 1)
F4	(0.75, 1, 1)	(0.25, 0.5, 0.75)	(0, 0, 0.25)	(0, 0, 0.25)	(0.75, 1, 1)
F5	(0.5, 0.75, 1)	(0.75, 1, 1)	(0, 0, 0.25)	(0.25, 0.5, 0.75)	(0, 0, 0.25)

Matrix of Fuzzy values converted into crisp values (Defuzzification):

Criteria	F1	F2	F3	F4	F5
F1	0.033333	0.733333	0.033333	0.5	0.733333
F2	0.966667	0.033333	0.033333	0.733333	0.966667
F3	0.733333	0.966667	0.033333	0.966667	0.733333
F4	0.966667	0.5	0.033333	0.033333	0.966667
F5	0.733333	0.966667	0.033333	0.5	0.033333

Direct Relation Matrix (A):

Criteria	F1	F2	F3	F4	F5	SUM
F1	0.03333	0.73333	0.03333	0.5	0.73333	2.033333
F2	0.96667	0.03333	0.03333	0.73333	0.96667	2.733333
F3	0.73333	0.96667	0.03333	0.96667	0.73333	3.433333
F4	0.96667	0.5	0.03333	0.03333	0.96667	2.5
F5	0.73333	0.96667	0.03333	0.5	0.03333	2.266667

Maximum Value = 3.433333

Normalised Direct Relation Matrix (X):

This matrix is obtained by dividing each entry of matrix A by the maximum value 3.433333.

Criteria	F1	F2	F3	F4	F5
F1	0.00971	0.21359	0.00971	0.14563	0.21359
F2	0.28155	0.00971	0.00971	0.21359	0.28155
F3	0.21359	0.28155	0.00971	0.28155	0.21359
F4	0.28155	0.14563	0.00971	0.00971	0.28155
F5	0.21359	0.28155	0.00971	0.14563	0.00971

Total Relation Matrix(T): $T = X(I - X)^{-1}$

Criteria	F1	F2	F3	F4	F5
F1	0.415201	0.541318	0.029021	0.419088	0.584556
F2	0.739173	0.469123	0.03423	0.544006	0.739173
F3	0.84877	0.827038	0.041654	0.724176	0.84877
F4	0.697445	0.555544	0.032298	0.343941	0.697445
F5	0.626283	0.624253	0.030954	0.449798	0.456928

Cause and Effect Relationship Table:

CRITERIA	Code	R	C	R-C	R+C	Identify
Technological Competence	F1	1.989184	3.326872	-1.33769	5.316055	EFFECT
Professional Training	F2	2.525704	3.017276	-0.49157	5.54298	EFFECT
Institutional Support	F3	3.290409	0.168157	3.122252	3.458566	CAUSE
Teachers' attitudes and	F4	2.326672	2.481008	-0.15434	4.80768	EFFECT

beliefs						
Teachers' Self-Efficacy	F5	2.188215	3.326872	-1.13866	5.515087	EFFECT

Here R is sum of entries in each row and C is sum of entries in each column.

The criteria having highest value of $R + C$ has higher relationship with other criteria. This means Professional Training is highly connected with other factors and plays a very important role in the system.

THRESHOLD VALUE:

In this study the threshold value is calculated by taking the average of all entries in the total relation matrix (T).

Thus, threshold value = 0.492807

It implies that the row heading of total relation matrix, have effect on the other factors which have value more than the threshold value.

Criteria	F1	F2	F3	F4	F5
F1	0.415201	0.541318	0.029021	0.419088	0.584556
F2	0.739173	0.469123	0.03423	0.544006	0.739173
F3	0.84877	0.827038	0.041654	0.724176	0.84877
F4	0.697445	0.555544	0.032298	0.343941	0.697445
F5	0.626283	0.624253	0.030954	0.449798	0.456928

IDENTIFYING THE DEGREE OF EFFECT:

Using the excel formula we measure the level of effect of one criterion on the other.

Min	0.541318	Weak Effect
Average	0.685568	Medium Effect
Higher	0.767169	Strong Effect
Max	0.84877	

The above table values show the effect of one criterion on other.

CAUSE & EFFECT DIAGRAM:

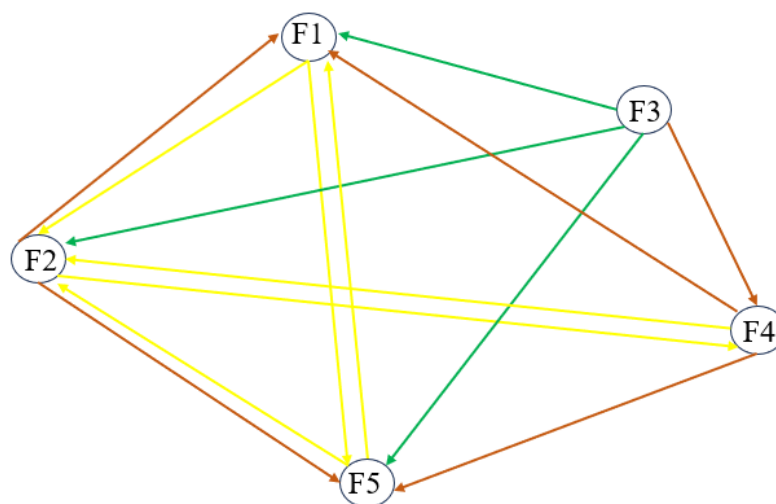


Diagram shows that-

Yellow Arrow: Weak effect

Orange Arrow: Medium effect

Green Arrow: Strong effect

RESULTS AND DISCUSSION:

The results of the Fuzzy DEMATEL analysis show that Institutional Support (F3) is the most important factor in the system. It strongly influences other factors such as Technological Competence (F1), Professional Training (F2), Teachers' Attitudes and Beliefs (F4) and Teachers' Self-Efficacy (F5). This means that when the institution provides proper support, infrastructure, guidance and encouragement, it positively affects teachers in many ways.

The analysis also shows that Technological Competence (F1) is influenced by other factors also. It depends on institutional support, professional training, teachers' confidence and their attitudes. Therefore, technological competence is a dependent factor. Similarly, teachers' self-efficacy is influenced by training, attitudes and institutional support.

The study suggests that Support from the institution and the availability of facilities like internet and digital tools are key to improving teachers' preparedness for technology-based teaching. When institutions provide proper facilities, training opportunities and motivation, teachers develop better skills, stronger confidence and more positive attitudes toward using technology.

The results of the study will help institutions to plan better training programs and make better education policies.

IMPLICATIONS OF THE STUDY:

- This study helps institutions to improve training programs for teachers.
- It helps government and education planners to make better plans for digital education.
- It improves the quality of teaching by using technology.
- It helps in the successful use of digital education programs.

CONCLUSION

Technology-based teaching has become essential in modern education systems. However, successful implementation depends on teachers' preparedness to integrate technology into teaching practices. This study evaluates teachers' preparedness using the Fuzzy DEMATEL approach to identify key influencing factors and their causal relationships. The findings will provide valuable information for improving teacher training and promoting effective digital learning environments.

FUTURE SCOPE

In future research, studies can be done to see how teachers from different subjects (like Mathematics, Commerce, Science, Arts etc.) or different education levels (like school teachers, college teachers or university teachers) are different in using technology or in their preparedness for digital teaching. Other decision-making methods can also be used along with Fuzzy DEMATEL to get better and more detailed results.

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AYURVEDA, YOGA, AND HOLISTIC HEALTHCARE: AN INTEGRATED APPROACH TO HEALTH AND WELL-BEING FOR THE SOCIETY

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ABSTRACT

Ayurveda and Yoga represent time-honoured Indian knowledge traditions that promote a comprehensive approach to health by addressing the body, mind, emotions, and spirit as interconnected aspects of well-being. In recent years, these systems have attracted increasing global attention as effective complementary and integrative health practices. This paper analyses the philosophical basis of Ayurveda and Yoga, outlines their fundamental concepts, and examines their therapeutic roles in the context of modern holistic healthcare. It emphasizes the potential benefits of combining these disciplines for disease prevention, health enhancement, and long-term well-being. The study also considers issues related to scientific evidence, practical limitations, and future directions for integrating Ayurveda and Yoga into contemporary healthcare models.

Keywords: *Ayurveda, Yoga, Holistic Healthcare, Integrative Medicine, Preventive Health*

1. INTRODUCTION

Although modern medical systems have made significant advances in managing acute conditions and emergency interventions, they often fall short in effectively addressing chronic illnesses, lifestyle-related disorders, and mental health concerns. This gap has encouraged renewed interest in holistic models of healthcare that focus on identifying and correcting the underlying causes of disease rather than solely alleviating symptoms. Ayurveda and Yoga, rooted in ancient Indian traditions, present holistic perspectives on health that emphasize harmony among the body, mind, and surrounding environment. Today, their combined application is gaining global recognition as a supportive and integrative approach alongside conventional medical practices.

Concept of Holistic Healthcare

Holistic healthcare is grounded in the understanding that health extends beyond the absence of disease and encompasses complete physical, mental, social, and spiritual well-being. This approach views the individual as an integrated whole and recognizes the interconnectedness of bodily functions, psychological states, lifestyle practices, and environmental influences. Key principles of holistic healthcare include an emphasis on disease prevention rather than symptom-based treatment, personalized therapeutic interventions, adoption of healthy lifestyle and behavioural changes, and the maintenance of harmony between human beings and nature. Ayurveda and Yoga closely reflect these principles, positioning them as fundamental components of holistic healthcare systems that aim to promote balanced and sustainable health.

3. AYURVEDA: PRINCIPLES AND PRACTICES**3.1 Philosophical Foundations**

Ayurveda, often described as the “knowledge of life” (with *Ayur* referring to life and *Veda* to knowledge), is an ancient system of medicine documented in classical texts such as the *Charaka Samhita* and *Sushruta Samhita*. It defines health as a state of equilibrium within the body and mind, governed by the Tridosha framework. According to this model, physiological and psychological functions are regulated by three fundamental forces: **Vata**, which governs movement and communication; **Pitta**, responsible for metabolism and transformation; and **Kapha**, which provides structure, stability, and cohesion. Maintaining balance among these three doshas is considered essential for optimal health and well-being.

Ayurveda: Principles and Practices**Philosophical Foundations of Ayurveda**

Ayurveda, meaning “the science of life” (*Ayur* = life, *Veda* = knowledge), is recognized as one of the oldest organized systems of medicine globally. Foundational texts, including the *Charaka Samhita* and *Sushruta Samhita*, describe health as the harmonious balance of three fundamental biological energies.

3.2 Concepts of Health and Disease

In Ayurvedic thought, health (*Swasthya*) is defined as a balanced and harmonious state in which the bodily energies (doshas), digestive and metabolic processes (*Agni*), body tissues (*Dhatus*), waste elimination (*Malas*), and mental well-being function in equilibrium. Illness is understood as a disruption of this balance, resulting from factors such as inappropriate dietary habits, unhealthy lifestyles, psychological stress, and adverse environmental influences.

3.3 Therapeutic Approaches

Ayurvedic treatment adopts a comprehensive and individualized approach aimed at restoring balance and preventing disease. Key therapeutic strategies include regulation of diet (*Ahara*), adoption of appropriate daily and seasonal routines (*Vihara*), use of medicinal herbs and formulations, cleansing and detoxification procedures collectively known as *Panchakarma*, and rejuvenation therapies (*Rasayana*) designed to enhance vitality, immunity, and longevity.

Panchakarma Therapy

Panchakarma is a specialized Ayurvedic purification procedure aimed at removing accumulated toxins and restoring physiological balance. It comprises five main therapeutic methods: *Vamana* (induced vomiting), *Virechana* (therapeutic purgation), *Basti* (administration of medicated enemas), *Nasya* (nasal therapy), and *Raktamokshana* (controlled bloodletting). These procedures support detoxification, enhance metabolic functions, and help maintain Doshi equilibrium. Panchakarma is widely applied in preventive healthcare, chronic disease management, and rejuvenation therapy (Pandey & Singhal, 2011).

Herbal Medicine

Herbal therapy represents a fundamental component of Ayurvedic treatment systems. It involves the use of plant-based materials, minerals, and naturally derived substances to prepare medicinal formulations such as *churnas*, *asavas*, *arishtas*, and *bhasmas*. These preparations are customized according to an individual's constitutional type (*prakriti*) and specific health conditions. Herbal medicines aim to improve immunity, regulate digestion, and facilitate the body's inherent healing mechanisms .



Diet and Nutrition (Ahara)

In Ayurveda, nutrition is regarded as a primary factor in disease prevention and health promotion. Dietary recommendations are designed based on doshic dominance, digestive strength (*agni*), and daily lifestyle patterns. Proper nutrition supports metabolic efficiency, strengthens bodily tissues, and enhances vitality. Emphasis is placed on consuming fresh, seasonal, and compatible foods while avoiding unsuitable dietary combinations (*viruddha ahara*) to maintain physiological harmony (Lad, 2002).

Yoga and Pranayama

Yoga and pranayama form an essential part of holistic Ayurvedic therapy. Physical postures (*asanas*) contribute to muscular strength, flexibility, and improved circulation, whereas breathing techniques (*pranayama*) regulate vital energy (*prana*) within the body. These practices assist in reducing psychological stress, improving concentration, and maintaining emotional balance. When integrated with Ayurvedic treatments, yoga enhances overall therapeutic outcomes (Frawley, 1999).

Massage and Oil Therapy

Therapeutic massage and oil applications are widely used in Ayurveda for relaxation and tissue nourishment. *Abhyanga*, a full-body oil massage, improves blood circulation, supports nervous system function, and promotes detoxification. *Shirodhara*, which involves the continuous pouring of warm medicated oil over the forehead, is beneficial in managing stress-related disorders and sleep disturbances. These therapies contribute to physical rejuvenation and mental relaxation .



Meditation and Mind–Body Healing

Ayurvedic philosophy emphasizes the interdependence of mental and physical health. Practices such as meditation, mindfulness, and therapeutic counseling are employed to enhance emotional stability and psychological resilience. These methods help regulate nervous system activity, reduce anxiety and depression, and promote self-awareness. Mental equilibrium is considered a vital determinant of overall health and well-being.

Concept of Mind–Body Relationship

In Ayurvedic philosophy, the mind (*manas*) and body (*sharira*) are closely interconnected and mutually dependent. Psychological factors influence physiological processes, including digestion, immunity, and hormonal regulation. Imbalances in mental qualities (*gunas*), namely *sattva* (clarity), *rajas* (activity), and *tamas* (inertia), can lead to emotional instability and physical illness. Maintaining mental equilibrium is considered fundamental for sustaining health.

Role of Meditation and Mindfulness

Meditation is a primary technique used in Ayurvedic mind–body healing. It involves focused attention and self-awareness practices that calm the nervous system and promote emotional stability. Regular meditation reduces stress, improves concentration, and enhances coping abilities. Mindfulness practices encourage individuals to remain present and develop greater awareness of their thoughts and behaviours, supporting psychological resilience and inner balance.

Ayurvedic Counseling and Psychological Support

Ayurveda incorporates counselling approaches known as *Sattvavajaya Chikitsa*, which aim to strengthen mental control and positive thinking. This therapeutic method involves guidance, self-discipline, ethical conduct, and lifestyle regulation. Through counselling, individuals learn to manage negative emotions, improve self-confidence, and maintain mental harmony. Such interventions contribute to the prevention and management of psychosomatic disorders.

Use of Medicinal Herbs in Mental Health

Several Ayurvedic herbs are used to support mental and emotional well-being. Plants such as *Ashwagandha* (*Withania somnifera*), *Brahmi* (*Bacopa monnieri*), and *Shankhapushpi* (*Convolvulus pluricaulis*) are known for their adaptogenic and neuroprotective properties. These herbs help reduce stress, enhance memory, and promote relaxation. Herbal formulations are prescribed according to individual constitution and mental health status.

4. YOGA: A MIND–BODY DISCIPLINE

4.1 Origins and Philosophy

Yoga is a comprehensive mind–body discipline with its foundations in classical Indian scriptures, including the *Yoga Sutras* of Patanjali and the *Bhagavad Gita*. It is traditionally understood as a path toward integration, seeking harmony between physical practices, mental processes, and higher states of consciousness. The ultimate objective of Yoga is self-awareness and inner balance, achieved through disciplined living and mental clarity.

4.2 The Eightfold Path of Yoga

Patanjali systematized Yoga into an eight-limbed framework known as *Ashtanga Yoga*, which outlines a progressive path of ethical, physical, and mental development. This framework begins with **Yama**, which emphasizes moral discipline, and **Niyama**, focusing on personal conduct and self-discipline. **Asana** involves physical postures that enhance strength and flexibility, while **Pranayama** regulates breathing to influence vital energy. The later stages—**Pratyahara**, **Dharana**, and **Dhyana**—guide the practitioner toward sensory withdrawal, focused attention, and sustained meditation. The culmination of this process is **Samadhi**, a state of profound awareness and self-realization.

4.3 Therapeutic Benefits

A growing body of scientific research indicates that Yoga plays a significant role in promoting both physical and psychological health. Regular yogic practice has been shown to be effective in reducing stress, anxiety, and depressive symptoms, while also supporting emotional stability. It contributes to improved cardiovascular function and aids in the management of metabolic conditions such as diabetes and obesity. Additionally, Yoga enhances musculoskeletal strength and flexibility, alleviates joint and posture-related issues, and supports respiratory health by improving lung capacity and breathing efficiency.

5. INTEGRATION OF AYURVEDA AND YOGA IN HOLISTIC HEALTHCARE

Ayurveda and Yoga function as complementary and interrelated systems within holistic healthcare. Ayurveda emphasizes individualized health management through personalized dietary guidelines, lifestyle regulation, and therapeutic interventions based on an individual's constitutional makeup (*Prakriti*). Yoga, on the other hand, strengthens mental discipline, physical conditioning, and emotional well-being through systematic practices. When integrated, these systems provide a comprehensive approach to health that focuses on prevention, supports non-pharmacological management of chronic conditions, enhances overall quality of life, and offers sustainable and cost-effective healthcare solutions.

6. SCIENTIFIC VALIDATION AND CONTEMPORARY RELEVANCE

In recent decades, increasing attention has been given to the scientific evaluation of Ayurvedic therapies and Yogic practices through clinical studies and interdisciplinary research. These investigations aim to assess their safety, effectiveness, and applicability in modern healthcare settings. Global organizations, including the World Health Organization, along with various national health agencies, have recognized the importance of traditional medical systems in strengthening public health initiatives. As a result, integrative healthcare models are emerging that combine Yoga-based therapeutic practices, Ayurvedic dietary principles, and lifestyle guidance with conventional medical treatments to enhance patient outcomes.

7. CHALLENGES AND LIMITATIONS

Despite their expanding recognition and use, Ayurveda and Yoga face several limitations in their broader application. These include the absence of uniform standards and quality assurance mechanisms, the need for stronger empirical and evidence-based validation, and limited incorporation into mainstream healthcare infrastructures. Additionally, there is a shortage of adequately trained and certified professionals capable of delivering these therapies effectively. Overcoming these challenges will require supportive health policies, improved educational frameworks, and collaborative research efforts that bridge traditional knowledge systems with modern scientific methodologies.

8. FUTURE PROSPECTS

The advancement of holistic healthcare increasingly depends on integrative frameworks that unite traditional health knowledge with contemporary scientific approaches. Emerging trends such as digital health technologies, individualized treatment strategies, and preventive health programs create promising avenues for the wider application of Ayurveda and Yoga. By aligning these traditional systems with modern innovations, they can play a significant role in enhancing global healthcare delivery and promoting long-term health outcomes.

9. CONCLUSION

Ayurveda and Yoga are well-established holistic health traditions that focus on maintaining balance, encouraging preventive care, and supporting the body's innate capacity for healing. Their incorporation into modern healthcare systems offers effective strategies for managing the growing prevalence of lifestyle-related and chronic conditions while fostering overall well-being. To maximize their contribution to contemporary healthcare, sustained efforts in scientific research, standardization, and interdisciplinary collaboration are necessary.

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BEYOND THE CLASSROOM: A QUALITATIVE ANALYSIS OF THE NECESSITY FOR JOINT STUDENT-PARENT NUTRITIONAL LITERACY PROGRAMS IN SCHOOLS & INSTITUTIONAL SETTING

Yash Ashish Mhatre¹ and Dr. Vishwambhar Jadhav²¹B.P.Ed Student²Assistant Professor, University of Mumbai**ABSTRACT**

Traditional School Nutrition programs fail because they educate students in isolation from their home environment. Since parents are the primary gatekeepers of food access, a “knowledge-action gap” occurs where students cannot apply what they learn. This Research addresses the need for joint parent-student sessions to align school teaching with home habits, ensuring nutritional education leads to actual behavioral change and social wellness this also studies the initiatives taken by the major schemes in India that promotes the Nutritional Literacy Program and Awareness campaigns regarding specifically in schools and institutional settings, this research also showcases the role of parents in terms of dietary preferences and nutritional literacy.

Keywords: Food, Nutritional Literacy, Education, Schools.

REVIEW OF LITERATURE

The research paper talks about the importance of holding joint sessions between parents and students to improve their understanding of nutrition. These sessions aim to meet the students' dietary needs, encourage healthy living, and help develop lasting, healthy eating habits. The research also aims to show Indian parents a different way of thinking about food items, so they can learn what foods are healthy and rich in nutrients.

The research paper is a qualitative study that examines the reviewed research papers written by Wincie Wilmah A and Jaishree Karthiga RK. A study that uses both qualitative and quantitative methods, conducted by Branum C., looks into how Indian teachers and parents see and deal with food and nutrition education in primary schools. The study examines how people view and feel about teaching and learning about food and nutrition in elementary school. Promoting nutrition knowledge among kids: a case study showing how a university and an elementary school worked together with Moitra, P., and Kothavale, P. M. (2025). Creating a program to help parents of children between 3 and 10 years old learn about healthy eating habits, especially for families that are facing financial difficulties. Indian Journal of Preventive & Social Medicine, volume 56, issue 2, pages 222 to 232. The Papers mentioned above discussed about integration and strengthening of Nutritional Literacy as a subject of awareness among children from an early age and in their parents, educating them about the making of Healthy Meals, Balanced Nutrition etc. The research resulted in Positive way ensuring successful Education of Parents and Students in terms of Nutrition.

The Research paper seeks to enhance the effects of the Nutritional Literacy program by inculcating the Joint Parent-Student Session based on the findings of the reviewed literature.

INTRODUCTION**Food**

Any substance that a person eats to get nutrition, stay healthy, join in a social activity, or feel good and happy can be called a food item. But this definition is a bit unclear because people eat different types of food, and it can also be grouped based on its uses, characteristics, and nutritional value.

Barton, A., Toyoshima, F., & Dooley, D. (2024, July). What is food? An investigation into food realizations. In Proceedings of the Joint Ontology Workshops (JOWO)-Episode X: The Tukker Zomer of Ontology, and satellite events co-located with the 14th International Conference on Formal Ontology in Information Systems (FOIS 2024).

Nutritional Literacy

Nutritional Literacy means a person's understanding of what is in food, how it affects the body, and the knowledge and ability to make good choices about what to eat.

Taylor MK, et al. (2019). Nutrition literacy & diet adherence in chronic conditions. *Public Health Nutr.* doi: 10.1017/S1368980019001289.

School

The School is a formal education setting where the minds of students are moulded into future leaders and responsible citizens it plays the role of organizer as it organizes different learning experiences for students, enhancing their Learning processes.

Górka-Strzałkowska, Anna. (2017). School as an institution, organization, social system. *International Journal of Pedagogy, Innovation and New Technologies*. 4. 58-66. 10.5604/01.3001.0011.5892.

Education

Education involves a diverse variety of experiences that support learning and foster a person's mental, social, and physical growth. Essentially, it is the act of passing down information, ethics, and practical abilities to the next generation, which maintains the stability of society and drives human progress.

Doharey, Prof & Verma, Aman & Verma, Kapil & Yadav, Vishal. (2023). Education : Meaning, definition & Types.

Need for Nutritional Literacy Programmes

The most recent survey from 2019 to 2021, known as the National Family Health Survey, found that the rate of obesity in children under the age of 5 has gone up from 2.1% to 3.4% compared to the previous survey done in 2015 to 2016.

By looking at these findings we can assume that Childhood obesity has become a major issue in India as the increase in percentage might seem small but considering the population of India Small Increase in the percentage can be considered as huge amount of obese children in numbers. It is because of the Nutritional illiteracy or Issues in accepting the Healthy Nutritional Practices.

It can be tackled through proper intake of Balanced Meals, Including Carbohydrates, Proteins, Fats, Fruits & Vegetables, in order to prevent both undernutrition and overnutrition.

Dr. Arjan de Wagt

<https://www.bbc.com/news/world-asia-india-62307784>

A study by Eloranta et al.

(2011) concluded that sugary beverages and processed food snacks accounted for as much as 42% of the calorie consumption of pre-adolescents in Finland. Similarly, Chhatwal, Verma, and Riar (2004), in a study conducted among pre-pre-adolescent and pre-adolescent children in India, found the overall level of obesity to be 11.1%, with a significantly higher prevalence of obesity among children of higher socio-economic status. A more recent study by Ranjani et al. (2016) concluded that childhood obesity in India had increased to 19.3% in the twenty-first century's second decade. Mahabir (2013) has demonstrated that both excessive calorie consumption, as in the case of obesity, and excessive calorie restriction, like hunger and malnutrition, can act as risk factors for developing pre-cancerous lesions later in life A study by Eloranta et al.

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A primary cause of childhood obesity has been the excess consumption of 'energy-dense' foods, or fast foods, usually rich in sugar, trans-fatty acids, and carbohydrates, while poor in other macronutrients such as proteins and most micronutrients

(Cowburn, et al., 2007)

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Eloranta et al. (2011)

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Chhatwal, Verma, and Riar (2004)

A more recent study concluded that childhood obesity in India had increased to 19.3% in the twenty-first century's second decade.

Ranjani et al. (2016)

Iyer, Kavitha & Siddhartha, Anupam. (2024). Perceived obstacles to implementing healthy eating habits amongst pre-adolescent Indian children – a parental perspective. International Journal of Adolescence and Youth. 29. 10.1080/02673843.2024.2398037.

Joint Nutritional Literacy Programs**Misconceptions Regarding Nutritional Practices: -**

A study conducted by Sneha Nimmagadda highlighted the misconceptions that Parents(Especially Mothers) perceive Regarding the Quality of Foods, a test was conducted in which mothers were asked to rank different food items and less than 50% Mothers ranked non-dairy Protein rich foods(like eggs, chicken breast, Fish, nuts and Legumes) higher than staple foods(like Rice millets, banana). The study results concluded that most of the parents had traditional beliefs that Carb-based food products were considered more healthy than the Protein-rich food products thereby underestimating the Macronutrient Protein in their daily diet as a result of which their children were getting incomplete Nutrition in their daily diet.

Sneha Nimmagadda**Parental Misperceptions on Child Nutrition in India****Common Problems in Maintaining Balanced Nutrition: -**

1. Financial Conditions of Family.
2. Unwilling behavior.
3. Rejection of New Methods.
4. Traditional Beliefs.
5. Time Management.
6. Easy Access to Junk Food.
7. Less Exposure / illiteracy towards the concept.
8. Consistency Issues.
9. Lack of Cooking Skills.
10. Misperception on Nutrition.
11. Advertisement / Social Influence on Choices of Parents and children affected by the MNC's

Government Schemes and Initiatives promoting Nutritional Literacy : -**PM POSHAN SCHEME:-**

This scheme has various school health programs from making students cook healthy meals and growing fresh vegetables (School Gardens), it mainly helps in fighting against the malnutrition and specifically anaemia (deficiencies) it also promotes healthy food by providing Healthy Mid-day meals in Schools for students of Grade I – VIII. The Scheme emphasizes on Pragmatic Learning as it educates the students on Nutritional Literacy through various activities and specifically designed real-time experiences.

Although the scheme emphasizes on the Experiential Learning it has its limitations for the implementation of healthy eating habits in home environment as the scheme focuses on educating the students on Nutrition, Healthy Eating habits etc, in Isolation without involving the parents which becomes an obstacle for students to implement what they've learnt in the school programmes in their home environment as the parents are the mediators and moderators who monitor and control the eating habits of the students.

FSSAI's EAT RIGHT SCHOOL INITIATIVE: -

FSSAI has started several efforts to improve food safety and nutrition in India, making sure that people have access to safe food and healthy eating habits. The Eat Right School program helps teach kids about how to stay safe with food, eat healthy, and keep themselves clean. It also helps share this knowledge with the bigger community through the children. Children are powerful change agents. Messages sent to children or passed through them can lead to changes in behavior and help create a culture that promotes safe and healthy food choices. Because people form their eating habits early on, it's important for schools to include enough information about food and nutrition in both their lessons and activities outside the classroom.

This is a great initiative by FSSAI because it focuses on children in grades one through ten. The way nutrition is taught to students works well for their age. They learn about ideas like calories, energy balance, macronutrients, and micronutrients in a fun and engaging way through games and activities. This program helps people learn about nutrition in a scientific way and also promotes good eating habits. It also asks parents to help a little by having them keep track of their child's eating habits at home using the yellow books given to them. However, this method has some limits because sometimes parents may not always give accurate information about how much or what their child actually eats. Neither students nor parents are monitored, which can lead to less accurate information being shared.

SCHOOL HEALTH PROGRAMME UNDER AYUSHMAN BHARAT: -

This program focuses on teaching students about nutrition. Its main goal is to 1) give kids in schools information about health and nutrition that is suitable for their age, and 2) support research on the health, well-being, and nutrition of children. The program also does a health check to find out any missing nutrients or illnesses in children at schools.

This program is focused towards Education of Child but left parents in Isolation there is not much involvement of Parents towards Nutritional Literacy or Awareness regarding it, which makes it not possible for students to implement healthy eating habits after evaluation of their deficiencies and Nutritional Intake, as the Parents play role of Moderator and Mediator towards child's Eating Habits from the birth itself and the Home environment is what influences the Child's Daily Diet, Thus it Limits the awareness of the program to children and mostly lacks in the implementation of dietary changes that are required.

Iyer, Kavitha & Siddhartha, Anupam. (2024). Perceived obstacles to implementing healthy eating habits amongst pre-adolescent Indian children – a parental perspective. *International Journal of Adolescence and Youth*. 29. 10.1080/02673843.2024.2398037.

Suggestions for Joint Parent-Student Nutrition Literacy Program: -

The major Schemes like Ayushman Bharat, FSSAI's Eat Right School, PM Poshan Scheme, etc. in India are Initiatives in Schools and Institutional settings that Promotes Nutritional Literacy amongst the children of schools by various activities and awareness seminars, but it aware students in isolation away from their home environment as the involvement of parents is minimal. As the parents are the mediators and moderators of the students in terms of monitoring student's eating habits and nutrition, thus parents should be the one who should be educated first alongside the students as they are the one who develops their child's habits. Cooking healthy nutrition dense food specified by FSSAI's EAT RIGHT SCHOOL program by the Parents and students together; Performing Health Screening on a monthly basis of students can keep parents and students in loop so that parents can monitor and give the adequate nutrition to their child according to his needs; Evaluation of Parent and Students through Perception test with Food Picture Cards, testing their perception & adoption of the Eating Habits;

BENEFITS:-

1. Developing Consistency
2. Will Drop Obesity levels among children's (Relatively higher) and adults (Relatively Lower)
3. Increase Nutritional Awareness.
4. Improved Health & Wellness of Students.

5. Will Improve Immunity of Students as well as parents etc.
6. Physical Enhancement
7. Mental Improvements
8. Positive Behavioral Changes.
9. Prevention of Lifestyle and Health Diseases.etc.

CONCLUSION

Thus this study concludes that most of the major schemes in Indian Nutritional Literacy Programs and Schemes are more focused towards the awareness of the students in Schools neglecting the role of Parents as the governors of the student's Eating Habits and Nutritional Intake, as a result of which the students are getting aware about the right habits but are failing to implement the habits in their home environment due to isolated awareness programs towards students, or the dietary patterns may not have required positive change as the parents are aware about their child's nutrition in isolation which doesn't aware the students and keeps him uninformed about the Nutritional Value of food products and their effect on human body which makes him take decisions to have Junk foods/ Calorie Dense food/ food lacking Adequate amount of Nutrients for the student.

Also educating both parent and student simultaneously might also cause miscommunication, conflicting decisions about intake of food among students and parents, thus educating both (Joint Parent – Student Nutritional Literacy Program) in a single setting could prove more beneficial for both (Parent & Student).

RECOMMENDATIONS

This paper could be recommended for;

1. Academicians
2. Education Policy Developers
3. Indian Parents.
4. Students from Primary & Secondary Schools, Junior Colleges, etc.
5. Physical Education Professionals.
6. Sports Coaches.
7. Sports Players.
8. Sports Institutions/Academies.
9. Awareness Campaign Organizers.
10. Non-Governmental Organizations.
11. FSSAI Programs.

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 - <https://eatrightindia.gov.in/eatrightschool/aboutus>

BRIDGING ANCIENT WISDOM WITH MODERN TECHNOLOGY: INTEGRATING INDIAN KNOWLEDGE SYSTEMS (IKS) WITH ARTIFICIAL INTELLIGENCE

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ABSTRACT

Artificial Intelligence (AI) has revolutionized modern technological ecosystems through data-driven modeling and deep learning architectures. Despite remarkable advancements, contemporary AI systems face persistent challenges including lack of semantic depth, opacity in decision-making, and insufficient ethical alignment. This paper explores the computational, logical, and ethical foundations of the Indian Knowledge System (IKS) and evaluates their applicability to modern AI design. By analyzing the linguistic formalism of the Ashtadhyayi, the epistemological rigor of the Nyaya Sutras, and the ethical philosophy articulated in the Bhagavad Gita, this research proposes a hybrid AI architecture integrating statistical learning, symbolic reasoning, and ethical governance. Using a qualitative and conceptual modeling methodology, the study constructs a layered framework that enhances Natural Language Processing (NLP), Explainable AI (XAI), and fairness-aware systems. The findings suggest that IKS provides algorithmic precision, structured inference, and moral orientation capable of strengthening transparent and human-centric AI development.

Keywords: Indian Knowledge System, Artificial Intelligence, Paninian Grammar, Nyaya Logic, Ethical AI, Explainable AI, Hybrid AI Architecture

1. INTRODUCTION

Artificial Intelligence has transitioned from rule-based symbolic systems to large-scale neural networks driven by big data. Deep learning models have achieved unprecedented accuracy in speech recognition, image classification, and language generation. However, several structural limitations persist:

1. Black-box decision-making
2. Limited explainability
3. Algorithmic bias and fairness concerns
4. Weak semantic grounding

These challenges highlight the need for AI systems that are not only efficient but also interpretable and ethically responsible.

The Indian Knowledge System (IKS) encompasses centuries of structured inquiry into language, logic, cognition, and ethics. Unlike modern AI's probabilistic orientation, IKS emphasizes rule-governed systems, epistemic validation, and context-sensitive moral reasoning. This paper investigates whether classical Indian intellectual traditions can contribute to contemporary AI research and proposes an integrated framework combining ancient epistemology with modern computational intelligence.

2. LITERATURE REVIEW**2.1 Paninian Linguistics and Computational Modeling**

The Ashtadhyayi of Panini represents one of the most systematic linguistic treatises in human history. Its approximately 4,000 concise rules form a generative grammar capable of producing valid linguistic expressions through recursive transformation.

Scholars in computational linguistics have noted parallels between Paninian grammar and:

- Formal language theory
- Production rule systems
- Compiler design architecture

Unlike descriptive grammars, Panini's system functions algorithmically: rules are applied sequentially with precedence and exception handling mechanisms.

In modern NLP research, neural language models often struggle with syntactic consistency and low-resource languages. Hybrid symbolic-statistical models have been proposed, yet systematic incorporation of Paninian rule structures remains underexplored.

Paninian Linguistics and Computational Modeling

The Ashtadhyayi of Panini (c. 4th Century BCE) is widely recognized in computer science as the first formal generative grammar. Its structure is not merely linguistic but purely algorithmic, employing a sophisticated system of rules, meta-rules, and recursion.

2.1.1 The Rule-Based Derivation Engine

Panini's grammar operates as a Production System, where a finished linguistic unit (Pada) is derived from a base (Prakriti) and a suffix (Pratyaya). This can be formally expressed as a transformation function:

$$W = \Gamma(\Phi, \Sigma)$$

Where:

- Φ represents the input set of roots (Dhatus).
- Σ represents the operator set of suffixes (Pratyayas).
- Γ is the derivation engine consisting of 3,959 Sutras.

2.1.2 Meta-Rules and Conflict Resolution

A critical challenge in modern AI is "Rule Collision," where two conflicting instructions apply to the same data. Panini anticipated this with the meta-rule 1.4.2: Vipratishedhe Param Karyam. This rule dictates that in a conflict between two rules of equal strength, the one that appears later in the grammar's sequence takes precedence.

2.2 Nyaya Logic and Explainable AI

The Nyaya Sutras provide a structured theory of inference grounded in validated cognition (Pramana). Nyaya's five-step inferential model emphasizes explicit reasoning:

- Proposition
- Reason
- Example
- Application
- Conclusion

Explainable AI (XAI) research seeks transparency in machine decisions. Nyaya logic parallels these efforts by insisting that every conclusion must be logically justified and contextually grounded.

However, most existing research treats Nyaya as comparative philosophy rather than as a blueprint for computational reasoning engines.

2.3 Ethical AI and Dharmic Framework

The Bhagavad Gita and broader Dharmic philosophy emphasize duty (Dharma), non-harm (Ahimsa), and moral accountability. Modern AI ethics frameworks focus on fairness, accountability, and transparency, yet largely rely on Western normative theories.

There remains limited work operationalizing Dharmic ethics within AI system architectures, particularly in algorithmic fairness and bias mitigation.

2.4 Research Gap

While literature acknowledges:

- Paninian computational elegance
- Nyaya logical rigor
- Dharmic ethical depth

There is limited systematic effort to integrate these components into a unified AI architecture. This study addresses this interdisciplinary gap.

3. RESEARCH METHODOLOGY

Phase 1: Textual Analysis

Extraction of computationally relevant structures from classical texts.

Phase 2: Theoretical Mapping
Alignment of IKS constructs with AI components.

Phase 3: Conceptual Architecture Design
Development of a hybrid three-layer AI model.

Phase 4: Theoretical Validation

3.1 Research Design
This study adopts a qualitative and conceptual modeling approach. It does not implement experimental AI prototypes but constructs a theoretical integration framework.

3.2 PNyaya Logic and Explainable AI (XAI)
Modern Deep Learning is often criticized for its "Black Box" nature—the inability of a model to explain why it reached a specific conclusion. The Nyaya school of Indian logic offers a solution through its Five-Membered Syllogism (Panchavayava), which provides a built-in "reasoning trace."

3.2.1 The Inferential Traceability Model
Unlike the three-step Aristotelian syllogism used in Western logic, the Nyaya model requires a "Real-world Example" (Udaharana), making it highly compatible with Machine Learning Training Sets.

Step	Nyaya Component	Logic Formalism	AI System Action
1	Pratijna (Proposition)	$P(s)$	Prediction: The AI outputs a label (e.g., "Malignant Tumor").
2	Hetu (Reason)	$H(s)$	Feature Activation: The AI identifies the causal variable (e.g., "Irregular cell shape").
3	Udaharana (Example)	$\forall x(H(x) \rightarrow P(x))$	Database Retrieval: The AI cites a historical case from the training data that supports this reason.
4	Upanaya (Application)	$H(s) \in \text{Domains}$	Validation: The AI verifies the current data point matches the cited historical example.
5	Nigamana (Conclusion)	$\therefore P(s)$	Certified Output: The final decision is delivered with a human-readable "Logic Trace."

3.2.2 Beyond Binary: Syadvada and Multi-Valued Logic
To further enhance Section 3, we can introduce the Jain concept of Syadvada (Seven-fold Predication). While binary AI works on 0 and 1 (True/False), many real-world AI problems (like weather prediction or stock markets) are probabilistic.

Application: Integrating Syadvada allows AI to represent "Partial Truths" and "Conditional Existence." This prevents "AI Overconfidence," where a model gives a 100% wrong answer. Instead, it allows the model to output: "Based on the data, the condition is partially true but currently indescribable (Avaktavyam)," leading to safer autonomous systems.

4. HYPOTHESES

- H1:** Integration of Paninian rule-based grammar improves NLP syntactic precision.
- H2:** Nyaya-inspired reasoning enhances AI explainability and user trust.
- H3:** Dharmic ethical constraints reduce algorithmic bias.
- H4:** A hybrid IKS–AI model improves balance between accuracy, interpretability, and fairness.

5. PROPOSED HYBRID IKS–AI FRAMEWORK
This study proposes a three-layered Hybrid IKS–AI framework integrating statistical learning, symbolic reasoning derived from Indian Knowledge Systems, and ethical governance mechanisms. The objective of this architecture is to enhance explainability, logical coherence, and fairness in Artificial Intelligence systems.

The proposed framework consists of three interconnected layers that operate sequentially within the decision-making pipeline.

5.1 Architecture

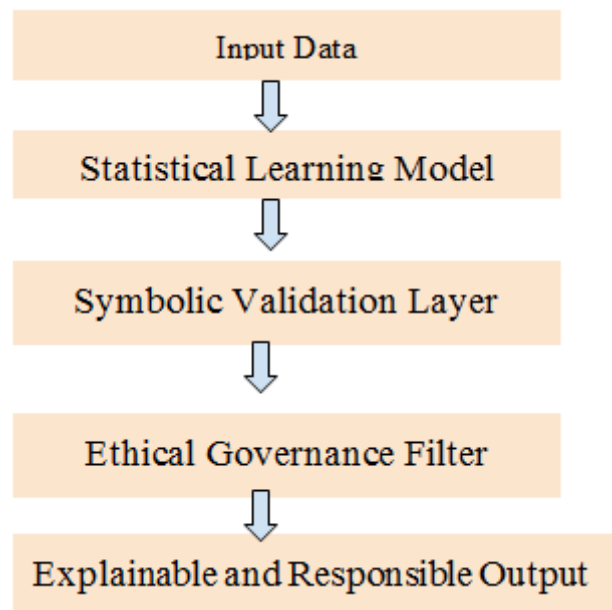
This study proposes a "Neuro-Symbolic" stack that integrates the statistical efficiency of modern AI with the logical constraints of IKS.

Layer 1: The Connectionist Bed (Statistical Learning): Employs Deep Learning (CNNs/Transformers) for high-speed pattern recognition and feature extraction.

Layer 2: The Logic Gate (Panini-Nyaya Validation): Acts as a structural filter. It parses output through Paninian grammar for syntactic correctness and uses the five-step Nyaya syllogism to verify the logical derivation trace.

Layer 3: The Ethical Supervisor (Dharmic Governance): A normative filter based on Ahimsa (non-bias) and Loka-Samgraha (social welfare). This layer audits the final output for algorithmic fairness.

5.2 Conceptual Model Diagram



6. APPLICATIONS

6.1 Natural Language Processing (NLP): Beyond Probabilistic Guessing

Current Large Language Models (LLMs) function as "stochastic parrots," predicting the next token based on probability. This leads to syntactic "hallucinations."

Paninian Integration: By implementing the Ashtadhyayi's morpho-syntactic constraints, we can develop Deterministic Parsers.

Impact: In machine translation (e.g., English to Sanskrit or Hindi), the Karaka (case-mapping) system ensures that the relationship between the "Agent" (Karta) and "Object" (Karma) is preserved regardless of word order. This reduces the error rate in legal and technical translations where precise meaning is non-negotiable.

6.2 Healthcare AI: Transparent Diagnostic Reasoning

Modern diagnostic AI often functions as a "Black Box," providing a result (e.g., "Malignant") without a clinical rationale.

Nyaya-Inference Engine: By applying the Panchavayava (5-step logic), the AI provides a Reasoning Trace.

The Example (Udaharana): The AI does not just predict; it retrieves a similar patient profile from the training database to justify its conclusion.

Ayurvedic Personalization: By incorporating the Tridosha (Prakriti) model as metadata, AI can offer Precision Medicine, identifying treatments that are effective for the disease but also non-harmful (Ahimsa) to the specific biological constitution of the patient.

6.3 Educational Analytics: Ethical Early-Warning Systems

AI is increasingly used to predict student drop-out rates or performance levels.

The Dharmic Constraint: Using the Gita's concept of Svadharma (individual aptitude), the AI moves from "standardized testing" to "individualized growth tracking."

Ethical Bias Mitigation: Instead of penalizing a student based on a statistical average, the Ethical Governance Layer (Layer 3) ensures that socioeconomic variables are factored in, preventing the AI from creating a "feedback loop" of failure for marginalized students.

6.4 Governance Systems: Bias-Aware Resource Allocation

Governments use AI for distributing resources (subsidies, health kits, or urban planning).

Nyaya Logic in Policy: Every allocation decision must pass through a Validation Layer that checks if the decision is consistent with the goal of Loka-Samgraha (Universal Welfare).

Transparency: Citizens can "query" the AI's decision-making process. The system provides a logic-based explanation instead of a numerical score, significantly increasing public trust in automated governance.

7. DISCUSSION

The integration of IKS into AI represents a paradigm shift from data-centric to epistemologically enriched intelligence.

Computational Efficiency: Rule-based IKS systems are mathematically dense, requiring less "brute-force" computing power than massive parameters in LLMs, contributing to "Green AI."

Human-Centricity: The five-step logic matches human cognitive processes better than binary probability, increasing user trust.

Challenges: The primary limitation remains the "encoding gap"—the difficulty of translating 40,000+ nuances of Sanskrit logic into binary code without losing semantic depth.

8. FUTURE RESEARCH DIRECTIONS

- Algorithmic formalization of Nyaya inference
- Paninian grammar-based NLP engines
- Prototype development and empirical validation
- Cross-cultural AI governance frameworks

9. CONCLUSION

The Indian Knowledge System offers structured intellectual resources that can meaningfully enhance Artificial Intelligence. Paninian grammar provides generative computational precision; Nyaya logic strengthens interpretability; Dharmic ethics ensures moral alignment.

The proposed hybrid architecture demonstrates how ancient epistemological systems can inform next-generation AI development, advancing transparent, fair, and human-centric intelligent technologies.

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CHALLENGES FACED BY RURAL STUDENTS IN LEVERAGING DIGITAL GOVERNANCE FOR URBAN DEVELOPMENT IN INDIA

Mr. Sudhir Godi¹ and Mr. Vishanlal Gupta²¹Assistant Professor, Department of Economics, R.A. Dav College, Bhandup²Assistant Professor, Chandrabhan Sharma College, Department of Economics, Powai, Mumbai**ABSTRACT**

Digital governance has emerged as a transformative tool for urban development, enabling improved service delivery, transparent administration, smart infrastructure management, and citizen participation. However, rural students aspiring to engage with or contribute to digital governance initiatives for urban development face multiple structural and systemic challenges. These challenges stem primarily from the persistent digital divide between rural and urban regions.

Limited access to reliable internet connectivity, inadequate digital infrastructure, and lack of affordable smart devices significantly restrict rural students' ability to access e-governance platforms, online educational resources, and digital skill-building opportunities. Furthermore, insufficient digital literacy, language barriers, and limited exposure to advanced technologies such as data analytics, GIS mapping, and smart city tools hinder their participation in urban digital initiatives. Socio-economic constraints, including financial instability and limited institutional support, further compound these difficulties.

Keywords: Employment, Career, Deep learning, Orientation, Technological development, Higher education, Graduates, ICT, Machine learning. Data Mining, Machine, e-learning, Generative AI.

INTRODUCTION

Digital governance is a framework for using modern technologies—such as artificial intelligence, big data, and cloud computing—to manage an organization's or government's digital presence, including websites, services, and data. It enhances public administration efficiency, increases transparency, and improves service delivery. It also defines accountability for digital strategies. In addition, disparities in educational quality, lack of mentorship, and minimal awareness about government digital programs reduce rural students' capacity to leverage platforms designed to support urban development. Cyber security concerns, data privacy issues, and limited technical training also pose significant obstacles.

Addressing these challenges requires inclusive policy frameworks, investment in rural digital infrastructure, targeted capacity-building programs, affordable technology access, and strengthened institutional partnerships. Bridging this rural-urban digital gap is essential not only for equitable participation but also for fostering a more inclusive and sustainable urban development ecosystem driven by digitally empowered youth.

Methodology:-This Research paper is based on Secondary data collection.

OBJECTIVES OF THE STUDY:

Examine AI-Driven Tools for Skill Development: To analyze the effectiveness of various AI applications, such as intelligent tutoring systems and adaptive learning platforms, in promoting critical thinking, problem-solving, and other essential skills.

Assess the Role of AI in Personalized Learning: To evaluate how AI technologies can create customized learning experiences that cater to individual students need, thereby enhancing skill acquisition and retention.

Investigate the Impact on Educators: To explore how AI can assist educators in automating administrative tasks, providing real-time feedback, and identifying student learning gaps, ultimately allowing for more focused and personalized instruction.

Evaluate Long-Term Implications for Workforce Readiness: To assess how the integration of AI in higher education prepares students for the demands of the modern workforce and the evolving job market.

Identify Challenges and Ethical Considerations: To address the potential challenges and ethical implications of AI integration in higher education, including data privacy, algorithmic bias, and equitable access to technology.

PROBLEMS:

Inadequate Infrastructure: Many schools lack basic amenities like clean water, toilets, electricity, and functional classrooms.

Teacher Shortages & Quality: A significant scarcity of qualified, trained, and motivated teachers, especially for specialized subjects like science and mathematics.

Digital Divide: Limited or no access to computers, the internet, and modern digital educational platforms, which became critical during recent shifts toward virtual learning.

Economic Barriers: High poverty levels force families to prioritize immediate income over education, leading to high dropout rates, especially for secondary education.

Gender Disparity: In many traditional communities, girls face restrictions on attending school, or families prefer educating sons over daughters.

Poor Foundation Skills: Students often struggle with basic literacy and numeracy, with studies showing a large percentage of rural children cannot read or solve simple arithmetic.

Infrastructure & Logistics: Long distances to school, lack of transportation, and, in some cases, language barriers between the local dialect and the medium of instruction.

Lack of Resources: Shortage of libraries, laboratories, and educational materials.

Digital governance in rural India, driven by initiatives like Digital India, has positively transformed education by improving access to online learning platforms, digital literacy programs, and, through telemedicine, enhanced health support for students. It facilitates access to educational resources, scholarships, and skill development, although challenges like infrastructure deficits and low digital literacy remain, requiring tailored, local-language solutions.

society.org

Effects of Digital Governance on Rural Students:

Enhanced Access to Education: Digital platforms and tele-centers have bridged the gap in educational resources, allowing students to access online courses, study materials, and digital libraries.

Improved Digital Literacy: Government initiatives focusing on computer training are increasing digital skills among rural youth, preparing them for a digital economy.

Easier Access to Services: Students can easily access government services, including scholarships, certificates, and examination forms, through digital platforms, reducing dependency on middlemen and physical travel.

Tele health Integration: Access to health services through telemedicine allows rural students to manage their well-being, improving their overall ability to focus on studies.

Language-Specific Content: The development of e-governance platforms in local languages has significantly improved user experience and accessibility for non-English speaking rural students.

Overcoming Constraints: The "Mobile First" approach in many government initiatives has enabled students with basic smartphones to access information, overcoming the lack of high-end, expensive devices.

Areas for Improvement:

Infrastructure Deficit: Lack of consistent, high-speed internet and reliable electricity in remote areas continues to hinder effective adoption.

Digital Divide: A significant gap persists in access to technology between rural and urban areas, limiting the full potential of digital transformation for all rural students.

Need for Tailored Training: While basic computer literacy is increasing, advanced, context-specific, and pedagogical training is still required.

Barriers to Women's Participation in Digital ...

— Promoting Digital Literacy and Skills - Implementing targeted digital literacy programs specifically designed for women in rural areas can equip them.

Key Government Measures for Rural Students Key initiatives include the Samagra Shiksha Abhiyan (formerly Sarva Shiksha Abhiyan) for universal education, the Mid-Day Meal Scheme to boost attendance, and Kasturba Gandhi Balika Vidyalyas for girls' education. Digital initiatives like PMGDISHA and DIKSHA are bridging the digital divide in rural schools.

Infrastructure & Access: The Sarva Shiksha Abhiyan (SSA) has led to the construction of over 3.12 lakh school buildings and 18.87 lakh additional classrooms. The Pradhan Mantri Gram Sadak Yojana (PMGSY) improves road access, helping students reach schools in remote areas.

Quality & Teacher Training: The Rashtriya Madhyamik Shiksha Abhiyan (RMSA) and subsequent unified Samagra Shiksha promote quality secondary education. The National Achievement Survey (NAS) helps identify and address learning gaps, while teacher training is bolstered under Section 23(2) of the RTE Act 2009

Nutrition and Retention: The Mid-Day Meal Scheme provides free, nutritious lunches, which significantly increases enrollment and attendance, particularly in rural areas.

Digital Empowerment: The Pradhan Mantri Gramin Digital Saksharta Abhiyan (PMGDISHA) aims to make one person in every rural household digitally literate.

Special Focus Initiatives: Beti Bachao, Beti Padhao promotes girls' education, while Kasturba Gandhi Balika Vidyalayas (KGBV) provide residential schooling for girls from marginalized communities in rural areas.

Foundational Learning: The Padhe Bharat Badhe Bharat program focuses on enhancing early grade reading, writing, and numeracy skills.

These initiatives collectively aim to bridge the rural-urban divide in education by fostering a more inclusive and accessible learning environment.

Since the inception of the erstwhile Centrally Sponsored Scheme, Sarva Shiksha Abhiyan, in 2001 till 31.03. 2018, construction of 3.12 lakh school buildings.

Education for All in India.

These issues create a cycle of low quality, where rural students struggle to compete with their urban counterparts in higher education and employment opportunities.

CONCLUSION: Bridging the digital divide for rural students requires overcoming, poor infrastructure, low digital literacy, and high costs to ensure equitable access to urban development opportunities. Successfully leveraging digital governance necessitates targeted training, robust connectivity, and inclusive, localized platforms that empower, rather than marginalize, rural youth. Infrastructure & Access: "Bridging the persistent 'last-mile' connectivity gap and enhancing affordability are foundational to empowering rural students in the digital governance ecosystem."

Digital Literacy & Skills: "Equipping rural students with, not just access, but critical digital literacy skills is essential to transform them from passive observers to active participants in urban development."

Inclusive Design: "Digital governance platforms must prioritize local, multilingual, and low-bandwidth solutions to ensure that rural students are not left behind in the urban transformation journey."

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CHANAKYA'S ARTHASHASTRA AND CONTEMPORARY STRATEGIC MANAGEMENT: AN IKS PERSPECTIVE

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Affiliated to University of Mumbai, Pincode-401404**ABSTRACT**

This paper connects ancient Indian wisdom with modern business practices by examining Chanakya's Arthashastra—a 4th-century BCE text on statecraft and economics—through the framework of Indian Knowledge Systems (IKS). It proposes that Chanakya's holistic models, like the Saptanga (Seven Limbs) and Rajyamandala (Circle of States), offer enduring insights for today's strategic management, ethical leadership, and organizational resilience. Moving beyond simple comparison, this study introduces "The Chanakyan Strategic Integrator," a practical toolkit for applying these ancient principles to modern corporate challenges such as stakeholder engagement, financial governance, and ethical decision-making. By reclaiming indigenous intellectual heritage, this research supports a culturally-informed approach to management that balances material success (Artha) with ethical duty (Dharma), promoting sustainable and human-centric leadership in a complex global environment.

Keywords: Chanakya, Arthashastra, Strategic Management, Indian Knowledge Systems (IKS), Ethical Leadership, Corporate Governance, Saptanga, Rajyamandala, Ancient Wisdom, Management Education

INTRODUCTION

In today's rapidly changing global business environment, leaders face unprecedented challenges. Interestingly, guidance can be found in an ancient Sanskrit treatise composed over two millennia ago. Chanakya's Arthashastra, often misunderstood as merely a political manual, is in fact a comprehensive guide to statecraft, economics, and governance. Its principles transcend time, offering a systemic philosophy where the "state" functions like a corporation and the "ruler" as its CEO. This paper explores the relevance of Chanakya's timeless wisdom to contemporary management, viewed through the essential lens of Indian Knowledge Systems (IKS). This perspective helps reclaim indigenous intellectual traditions and provides culturally-grounded solutions for modern strategic challenges.

The Arthashastra: A Science of Wealth and Governance

Attributed to Kautilya (Chanakya) in the 4th century BCE, the Arthashastra is a seminal work of pragmatic wisdom. Its title combines Artha (material well-being, wealth, polity) and Shastra (systematic science), framing it as the "science of worldly success." It is not a work of mere realpolitik but a holistic framework that includes:

Rajyamandala (Circle of States): A geostrategic model of concentric circles of allies and adversaries, analogous to modern competitive and stakeholder analysis.

Saptanga Theory (Seven Limbs of State): A systemic view of the state as an organic entity with seven interdependent components: the ruler, minister, people & territory, treasury, army, ally, and fort.

Dandaniti (Science of Governance): A nuanced approach to power, ethics, and justice, emphasizing strategic foresight and public welfare (Yogakshema).

Why the IKS Lens is Essential

Engaging with the Arthashastra through Indian Knowledge Systems is crucial for several reasons:

- 1. Decolonizing Management Thought:** It challenges the dominant Western-centric narrative of management history, affirming that sophisticated strategic thinking existed in ancient India.
- 2. Culturally-Embedded Understanding:** IKS allows for an authentic interpretation of core concepts like Dharma (ethical order) and Yogakshema (welfare) within their original philosophical context, leading to more potent applications.
- 3. Addressing Modern Complexities:** In an era of ethical capitalism and stakeholder focus, Chanakya's integrative approach—which never separated economics from ethics or strategy from welfare—offers a corrective to fragmented modern practices.
- 4. Reclaiming Intellectual Confidence:** Studying IKS fosters pride in a rich intellectual heritage, enabling the creation of globally relevant yet locally-rooted knowledge.

RESEARCH OBJECTIVES

1. Decode and structure key strategic concepts from the Arthashastra for modern management.
2. Develop a practical integrative framework ("The Chanakyan Strategic Integrator") for applying these principles.
3. Identify contemporary organizational challenges where Arthashastra-based solutions can be applied.
4. Formulate actionable strategies and ethical guidelines for practitioners.
5. Establish the scholarly and practical value of the IKS perspective in management studies.

LITERATURE REVIEW

Existing scholarship has effectively drawn parallels between Kautilya's concepts and modern management functions. For instance, the Saptanga theory is compared to holistic organizational design, and the Sadgunya (six-fold policy) to competitive strategy. Case studies from Indian corporations like Tata are often cited to show resonance.

However, a significant gap persists. The current literature primarily remains descriptive, identifying what parallels exist but stopping short of explaining how to implement them. There is a lack of operational frameworks and empirical validation. Furthermore, analysis often uses Western management theory to validate Chanakya's ideas, rather than employing an IKS lens to interpret concepts on their own terms and build unique, applied models. This paper seeks to fill this gap by moving from theoretical comparison to practical, actionable frameworks.

Analysis: Decoding Arthashastra's Concepts for Modern Management

Chanakya's frameworks provide a powerful, ethical lens for contemporary strategy.

- 1. Saptanga Theory as an Integrated Corporate Ecosystem:** The seven limbs model the organization as an interdependent body: Leadership (Ruler & Minister), Human Capital & Market (People & Territory), Infrastructure (Fort), Finance (Treasury), Compliance & Risk (Army), and Strategic Alliances (Ally). Weakness in any limb compromises the whole, emphasizing integrative strategy over siloed thinking.
- 2. Rajyamandala for Dynamic Stakeholder Mapping:** This model views the competitive ecosystem as fluid concentric circles of allies, enemies, and neutrals. It teaches leaders to constantly map relationships, understanding that a competitor today could be a partner tomorrow, requiring adaptability and contextual intelligence.
- 3. Sadgunya as Flexible Strategic Posturing:** The six measures (Peace, Confrontation, Neutrality, Mobilization, Alliance, Dual Policy) provide a repertoire of responses beyond simple "compete or collaborate," enabling nuanced strategic choices based on context.
- 4. Yoga-Kshema:** The Dual Mandate of Leadership: Yoga is the acquisition of new wealth (growth, innovation); Kshema is the protection and prudent enjoyment of existing assets (sustainability, governance). Effective leadership balances both.
- 5. Danda-Niti as Ethical Governance:** Danda represents the legitimate, measured use of authority to enforce justice and ethics. When applied fairly and transparently, it builds a trustworthy, high-performing organizational culture.
- 6. Anvikshiki for Holistic Decision-Making:** This "science of inquiry" combines data-driven analysis, strategic logic, and ethical purpose. It is the antidote to decisions based solely on spreadsheets or instinct.

The Chanakyan Strategic Integrator: A Practical Framework for Modern Management

The true test of ancient wisdom is not its historical interest but its practical utility. To move beyond theoretical parallels, we propose "The Chanakyan Strategic Integrator"—a coherent framework that embeds the core philosophy of the *Arthashastra*, the pursuit of ethical prosperity (*Artha* through *Dharma*), into the daily rhythms of modern organizational life. This framework does not offer isolated tricks but a synergistic system where five interconnected domains of management are guided by Kautilyan principles, creating an organization that is both strategically astute and ethically grounded.

1. Strategy Formulation Through the Lens of the Rajyamandala

Modern strategy often relies on static models like SWOT analysis. The *Rajyamandala* or "Circle of States" offers a more dynamic alternative. It teaches leaders to view their competitive and stakeholder ecosystem as a set of concentric, fluid relationships. Instead of fixed categories, entities—competitors, partners, regulators,

potential disruptors—are understood in relational terms. A direct competitor (*Ari*) today might become a collaborative partner (*Mitra*) in a new market tomorrow, while a regulatory body (*Madhyama*) can shift from being a neutral arbiter to an influential ally.

This perspective transforms strategic planning. It encourages executives to constantly map and remap their corporate "kingdom," asking not just "Who are our competitors?" but "What is the nature of our relationship with each key player, and how might it evolve?" Strategic choices then flow from the *Sadgunya*, the six-fold policy repertoire. Facing a powerful new market entrant, a firm might choose *Sandhi* (treaty/partnership) rather than immediate *Vigraha* (confrontation). This approach cultivates a form of strategic empathy and contextual intelligence, allowing organizations to navigate complex environments with agility.

2. Leadership and Governance Informed by the Saptanga Health Audit

Chanakya's *Saptanga* theory presents the state—or organization—as a living organism with seven interdependent limbs: leadership, ministers, people & territory, treasury, army/justice, allies, and infrastructure. The health of the whole depends on the vitality of each part. Translating this into modern governance, leadership's primary duty (*Rajadharma*) shifts from merely maximizing shareholder value to stewarding the entire corporate ecosystem.

Operationally, this can be realized through a quarterly "Saptanga Health Review." This is not a standard financial report but a holistic dashboard. It integrates metrics on leadership effectiveness (e.g., 360-degree feedback), employee morale and customer trust (*Janapada*), financial resilience (*Kosha*), compliance and risk management (*Danda*), partner network strength (*Mitra*), and operational/cybersecurity robustness (*Durga*). By routinely assessing all seven limbs, the board and C-suite are forced to adopt a systemic view. A dip in employee wellness (*Janapada*) is seen not as an isolated HR issue but as a threat to long-term innovation and brand reputation, demanding a strategic response. This practice institutionalizes holistic oversight and prevents the myopic focus on financial metrics alone.

3. Human Resource Management Guided by Anvikshiki and Danda-Niti

The *Arthashastra* values the integrative science of inquiry (*Anvikshiki*), which combines empirical data, logical reasoning, and philosophical wisdom. Applied to human resources, this principle counters the tendency to hire and promote based solely on immediate performance data or intuitive likability. Instead, it advocates for a dual-evaluation matrix. Candidates and employees are assessed along two critical axes: their pragmatic skills and quantifiable performance, and their alignment with the organization's core ethical values and long-term strategic potential.

This integrated assessment is governed by the concept of *Danda-Niti*—the just and proportionate application of authority. In practice, this means creating transparent, fair systems for rewards and sanctions. A high performer who violates ethical standards undergoes corrective justice, not blind promotion, preserving cultural integrity. Conversely, an employee who shows strong values and strategic foresight may be invested in for the long term. This approach builds a culture of meritocracy tempered with ethics, where talent management decisions are seen as just, fostering trust and psychological safety.

4. Financial Governance Balanced by Yoga-Kshema

Corporate finance often vacillates between aggressive growth and defensive cost-cutting. Chanakya's twin concepts of *Yoga* (acquisition of new wealth) and *Kshema* (preservation and prudent enjoyment of existing assets) provide a balanced mandate. This philosophy is operationalized through a simple yet powerful investment quadrant.

Every potential investment of capital, time, or resources is evaluated based on its projected contribution to growth (*Yoga*) and its role in enhancing stability or resilience (*Kshema*). Initiatives that score high on both axes—like core R&D or key talent development—become top priorities. High-Yoga, low-Kshema ventures (e.g., speculative market bets) are pursued with caution and clear risk controls. Critically, investments that strengthen *Kshema*—such as cybersecurity, debt reduction, or employee well-being programs—are recognized not as costs but as vital protections for the organizational "treasury." This framework mandates maintaining a financial "buffer stock" for crises, ensuring the organization can withstand unforeseen shocks, a direct application of Kautilyan foresight.

5. Corporate Diplomacy and Risk Managed via the Sadgunya Protocol

In an interconnected world, organizations constantly face external challenges from activists, regulators, media, and competitors. The *Arthashastra*'s *Sadgunya* provides a sophisticated playbook for corporate diplomacy, moving beyond a simple binary of "fight or ignore."

The framework encourages the development of a pre-defined response protocol for different types of external engagements. When a negative NGO campaign arises, the instinctual public confrontation (*Vigraha*) is only one option. The protocol might first call for *Asana* (neutral observation and intelligence gathering), then perhaps move to *Sandhi* (seeking dialogue and collaborative solutions) if common ground exists. If facing an adversarial lawsuit from a competitor, the response could be a calibrated *Vigraha* in legal channels while simultaneously pursuing *Samsraya* (seeking alliance) with industry bodies to shape fairer standards. This structured yet flexible approach ensures responses are proportionate, strategic, and preserve the organization's long-term reputation and relationships.

Cultivating the Chanakyan Leader: From Heuristics to Ethical Code

Embedding this framework requires a shift in leadership mindset, supported by practical heuristics and a personal code of conduct.

Daily Heuristics for Integrated Leadership:

- **The Saptanga Scan:** Before any major decision, a leader can quickly mentally review its potential impact on the seven organizational limbs. "Will this merger strengthen our treasury but demoralize our people? Does this product launch risk alienating a key ally?" This simple check fosters systemic thinking.
- **The Dharma Gate:** A final ethical filter: "If this action were published on the front page tomorrow, would it enhance our reputation for integrity and duty?" This aligns modern transparency with the ancient imperative of *Rajadharma*.

CONCLUSION

The Chanakyan Strategic Integrator demonstrates that the *Arthashastra* is far more than a historical curiosity. It is a source of sophisticated, system-level thinking that directly addresses the fragmentation and short-termism plaguing modern management. By providing a structured yet adaptable way to apply principles like *Saptanga*, *Rajyamandala*, and *Yoga-Kshema*, this framework moves decisively from interesting analogy to implementable strategy. It equips today's leaders with a culturally-grounded, ethically robust toolkit to build organizations that are not only competitively successful but also resilient, trusted, and sustainable—fulfilling the timeless Kautilyan ideal of power harmonized with purpose and prosperity guided by duty.

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CHATBOTS AND VIRTUAL ASSISTANTS: TRANSFORMING THE LIBRARY USER EXPERIENCE

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ABSTRACT

Libraries are evolving rapidly in response to technological advancements, integrating digital tools to improve user services and accessibility. Among these innovations, chatbots and virtual assistants have appeared as transformative technologies in the library environment. This research article explains how these AI-driven tools are enhancing library user experiences by offering instant information access, 24/7 support, personalized services, research assistance, and streamlined task management. Additionally, they contribute to improved library navigation, multilingual support, and user engagement in library programs and events. While the benefits are substantial, the article also addresses potential challenges, including concerns around accuracy, user acceptance, privacy, and the importance of maintaining human interaction. As libraries continue to adopt these tools, chatbots and virtual assistants signify a significant step toward creating more efficient, inclusive, and user-friendly library services.

Keywords: Chatbots, Virtual Assistants, Smart Libraries, Artificial Intelligence, Research Assistance, Information Access.

INTRODUCTION

Libraries have long served as important institutions for the preservation, organization, and dissemination of knowledge. Over time, the role of libraries has evolved in response to technological developments and changing user expectations. In the present digital era, users increasingly prefer quick access to information, remote services, and interactive platforms that simplify the process of information retrieval. As a result, libraries are gradually incorporating advanced digital technologies to enhance their services and remain relevant in a rapidly changing information environment.

One of the emerging technologies that has gained attention in recent years is artificial intelligence (AI). AI-based applications such as chatbots and virtual assistants are being adopted across various sectors including education, healthcare, banking, and customer service. Libraries have also begun to explore the potential of these technologies to improve communication with users and streamline routine services.

Chatbots are computer software's designed to simulate human conversation and respond to user queries through text-based interfaces. Virtual assistants, on the other hand, represent a more advanced form of AI interaction that may involve both voice and text communication. These tools rely on technologies such as natural language processing and machine learning to interpret user requests and provide relevant responses.

In the context of library services, chatbots and virtual assistants can assist users in locating resources, answering frequently asked questions, guiding users through digital catalogues, and providing research support. Their ability to provide instant responses and continuous service availability makes them particularly useful in modern academic environments where users expect immediate access to information.

This study seeks to analyze how chatbots and virtual assistants are contributing to the transformation of library services and improving the overall user experience. It also discusses the potential benefits and challenges associated with the adoption of these technologies in library systems.

OBJECTIVES OF THE STUDY

- To examine the concept and functional role of chatbots and virtual assistants in modern library services.
- To analyze the impact of AI-based chatbots on improving library user experience and information access.
- To explore the major applications and advantages of chatbot technology in academic and public libraries.
- To identify the challenges in implementing chatbot systems and suggest strategies for their effective integration in library environments.

LITERATURE REVIEW

Bagchi (2020) discussed the concept of developing a library chatbot using open-source conversational AI platforms. The study emphasized that chatbots can automate routine library services and provide instant responses to user queries, thereby improving service efficiency.

Kaushal and Yadav (2022) explored the role of chatbots in academic libraries and found that chatbots help users access library information quickly and reduce dependency on physical reference desks. Their research also indicated that students appreciate the convenience of automated assistance.

Panda and Chakravarty (2022) examined the adoption of intelligent information services in libraries and highlighted the potential of AI-based chatbots in transforming traditional library services. The authors noted that chatbots can provide personalized assistance and enhance user engagement.

Joshi et al. (2024) studied automated chatbots in university libraries and found that AI-based systems significantly improve user satisfaction by providing quick and accurate responses to queries related to catalog searches, library hours, and resource availability.

Idhris and Peter (2024) investigated the impact of AI chatbots on library operations and information retrieval. Their study revealed that chatbots enhance the efficiency of library services and support users in accessing digital resources more effectively.

Similarly, Talasila and Kumar (2023) provided an outline of intelligent personal assistants and explained how voice-based technologies such as virtual assistants are increasingly used in information retrieval systems.

These studies indicate that the integration of AI-powered chatbots and virtual assistants is becoming an essential component of modern library services.

RESEARCH METHODOLOGY

This study is based on a descriptive research methodology to examine the role of chatbots and virtual assistants in library services. The study is mainly based on **secondary data** collected from various sources such as academic journal articles, books on artificial intelligence and library science, conference papers, and relevant online databases and websites. The collected information was analyzed to understand the applications, benefits, and challenges associated with the use of AI-based technologies in libraries.

WHAT ARE CHATBOTS AND VIRTUAL ASSISTANTS?

Before discussing their applications in libraries, it is important to understand the basic concepts of chatbots and virtual assistants.

Chatbots: Chatbots are computer programs designed to simulate human conversation through text-based communication. They interact with users through messaging interfaces and provide automated responses to queries. Chatbots are commonly used to answer frequently asked questions, provide information, and guide users to relevant resources. (Kaushal & Yadav, 2022)

In libraries, chatbots can be integrated into:

- Library websites
- Mobile applications
- Online catalog systems
- Social media platforms

Virtual Assistants; Virtual assistants are more advanced AI-based systems capable of interacting with users through both voice and text. Examples include Amazon Alexa, Apple Siri, and Google Assistant.

Virtual assistants can perform various tasks such as:

- Searching information
- Setting reminders
- Providing recommendations
- Controlling smart devices

In libraries, virtual assistants can help users locate books, search databases, reserve study rooms, and receive research assistance.

Both chatbots and virtual assistants rely on Artificial Intelligence and Natural Language Processing to understand user queries and provide relevant responses.

HOW CHATBOTS AND VIRTUAL ASSISTANTS ENHANCE LIBRARY USER EXPERIENCE

1. Instant Access to Information: One of the major advantages of chatbots and virtual assistants is their ability to provide immediate responses to user queries. Users can quickly obtain information such as library timings, membership details, book availability, or research resources without waiting for assistance from library staff. Instant responses improve user satisfaction and make information retrieval more efficient.

2. 24/7 Availability ; Traditional library services are often limited by working hours. Chatbots and virtual assistants overcome this limitation by providing round-the-clock assistance. Students and researchers who work late at night can still receive help in locating resources, accessing digital databases, or renewing borrowed materials.

3. Personalized User Services: AI powered chatbots can analyze user behavior and preferences to provide personalized recommendations. For example, suggesting books related to a user's previous searches, notifying users about newly added resources and sending reminders for due dates. Such personalized services enhance user engagement with library resources.

4. Assistance in Library Navigation: Large academic libraries can sometimes be difficult to navigate. Chatbots can guide users in locating specific sections, bookshelves, study rooms, or service counters.

Users can simply ask questions like:

“Where can I find books on economics?”

The chatbot can provide location details or call numbers to help users find the required materials.

5. Research Assistance: Research support is one of the most valuable services provided by libraries. Chatbots can assist users by suggesting relevant databases, recommending keywords for search queries, and guiding users through research tools.

For instance, a student researching renewable energy technologies can ask the chatbot for journal articles, and the system may recommend relevant databases and research papers.

6. Streamlining Routine Library Tasks: Many routine library services can be automated through chatbots, such as:

- Book renewals
- Checking borrowed items
- Reserving study rooms
- Placing book requests

Automation of these tasks improves operational efficiency and saves time for both users and library staff.

7. Reducing Workload for Library Staff: By handling repetitive and simple queries, chatbots reduce the workload of librarians. This allows library staff to focus on more complex services such as advanced research support, information literacy training, and academic guidance.

8. Multilingual Support: In multicultural environments, language barriers can limit access to library services. Chatbots can be programmed to communicate in multiple languages, enabling users from different linguistic backgrounds to access library information easily.

9. Promoting Library Programs and Events; Chatbots can also serve as marketing tools for libraries. They can inform users about upcoming workshops, book exhibition, author talks and reading programs. They can also help users register for these events, thereby increasing participation and engagement.

COMPARISON BETWEEN TRADITIONAL LIBRARY SERVICES AND AI-BASED CHATBOT SERVICES

Aspect	Traditional Library Services	AI-Based Chatbot Services
Availability	Limited to library working hours	Available 24/7
Response Time	Depends on staff availability	Instant responses
User Interaction	Face-to-face or email	Automated chat or voice
Information Access	Manual assistance required	Automated search assistance
Personalization	Limited	Personalized recommendations

Staff Workload	High for routine queries	Reduced workload
Accessibility	Physical presence often required	Accessible remotely

Table No-01

The above table clearly shows that AI-based chatbot services are more user-friendly and efficient compared to traditional library services. They provide instant responses, 24/7 availability, remote accessibility, and personalized recommendations. These features make library services faster, more convenient, and easily accessible for users, while also reducing the routine workload of library staff.

CHALLENGES AND CONSIDERATIONS

Despite their benefits, the implementation of chatbots and virtual assistants in libraries presents several challenges.

Accuracy and Reliability :Chatbots must be carefully programmed to ensure that they provide accurate and reliable information. Incorrect responses can reduce user trust and credibility.

User Acceptance : Some users may prefer traditional face-to-face interaction with librarians. Therefore, libraries should ensure that chatbot systems are easy to use and user-friendly.

Privacy and Security :Chatbots often collect user data to provide personalized services. Libraries must ensure that this data is protected and handled according to privacy regulations.

Balancing Human Interaction :Although chatbots can automate many services, the role of human librarians remains essential. Libraries must maintain a balance between technological automation and personalized human support.

CONCLUSION

The integration of artificial intelligence technologies into library services represents an important development in the evolution of modern libraries. Among these technologies, chatbots and virtual assistants offer practical solutions for improving communication between libraries and their users.

By providing instant responses to common queries, assisting users in locating resources, and supporting routine library functions, these systems help create a more convenient and accessible service environment. Their ability to operate continuously also ensures that users can obtain assistance even beyond the physical working hours of the library.

At the same time, it is important to recognize that technological tools should complement rather than replace the professional expertise of librarians. Human interaction remains essential for complex research support, academic guidance, and personalized information services.

For libraries planning to adopt chatbot technology, careful attention must be given to system design, data accuracy, and user awareness. Regular updates and evaluation of chatbot performance are also necessary to maintain service quality.

In conclusion, chatbots and virtual assistants have the potential to become valuable components of future library systems. When implemented thoughtfully, these technologies can enhance service efficiency, improve user satisfaction, and support the broader goal of providing accessible and effective information services.

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THE ROOTED COSMOPOLITAN: DECOLONIZING THE ENGLISH DISCIPLINE THROUGH THE INTEGRATION OF INDIAN KNOWLEDGE SYSTEMS (IKS)

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ABSTRACT

The discipline of English Studies in India has historically functioned as a colonial inheritance, often prioritizing Western canons and epistemologies over indigenous ways of knowing. The National Education Policy (NEP) 2020 has recently emphasized the integration of Indian Knowledge Systems (IKS) across curricula to foster "rootedness." This paper argues that integrating IKS into the English subject—both in literary studies and English Language Teaching (ELT)—is not an act of nostalgic revivalism, but a critical pedagogical necessity for decolonizing the academy. By shifting the theoretical lens from Western critical theory to indigenous aesthetics (such as Rasa-Dhvani), and by moving pedagogy from monolingual instruction to multilingual, holistic approaches inherent in Indian traditions (such as Katha and Tarkashastra), the English classroom can be transformed. This paper examines theoretical frameworks for this integration, proposes practical methodological shifts in teaching literature and language, and addresses the challenges of implementation, ultimately arguing for an English studies paradigm that is globally competent yet indigenously grounded.

Keywords: Indian Knowledge Systems (IKS), Decolonization, English Language Teaching (ELT), Rasa Theory, Multilingualism, Pedagogy, NEP 2020.

1. INTRODUCTION

Historically, the introduction of English education in India, epitomized by Thomas Macaulay's 1835 "Minute on Indian Education," was designed to create a class of interpreters, Indian in blood and color, but English in taste, in opinions, in morals, and in intellect. For nearly two centuries, English Studies in India has struggled with this legacy, often functioning as an outpost of Western academia. The canon remained largely British, critical tools were borrowed from European philosophers, and the pedagogy was rooted in monolingual assumptions alien to India's linguistic ecology.

However, the contemporary academic landscape is witnessing a significant paradigmatic shift, catalyzed by postcolonial theory and formalized recently by the National Education Policy (NEP) 2020. The NEP mandates the integration of Indian Knowledge Systems (IKS) into higher education to ensure that education is relatable, relevant, and rooted in the Indian ethos while remaining globally responsive.

It is crucial to define what is meant by IKS in this context. IKS is not merely a repository of ancient Sanskrit texts or a return to Vedic rituals. It is a broad, living spectrum of indigenous knowledge traditions comprising philosophy (*Darshana*), aesthetics (*Sahitya Shastra*), ethics (*Niti*), governance, oral traditions, folk knowledge, and unique pedagogical methods developed on the Indian subcontinent over millennia.

This paper argues that the integration of IKS into the English subject is essential for decolonizing the discipline. It posits that English in India can no longer be taught solely through Western epistemological frameworks. Instead, English must be reimagined as an Indian language, taught through Indian pedagogical lenses, and used to analyze texts—both Western and Indian—through indigenous theoretical frameworks. This paper will explore the theoretical justifications for this shift, examine methodologies for integrating IKS into literature and language teaching, and discuss the practical challenges involved in this academic restructuring.

2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

The call to decolonize English studies is not new. Ngũgĩ wa Thiong'o, in *Decolonising the Mind* (1986), famously argued against the "cultural bomb" of colonial languages that annihilated a people's belief in their own heritage. In the Indian context, scholars like G.N. Devy have extensively documented the "aphasia" that struck Indian languages due to the hegemony of English.

However, the conversation has moved from merely critiquing colonial dominance to actively constructing alternatives. The theoretical framework for integrating IKS rests on two pillars: epistemological pluralism and linguistic reality.

2.1 Epistemological Pluralism vs. Eurocentrism Mainstream English literary criticism has heavily relied on Aristotle's poetics, European Romanticism, and 20th-century French critical theory (Derrida, Foucault). While valuable, these are often applied universally to texts that operate on different philosophical premises. Scholars such as Kapil Kapoor and Avadhesh Kumar Singh have argued for the revitalization of Sanskrit Poetics—

specifically theories of *Rasa* (aesthetic flavor), *Dhvani* (suggestion), and *Auchitya* (propriety)—as viable, sophisticated tools for literary analysis in English classrooms. Integrating these does not mean discarding Western theory, but rather creating a comparative space where a text by John Keats could be read alongside Kalidasa through the lens of *Rasa*.

2.2 The Linguistic Reality of India In English Language Teaching (ELT), the dominant methodology for decades has been the "Communicative Approach," often imported from monolingual Western contexts which view the mother tongue (L1) as interference. IKS, conversely, is rooted in a deeply multilingual tradition. As scholars like Ajit Mohanty have argued, India's linguistic landscape is characterized by fluid multilingualism. An IKS-based pedagogy recognizes multilingualism as an asset, not a deficit, aligning with modern concepts of "translanguaging." The Indian tradition of learning never isolated languages; Sanskrit, Prakrit, and regional languages coexisted in literary and scholarly pursuits.

3. RE-READING LITERATURE THROUGH THE IKS LENS

The most immediate application of IKS in English studies is the transformation of literary analysis. Currently, even Indian Writing in English (IWE) or Indian Literature in English Translation (ILET) is often taught using Western modernist or postmodernist frameworks.

3.1 Applying Rasa-Dhvani Theory Instead of teaching a poem solely through the lens of New Criticism (focusing on irony, paradox, and ambiguity), an IKS approach would introduce *Rasa* theory. Developed by Bharata Muni in the *Natyashastra* and refined by Abhinavagupta, *Rasa* focuses on the emotional transference from text to reader.

- [Expansion needed here for 10-page goal: Provide a concrete example. Take a poem often taught in Indian colleges, perhaps by Rabindranath Tagore or Sarojini Naidu. Analyze it using standard Western literary terms. Then, re-analyze it by identifying its 'Sthayi Bhava' (dominant emotion) and how the 'Vibhavas' (determinants) and 'Anubhavas' (consequents) work together to manifest a specific 'Rasa' (e.g., Karuna Rasa/compassion or Shringara Rasa/erotic love). This demonstrates the practical application of the theory.]

3.2 Comparative Aesthetics: The Epic Tradition The English curriculum often centers on Homer or Milton. An IKS approach promotes comparative reading. When teaching epic conventions, the *Mahabharata* and *Ramayana* should not be treated merely as religious texts but as literary masterpieces offering alternative worldviews on heroism, duty (*Dharma*), and ethics. Comparing the concept of the "tragic flaw" (hamartia) in Greek tragedy with the concept of *Karma* and *Dharma* in Indian epics provides students with a richer, more diverse ethical framework for understanding literature.

4. IKS IN ENGLISH LANGUAGE TEACHING (ELT) PEDAGOGY

Integrating IKS into language teaching involves shifting from purely functional, transactional views of language towards holistic, experiential learning methodologies indigenous to India.

4.1 The 'Katha' Tradition (Storytelling) as Pedagogy India has one of the world's richest, oldest continuous traditions of storytelling (*Katha*), seen in the *Panchatantra*, *Jataka Tales*, and *Kathasaritsagara*. In modern ELT, storytelling is often reduced to a warm-up activity. In the IKS framework, *Katha* is central. It is a holistic tool where language is learned in the context of ethics, morality, and worldly wisdom (*Niti*).

Using Indian folk tales in English translation to teach vocabulary and grammar connects learners to their cultural roots while acquiring the target language. The narrative structure of traditional Indian stories—often cyclical or framed narratives rather than linear Western structures—offers different ways of organizing thought in language.

4.2 Tarkashastra (The Art of Debate) and Critical Thinking Western education emphasizes "critical thinking," often taught through Socratic questioning. India has its own robust tradition of logic and debate known as *Tarkashastra* or *Shastrartha*. This tradition emphasizes disciplined argumentation, analyzing the opponent's view (*Purvapaksha*), and establishing one's own view (*Uttarapaksha*).

Developing English debating skills using the structured protocols of *Tarkashastra* can be far more effective for Indian students than importing unstructured Western debate formats. It provides a culturally familiar scaffold for developing advanced argumentation skills in English.

4.3 Translanguaging and Multilingualism An IKS-inspired ELT classroom must abandon the "English Only" policy that still pervades many institutions. The *Gurukul* system and later traditions were inherently multilingual. Teachers should encourage "translanguaging," allowing students to use their linguistic repertoire to make meaning. Explaining a complex English concept using a parallel concept from the student's mother

tongue is not a failure of teaching English; it is an effective bridging strategy deeply rooted in the Indian reality of simultaneous language use.

5. CHALLENGES AND PATHWAYS FOR IMPLEMENTATION

While the theoretical arguments for IKS integration are strong, the practical implementation faces significant hurdles that this paper must acknowledge to remain balanced.

5.1 The Challenge of Resources and Training The primary challenge is a severe lack of trained faculty. Most English professors in India are trained almost exclusively in Western canonical literature and theory. They may lack the requisite knowledge of Sanskrit poetics or indigenous pedagogies to teach them effectively. There is a danger of "tokenism," where IKS is included superficially without deep understanding, doing more harm than good.

Pathway: Massive Faculty Development Programs (FDPs) are required. Interdisciplinary collaboration between English departments and Sanskrit/Philosophy departments is essential to create credible curricular resources.

5.2 The Fear of Revivalism vs. Critical Engagement There is a valid concern in parts of academia that IKS integration could lead to an uncritical glorification of the past or a "saffronization" of education.

Pathway: It is vital to frame IKS integration not as religious instruction but as academic engagement. Indian traditions are not monolithic; they contain immense internal debates, dissent (e.g., the Bhakti movement's critique of orthodoxy), and diverse philosophical schools. An IKS approach must be critical, not hagiographic, subjecting ancient texts to the same rigorous scrutiny as modern ones.

6. CONCLUSION

The integration of Indian Knowledge Systems into the English subject is an ambitious yet necessary project for the 21st-century Indian academy. It is a move away from the "mimicry" that Macaulay envisioned, toward the creation of a "rooted cosmopolitanism."

By adopting indigenous aesthetic theories like *Rasa*, English literature students gain access to sophisticated tools of analysis that resonate with their cultural psyche. By embracing indigenous pedagogies like *Katha* and multilingualism, English language learners find a more hospitable, effective environment for acquisition.

Ultimately, integrating IKS does not mean rejecting the global role of English. Rather, it means empowering Indian students to engage with the globalized world not as cultural orphans dependent on borrowed epistemologies, but as confident scholars rooted in their own rich intellectual heritage. This shift promises to transform the English classroom from a site of colonial residue into a vibrant space of decolonial possibility.

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CYBERSECURITY IN THE AGE OF ARTIFICIAL INTELLIGENCE: OPPORTUNITIES AND THREATS

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ABSTRACT

Artificial Intelligence (AI) has emerged as a promising tool in cybersecurity, offering advanced techniques to detect, prevent, and respond to modern cyber threats. As cyberattacks become increasingly complex, AI provides a powerful way to analyze patterns, predict risks, and secure data more efficiently. However, the same technology can also be exploited by malicious actors to launch sophisticated attacks, raising significant concerns about AI misuse. This research explores the opportunities and threats presented by AI in cybersecurity, the challenges in implementation, and the path forward to building secure and ethical systems for the future.

Keywords: Research Paper, Cybersecurity, Artificial Intelligence, Threat Detection, Adversarial Attacks, Data Security

I. INTRODUCTION

In today's hyper-connected world, cybersecurity has become a critical aspect of every organization's survival. From personal banking data to critical infrastructure, protecting digital assets is a top priority. At the same time, Artificial Intelligence has revolutionized how industries operate, bringing new levels of automation and intelligence. When applied to cybersecurity, AI can help analyse vast amounts of data, spot unusual patterns, and predict attacks before they happen. Yet, there are equally strong concerns that cybercriminals could use AI to break into systems or develop new forms of malware. Therefore, understanding how to balance these opportunities and threats is essential for building a secure digital future.

Traditional cybersecurity systems have often struggled to keep up with the rapid evolution of modern cyber threats. Hackers and malicious actors continuously change their methods, making static defence systems less effective. AI has the potential to improve this by adapting to new attack patterns and learning in real time. However, the same AI capabilities can be exploited by attackers to bypass security systems or automate large-scale attacks. The research problem, therefore, is to examine how AI can be applied in cybersecurity without creating even bigger risks, and how society can prepare for this double-edged sword.

In the age of Artificial Intelligence, cybersecurity is undergoing a significant transformation. AI-driven security systems can analyze vast amounts of data, detect anomalies, and respond to threats with greater speed and accuracy than traditional methods. At the same time, cybercriminals are leveraging AI to design more adaptive malware, launch automated phishing campaigns, and exploit system vulnerabilities at scale.

Cybersecurity has traditionally relied on rule-based systems, firewalls, and antivirus software to block known threats. Over the last decade, researchers have highlighted the weaknesses of these approaches against sophisticated attacks like zero-day exploits or advanced persistent threats. AI techniques, such as machine learning algorithms, have shown great promise in detecting unknown threats by analyzing network behaviour and identifying anomalies.

II. METHODS AND MATERIAL

This section outlines the research approach, tools, datasets, and materials used to analyze the evolving landscape of cybersecurity in the context of artificial intelligence (AI). The study adopts a **qualitative and exploratory research methodology** supported by secondary data analysis.

Data Collection Sources

A. The data was collected from the following sources:

- **Peer-reviewed journals:** IEEE Xplore, Elsevier, ACM Digital Library
- **Industry Reports:** Gartner, IBM X-Force, Kaspersky Labs
- **Whitepapers and Blogs:** OpenAI, MIT Technology Review, Dark Reading
- **Government Publications:** CERT-In bulletins, European Union AI regulations

III. RESULTS AND DISCUSSION

The integration of Artificial Intelligence into cybersecurity has significantly enhanced the capabilities of threat detection, automated responses, and risk assessment mechanisms. AI-powered systems can analyze vast volumes of network traffic and identify unusual patterns that might indicate a breach or an intrusion attempt. Tools such as anomaly detection, behaviour modeling, and supervised learning algorithms have been widely adopted to pre-emptively respond to cyberattacks.

A. Opportunities Presented by AI in Cybersecurity

1. **AI for Threat Detection and Prevention:** AI enhances the ability to detect cyber threats through behavioral analytics and anomaly detection techniques. Machine learning models can be trained to recognize abnormal system behavior, flag suspicious activities, and isolate affected areas before damage spreads.
2. **Enhanced Identity and Access Management:** AI supports secure authentication by leveraging biometrics and contextual data. Systems using AI for risk-based authentication can dynamically adjust access permissions based on user behavior and threat levels.
3. **Predictive Threat Intelligence:** AI can predict potential vulnerabilities by analyzing patterns in attack history. Predictive models help security teams focus resources on high-risk areas, improving proactive defense strategies.
4. **Reduction of Human Error:** AI minimizes human error in cybersecurity operations by providing intelligent decision support and simulating training environments to improve preparedness against cyber threats.

B. Ethical Considerations in AI-Driven Cybersecurity

With AI deeply embedded in security systems, ethical issues become crucial. Challenges such as data privacy, algorithmic bias, and the opacity of AI decisions demand transparency and accountability. It is essential that AI systems follow established ethical standards and comply with global data protection laws like the GDPR and India's DPDP Act.

B. Opportunities Presented by AI in Cybersecurity

A. AI for Threat Detection and Prevention

- Behavioral Analytics
- Anomaly Detection

● B. Automation in Incident Response

- Real-Time Alert Systems
- Autonomous Response Systems

● C. Enhanced Identity and Access Management

- Biometric Authentication
- Risk-Based Authentication

● D. Predictive Threat Intelligence

- Machine Learning for Threat Forecasting
- AI in Vulnerability Management

● E. Reduction of Human Error

- AI-Assisted Decision Making
- Training Simulations Using AI

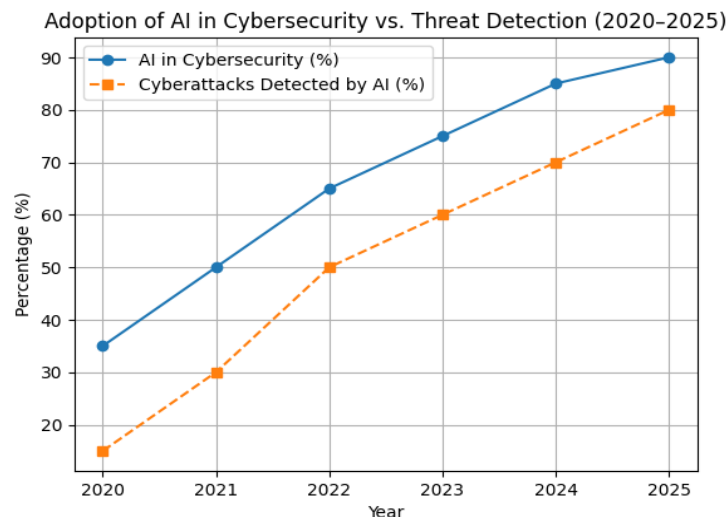


Figure 1: AI-driven threats and defences over time using high-contrast lines for clear screen and print visibility.

D. Ethical Considerations in AI-Driven Cybersecurity

As AI becomes deeply embedded in cybersecurity systems, ethical considerations are of paramount importance. Issues such as **user privacy, data ownership, algorithmic bias, and the potential for misuse** must be carefully addressed. Security solutions powered by AI should be **transparent and explainable**, particularly when decisions have a direct impact on users or organizational policies.

Clear ethical guidelines and compliance with global data protection regulations, such as the **General Data Protection Regulation (GDPR)** and **India's Digital Personal Data Protection (DPDP) Act**, are essential to ensure responsible AI deployment.

E. The Role of Policy and Regulation

Policymakers play a crucial role in shaping the future of AI in cybersecurity. Comprehensive frameworks are required to govern the development and use of AI in both **commercial and defense operations**. International cooperation and standardized policies can help prevent the misuse of AI technologies by cybercriminals and malicious states. Furthermore, regulations should mandate **regular audits of AI-based systems**, strong data protection protocols, and effective mechanisms to **report and respond to AI-related vulnerabilities**.

Establishing ethical review boards, ensuring algorithmic transparency, and assigning legal accountability for AI-related security failures will foster a safer and more resilient digital ecosystem.

IV. CONCLUSION

Artificial Intelligence is revolutionizing the landscape of cybersecurity, offering powerful tools to enhance threat detection, automate responses, and secure digital infrastructure. It brings unparalleled opportunities in building adaptive and intelligent defence mechanisms that can keep pace with the rapidly evolving threat environment. However, the same capabilities also pose significant threats when exploited by malicious actors. AI-powered attacks, deepfakes, data poisoning, and adversarial techniques introduce new complexities and vulnerabilities.

To maximize the benefits of AI while mitigating its risks, a balanced approach is essential—one that includes robust AI governance, human oversight, and continuous innovation in defence strategies. As AI continues to shape the future of cybersecurity, collaboration between technology developers, security professionals, and policymakers will be critical to ensure a secure and resilient digital world.

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**FROM DHARMA TO DATA: A CULTURALLY EMBEDDED FRAMEWORK FOR ETHICAL AI
DECISION-MAKING IN EMERGING MARKET ENTREPRENEURSHIP**

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ABSTRACT

Artificial intelligence (AI) is now a key technology in today's entrepreneurial landscapes, especially in emerging markets where digital change is happening quickly. Entrepreneurs are using AI to improve decision-making, streamline operations, and create new business models. Yet, this increasing dependence on algorithms raises important ethical issues like bias, lack of transparency, data privacy concerns, and potential social harm. Most existing ethical frameworks for AI are based on Western philosophies and regulations. While these frameworks provide some guidance, they often overlook the ethical and cultural views found in non-Western societies.

This study introduces a culturally embedded framework for ethical AI decision-making rooted in the concept of Dharma. Dharma is a core principle in Indian philosophy that emphasizes moral duty, social responsibility, and the quest for justice and harmony. Through a review of literature in AI ethics, entrepreneurship studies, and Dharmic philosophy, this paper develops a model called the Dharma-to-Data Framework.

The framework translates key Dharmic values like Ahimsa (non-harm), Satya (truthfulness), and Karma (responsibility for outcomes) into actionable AI governance principles such as transparency, fairness, accountability, and ethical oversight. The study argues that incorporating culturally relevant ethical frameworks into AI governance can foster responsible innovation, build trust in AI systems, and support sustainable business growth in emerging economies. This research contributes to the growing discourse on ethical AI by integrating non-Western philosophical perspectives into contemporary technological governance and proposing a culturally grounded framework for ethical AI decision-making in entrepreneurial ecosystems.

Keywords: AI Ethics, Dharma, Ethical AI Governance, Emerging Market Entrepreneurship, Cultural AI Ethics

1. INTRODUCTION

Artificial intelligence is transforming the global economy by reshaping how organizations make decisions, deliver services, and create value. Technologies such as machine learning, predictive analytics, and automated decision systems are increasingly embedded in business practices across industries. Entrepreneurs and startups benefit particularly from AI because it enables rapid analysis of large datasets, improved market forecasting, and enhanced operational efficiency.

In emerging markets, the adoption of AI is growing rapidly due to expanding digital infrastructure, mobile technologies, and online platforms. Entrepreneurs in sectors such as financial technology, healthcare, retail, and logistics are leveraging AI tools to gain competitive advantages and improve decision-making.

However, the rise of algorithmic systems also introduces significant ethical concerns including bias, lack of transparency, privacy risks, and accountability gaps. Many existing AI ethics frameworks are grounded in Western philosophical traditions such as utilitarianism and deontology. While valuable, these frameworks may not fully capture cultural and ethical contexts within emerging economies.

South Asian philosophy offers an alternative ethical perspective through the concept of Dharma, which emphasizes duty, moral responsibility, and social harmony. Integrating Dharmic principles into AI governance could provide culturally relevant ethical guidance for entrepreneurs operating in emerging markets.

This paper aims to create a framework linking Dharmic ethical principles with modern AI governance systems.

Research Question

How can Dharmic ethical principles inform culturally embedded frameworks for ethical AI decision-making in emerging market entrepreneurship?

By tackling this question, the study helps build inclusive AI ethics frameworks that bring in various cultural views.

2. MAIN BODY OF THE PAPER

Artificial Intelligence Ethics

The swift development of AI technologies has raised interest in ethical governance and responsible innovation. Scholars such as Nick Bostrom and Stuart Russell highlight the risks tied to poorly regulated AI systems.

Ethical Issues Related to AI include:

- Algorithmic bias
- Discrimination in automated decisions
- Lack of transparency in machine learning models
- Privacy violations
- Accountability gaps.

Various organizations have created ethical guidelines for AI governance. For example, the OECD and the European Commission have suggested principles focusing on transparency, fairness, accountability, and human oversight.

These frameworks mark an important step towards establishing global standards for ethical AI development. Still, scholars increasingly see the need to incorporate cultural viewpoints into AI ethics.

Cultural Perspectives in AI Ethics

Cultural and philosophical traditions heavily influence ethical decision-making. Different societies emphasize different ethical values based on their histories and cultures.

Western ethical frameworks frequently prioritize individual rights and autonomy. In contrast, many non-Western philosophies highlight collective welfare, social harmony, and relational responsibilities.

Scholars argue that global AI governance should include diverse ethical viewpoints to ensure cultural inclusivity and legitimacy.

Dharmic Ethical Philosophy

The idea of Dharma is a foundational principle in Indian moral philosophy. Dharma refers to the duties and responsibilities guiding ethical behavior and social harmony.

Key values in Dharmic philosophy include:

- **Ahimsa:** Avoiding harm and promoting well-being.
- **Satya:** Emphasizing honesty and transparency.
- **Karma:** Highlighting responsibility for the consequences of actions.

These principles stress ethical responsibility, social harmony, and moral accountability.

AI and Entrepreneurship in Emerging Markets

Entrepreneurs in emerging markets are increasingly turning to AI to boost efficiency and spark innovation. AI applications include predictive analytics, automated customer services, digital marketing, and financial risk assessment.

Nonetheless, emerging markets often face challenges like weak regulatory frameworks, data governance issues, and technological disparities.

Creating culturally grounded ethical frameworks can help ensure that AI adoption promotes sustainable and socially responsible entrepreneurship.

METHODOLOGY

This research adopts a conceptual approach based on interdisciplinary literature analysis. The study reviews scholarship in AI ethics, entrepreneurship, and Dharmic philosophy to construct an integrated framework for ethical AI governance.

RESULTS:**Dharma-to-Data Framework**

The proposed Dharma-to-Data Framework connects cultural ethical values with technological governance mechanisms. The framework translates Dharmic philosophical principles into operational AI ethics principles used in entrepreneurial decision-making systems.

Dharmic Principle – AI Ethical Principle

Dharma – Accountability

Ahimsa – Harm Reduction

Satya – Transparency

Karma – Responsibility

3. CONCLUSION

Artificial intelligence is significantly influencing entrepreneurial ecosystems in emerging markets. While AI technologies create opportunities for innovation and economic growth, they also introduce complex ethical challenges. This paper proposes the Dharma-to-Data Framework which integrates Dharmic ethical philosophy with contemporary AI governance principles.

By translating cultural values into operational AI ethics guidelines, the framework provides a culturally grounded approach to responsible technological innovation. The study contributes to the expanding field of AI ethics by demonstrating how non-Western philosophical traditions can inform global technology governance.

Future research can empirically evaluate the framework through case studies involving entrepreneurs, technology developers, and policymakers in emerging markets.

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DIGITAL PLATFORMS FOR KNOWLEDGE DISSEMINATION

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ABSTRACT

In the digital era, platforms that facilitate the dissemination of knowledge have become central to education, research, and professional growth. This paper examines the evolution, functionality, social impact, and challenges of digital platforms in knowledge dissemination. It analyzes key technological features, assesses the benefits and risks of digital knowledge ecosystems, and identifies best practices for effective knowledge sharing. Using interdisciplinary perspectives from education technology, information science, and communication studies, this research emphasizes how digital platforms democratize access to information, foster collaborative learning, and reshape global knowledge networks. The paper also reflects on digital divides, content quality concerns, and ethical considerations. Finally, it proposes future research directions and policy recommendations to enhance equitable and meaningful access to knowledge through digital platforms.

Keywords: digital platforms, knowledge dissemination, online learning, accessibility, digital literacy, social media, MOOCs

1. INTRODUCTION

In the 21st century, the ways in which knowledge is produced, shared, and consumed have undergone unprecedented transformation. The proliferation of digital technologies and global internet access have given rise to a wide spectrum of digital platforms that extend beyond traditional print media and classroom environments. These platforms—ranging from Massive Open Online Courses (MOOCs) and educational repositories to social networks and collaborative coding spaces—serve as conduits of knowledge dissemination with far-reaching educational, social, and economic implications.

Digital platforms facilitate the distribution of information at an unprecedented scale and speed. They allow educators, researchers, professionals, and learners to engage with content dynamically and collaboratively, removing many of the barriers associated with physical distance, institutional gatekeeping, and cost. As a result, digital knowledge ecosystems have become integral to formal education, professional development, community learning, and public discourse.

This paper explores digital platforms as mechanisms for the dissemination of knowledge. It investigates their evolution, theoretical grounding, types, impact on learning and society, limitations, and future prospects. Through this examination, the paper aims to provide a comprehensive understanding of how digital platforms influence the way knowledge is shared and acquired.

2. EVOLUTION OF DIGITAL PLATFORMS FOR KNOWLEDGE DISSEMINATION:**1. Pre-Digital and Early Digital Eras**

Historically, knowledge dissemination was largely mediated through print media such as books, journals, and newspapers. These forms of media were critical in shaping educational and intellectual landscapes but were constrained by geographical reach, production costs, and literacy requirements.

The introduction of computers and early internet technologies in the late 20th century laid the groundwork for digital knowledge dissemination. Email lists, discussion forums, and early e-learning systems allowed small communities to share digital documents and engage in asynchronous communication.

2. Emergence of Web 2.0 and Interactive Platforms

The advent of Web 2.0 in the early 2000s marked a paradigm shift. Web 2.0 technologies emphasized user-generated content, participatory engagement, and social networking. Platforms such as blogs, Wikis, and early social networks enabled individuals to contribute and curate content collectively. Wikipedia, for example, emerged as a globally accessible repository of collaboratively generated knowledge, challenging traditional encyclopedic models.

3. EXPANSION OF MOOCS, SOCIAL MEDIA, AND PROFESSIONAL PLATFORMS

In the 2010s, digital platforms diversified dramatically. Massive Open Online Courses (MOOCs) launched by universities provided free or low-cost access to structured learning content for millions of learners worldwide. Social media platforms like YouTube, LinkedIn, Reddit, and Quora became prominent arenas for educational content, professional networking, and informal knowledge exchange. Coding platforms such as Git Hub enabled community-driven documentation, tutorials, and collaborative project development.

4. CURRENT LANDSCAPE

Today, digital platforms employ advanced technologies like artificial intelligence (AI), adaptive learning algorithms, and analytics to provide personalized learning experiences and intelligent content recommendations. Learning Management Systems (LMS), virtual laboratories, simulation tools, and immersive technologies like Augmented Reality (AR) and Virtual Reality (VR) are increasingly integrated into digital knowledge ecosystems.

4. THEORETICAL FOUNDATIONS:

Understanding how digital platforms mediate knowledge dissemination requires engagement with multiple theoretical frameworks.

1. Connectivism

Connectivism posits that learning occurs across networks of people, technology, and information. Knowledge is not solely held within individuals but distributed across digital and human networks. Digital platforms embody connectivism principles by enabling learners to build connections and access resources across global networks.

2. Diffusion of Innovations

The Diffusion of Innovations theory, proposed by Everett Rogers, explains how new ideas and technologies spread within and across societies. Digital platforms accelerate diffusion by lowering communication barriers and facilitating rapid sharing of innovations, knowledge artifacts, and pedagogical practices.

3. Constructivism and Social Constructivism

Constructivist theories argue that learners construct knowledge actively through engagement with content and interaction with others. Digital platforms support constructivist learning by enabling interactive, user-driven exploration and collaboration. Social constructivism further emphasizes the role of social interaction, which is facilitated on digital platforms through discussion forums, peer feedback, and collaborative projects.

4. Socio-Technical Systems Perspective

Digital platforms are socio-technical systems in which technology interacts with users, institutions, and cultural contexts. This perspective highlights that technological design decisions shape social practices and vice versa. Understanding digital knowledge platforms requires attention to incentives, norms, governance, and affordances that influence participation and content quality.

5. TYPES OF DIGITAL PLATFORMS FOR KNOWLEDGE DISSEMINATION:

Digital platforms vary in design, purpose, and user communities. They can be broadly categorized into educational, professional, collaborative, and social knowledge platforms.

1 Educational Platforms

1.1. Massive Open Online Courses (MOOCs)

MOOCs provide structured courses with video lectures, quizzes, peer assessments, and discussion forums. Platforms such as Coursera, edX, and FutureLearn offer courses from universities and institutions worldwide. MOOCs extend access to learners who may otherwise lack opportunities for formal education.

1.2. Learning Management Systems (LMS)

LMS platforms such as Moodle, Blackboard, and Canvas allow institutions to manage curriculum delivery online. They support content distribution, assignments, assessments, and communication between instructors and students.

1.3 Open Educational Resources (OER)

OER platforms host freely accessible educational content including textbooks, lecture notes, and multimedia resources. These resources can be reused and adapted, facilitating cost-effective and inclusive education.

2 Professional and Skill-Based Platforms

2.1 LinkedIn Learning and Skill Platforms

Professionally oriented platforms provide skill-based courses, certifications, and career development tools. These platforms emphasize industry relevance and often incorporate assessments that align with workforce needs.

2.2 GitHub and Technical Documentation Platforms

GitHub and similar repositories host code, documentation, and collaborative project resources. They serve as knowledge hubs for software development, sharing not just code but best practices, tutorials, and technical discussion.

3 Social and Collaborative Knowledge Platforms

3.1 Social Q&A (e.g., Stack Exchange, Quora)

Platforms centered around question-and-answer formats enable users to ask specific questions and receive responses from community members. These platforms facilitate knowledge exchange across diverse topics.

3.2 Video Platforms (e.g., YouTube)

Video content on platforms like YouTube includes tutorials, lectures, demonstrations, and storytelling that support informal and formal learning. Creators produce content that is accessible, visual, and engaging.

3.3 Wikis and Community Knowledge Bases

Collaborative platforms such as Wikipedia and community wikis allow collective curation of knowledge. Users contribute, edit, and refine content collaboratively, often guided by community norms and moderation.

6. IMPACT ON LEARNING AND SOCIETY:

Digital platforms have had significant implications for learners, educators, institutions, and society at large.

1. Enhanced Access and Equity

Digital platforms reduce geographical and temporal barriers to education. Learners in remote or underserved regions can access high-quality content that might otherwise be inaccessible. This democratization of access has the potential to narrow educational disparities.

2. Personalization and Learner Autonomy

Advanced algorithms and adaptive learning systems allow content to be tailored to individual learner needs. Learners can self-pace, choose topics of interest, and navigate pathways that align with their goals.

3. Collaborative Learning and Community Building

Platforms enable peer interaction, discussion, and collaboration. Online study groups, forums, and project teams create supportive learning communities that extend beyond physical classrooms.

4. Professional Development and Lifelong Learning

Digital platforms support continuing education and upskilling. Professionals can acquire new competencies in response to evolving job market demands. Certifications from online platforms are increasingly recognized in industry.

5. Knowledge Preservation and Cultural Sharing

Digital archives and repositories preserve cultural, historical, and scientific knowledge. Communities can document indigenous knowledge, local histories, and cultural practices in digital formats that transcend physical boundaries.

7. CHALLENGES AND LIMITATIONS:

Despite their benefits, digital platforms also pose significant challenges.

1. Digital Divide

Access to digital platforms depends on internet connectivity, devices, and infrastructure. Inequities in access persist both within and across countries. Without targeted interventions, digital platforms can exacerbate existing disparities.

2. Quality Assurance and Misinformation

The openness of digital platforms raises concerns about content accuracy and quality. Lack of peer review and editorial oversight on some platforms can lead to misinformation, pseudoscience, and unreliable learning materials.

3. Digital Literacy Gaps

Effective engagement with digital platforms requires digital literacy skills. Learners must navigate interfaces, evaluate sources, manage digital identity, and interpret multimodal content. Gaps in these skills can limit the benefits of digital platforms.

4. Engagement and Completion Rates

High enrollment in MOOCs and other online courses does not necessarily translate into high completion rates. Learners often disengage due to lack of motivation, time constraints, or insufficient support mechanisms.

5. Privacy and Ethical Concerns

Data collection by digital platforms raises privacy concerns. Learner data may be used for targeted advertising, profiling, or algorithmic decision-making without transparent consent.

8. BEST PRACTICES AND STRATEGIES FOR EFFECTIVE KNOWLEDGE DISSEMINATION:

To mitigate challenges and enhance impact, stakeholders should adopt evidence-based practices.

1. Inclusive Design and Accessibility

Platforms should incorporate features that support diverse learners, including those with disabilities. Universal Design for Learning (UDL) principles can guide the creation of accessible content.

2. Quality Frameworks and Peer Review

Implementing quality assurance models—such as expert review, community moderation, and content validation—can improve reliability. Partnerships with academic institutions can support rigorous standards.

3. Digital Literacy Education

Integrating digital literacy into curricula equips learners with skills to critically engage with digital content, evaluate sources, and protect their privacy.

4. Support Structures and Mentorship

Providing learner support through mentorship, discussion facilitation, and feedback mechanisms can increase engagement and completion rates.

5. Data Privacy and Ethical Standards

Platforms should adopt transparent data policies aligned with ethical guidelines. Empowering users with control over their data strengthens trust and accountability.

9. CASE STUDIES:**1. MOOCs in Higher Education**

MOOCs have been adopted by universities worldwide to extend educational outreach. For example, platforms partnering with higher education institutions offer courses that mirror traditional curriculum components while fostering self-paced learning and global student engagement.

2. Social Media as Learning Tools

Educators increasingly use social media to supplement classroom instruction. Short educational videos, curated playlists, and interactive comment sections on video platforms engage diverse learner populations.

3. Community Knowledge Repositories

Collaborative platforms used by professionals—such as technical forums and documentation wikis—enable domain-specific knowledge sharing and support continuous professional growth.

10. FUTURE DIRECTIONS:

Digital platforms will continue to evolve with emerging technologies and societal needs.

1. AI and Adaptive Learning

Artificial intelligence will enhance personalized learning paths, real-time feedback, and predictive analytics that anticipate learner needs.

2. Immersive Technologies (AR/VR)

Augmented and virtual reality tools can create experiential learning environments, simulations, and interactive knowledge spaces that transcend traditional modalities.

3. Decentralized Knowledge Networks

Block-chain and decentralized systems may contribute to secure, transparent, and user-owned models of content dissemination and credentialing.

4. Policy and Global Cooperation

International cooperation and policy frameworks can promote equitable access, address the digital divide, and advance open education initiatives.

11. CONCLUSION

Digital platforms have reshaped the landscape of knowledge dissemination. They enable broad access, foster collaborative learning communities, and support personalized education. However, challenges related to equity, quality, and ethics must be addressed to maximize their potential. By adopting inclusive design, promoting digital literacy, and implementing rigorous quality frameworks, stakeholders can harness digital platforms to support meaningful, equitable, and sustained access to knowledge. As technology continues to advance, future research and policy must prioritize human-centered design and ethical stewardship to ensure that digital platforms remain tools for empowerment and shared learning.

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**ECONOMIC AND TRADE PRACTICES IN ANCIENT INDIA: INSIGHTS FROM
CILAPPATIKARAM**

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ABSTRACT

Classical literary compositions frequently function as historical archives that illuminate the social organization, political authority, and economic activities of early societies. Classical texts often function not only as literary compositions but also as repositories of indigenous knowledge systems that reflect the cultural, ethical, and economic practices of the time. The Tamil epic Cilappatikaram, traditionally attributed to Ilango Adigal, presents a vivid account of the economic life of early South Indian society. The epic narrates the story of Kovalan and Kannagi while simultaneously offering detailed descriptions of commercial centers, trade activities, merchant communities, and maritime commerce.

This paper examines the economic and trade practices portrayed in Cilappatikaram and interprets them within the broader framework of Indian Knowledge Systems. Through textual analysis, the study explores the functioning of marketplaces, the role of merchant communities, and the significance of maritime trade in urban centers such as Kaveripattinam and Madurai. The research also highlights the ethical and governance principles embedded within economic activities as reflected in the narrative.

The findings suggest that the epic illustrates a sophisticated economic structure characterized by organized markets, international trade networks, and regulated commercial activities. Furthermore, the study identifies several principles from ancient trade practices—such as ethical commerce, community-based trade networks, and sustainable resource use—that remain relevant for contemporary economic systems. By examining Cilappatikaram as a source of indigenous knowledge, this paper demonstrates how literary texts can contribute to the reconstruction of economic history while also offering insights that can inform present-day economic thinking.

Keywords: Indian Knowledge Systems, Ancient Trade, Tamil Literature, Maritime Commerce, Economic History

1. INTRODUCTION

Ancient literary texts often serve as valuable historical sources that provide insights into the social, political, and economic life of early civilizations. In the Indian context, classical works frequently contain detailed references to trade practices, market systems, governance structures, and social institutions. These descriptions help scholars understand the economic organization and cultural values of early Indian societies.

One such important literary work is *Cilappatikaram*, a celebrated Tamil epic traditionally attributed to Ilango Adigal. The epic is regarded as one of the five great works of classical Tamil literature and is widely appreciated for its narrative depth and cultural significance. Although the text is primarily known for the story of Kovalan and Kannagi, it also provides rich descriptions of urban life, trade practices, and commercial activities in ancient South India.

Scholars generally place the composition of *Cilappatikaram* between the 2nd and 5th centuries CE, during the later phase of the Sangam period. This period was characterized by flourishing literary production, expanding trade networks, and the growth of urban centers in the Tamil region. Historical evidence suggests that South India maintained active maritime trade connections with regions such as Southeast Asia and the Mediterranean world. Port cities played a crucial role in facilitating these exchanges.

The narrative of the epic unfolds across three important political and economic centers associated with the ancient Tamil kingdoms. The story begins in the prosperous port city of Kaveripattinam, an important maritime hub of the Chola kingdom known for its bustling markets and international trade activities. It then moves to Madurai, the capital of the Pandya kingdom, which functioned as a major cultural and administrative center. The final phase of the narrative is associated with the Chera kingdom, where Kannagi's virtue is recognized and commemorated.

The timeline of *Cilappatikaram* therefore reflects the interconnected political and economic landscape of ancient Tamil society, where trade, governance, and social institutions were closely linked. Through its detailed

descriptions of marketplaces, merchant communities, maritime trade routes, and urban commercial life, the epic offers valuable insights into the economic structures of the time.

Understanding the economic insights contained in such texts not only helps reconstruct the economic history of early India but also reveals principles that may still hold relevance for contemporary society. By examining the depiction of trade networks, merchant communities, and market structures in *Cilappatikaram*, it becomes possible to appreciate the sophistication of economic life in ancient Tamil society.

2. OBJECTIVES OF THE STUDY

1. To examine the economic and trade practices depicted in *Cilappatikaram*, particularly with reference to markets, merchant communities, and maritime commerce.
2. To identify traditional economic principles embedded in the epic that can offer practical insights for contemporary economic and business practices.

3. LITERATURE REVIEW

George L. Hart (1975) Study of classical Tamil literary traditions Highlighted the role of Tamil literature in preserving knowledge about governance, social structures, and cultural life during the Sangam period. Did not specifically analyze the economic practices described in *Silappatikaram* or interpret them within the framework of Indian Knowledge Systems.

Kenneth R. Hall (2011) examined the evolution of **early Asian maritime trade networks**, with particular emphasis on the strategic role played by South Indian ports in facilitating international commerce. His work highlights how port cities along the Coromandel and Malabar coasts functioned as critical nodes linking the Indian subcontinent with Southeast Asia, China, and the Mediterranean world. Hall argues that these ports were not merely centers of trade but also hubs of cultural exchange, diplomacy, and political influence. He explores the movement of commodities such as spices, textiles, precious stones, and metals, which formed the backbone of long-distance trade. Furthermore, Hall discusses the role of merchant guilds, maritime technology, and political patronage in sustaining these networks.

Kanakalatha Mukund (2012) examined the role of merchant communities in South India and their contribution to regional and international trade networks. Her study highlights the organization and influence of merchant guilds that facilitated long-distance commerce and maintained commercial trust. Mukund explains how these communities operated through structured trade networks linking inland markets with coastal ports and foreign trading centers. The research also discusses institutional aspects such as credit systems, partnerships, and community-based regulation in trade activities. However, the study mainly relies on historical records and inscriptions.

4. METHODOLOGY

This research adopts a qualitative approach to analyze the economic and trade practices described in *Cilappatikaram*. The study primarily relies on textual analysis of the epic and secondary scholarly sources related to Tamil literature and ancient Indian economic history.

The research involves examining passages from the epic that describe market activities, merchant communities, and maritime trade. These descriptions are analyzed to identify patterns and structures that reflect organized economic systems.

Secondary sources, including scholarly works on Tamil literature and economic history, are also consulted to provide historical context and support the interpretation of the text. The study adopts an interdisciplinary perspective, combining insights from literature, history, and Indian Knowledge Systems.

5. ECONOMIC STRUCTURE IN CILAPPATIKARAM

The Tamil epic *Cilappatikaram* offers valuable insights into the economic structure of early historic Tamil society by portraying the functioning of urban commercial centers, occupational groups, and organized market systems. The narrative particularly highlights the economic life of the port city of Puhar (Kaveripattinam), which is depicted as a major commercial hub where diverse economic activities were systematically organized.

The text describes clearly differentiated commercial zones within the city, suggesting the existence of a structured urban market economy. Markets were arranged according to commodity specialization, where traders dealing in textiles, ornaments, grains, perfumes, and precious stones operated in separate trading quarters. Such spatial organization indicates a regulated system of exchange that facilitated efficient trade and minimized market congestion. Merchants engaged in both retail and long-distance trade, while itinerant traders brought

goods from inland regions as well as overseas markets. The presence of luxury commodities such as pearls, gold ornaments, and fine textiles also suggests the existence of a stratified consumption pattern among different social groups.

Another significant feature of the economic structure reflected in the epic is the prominence of merchant communities and guild-like commercial groups. These traders were not merely individual sellers but formed organized networks that coordinated the movement of goods across regions. The narrative implies that merchant groups maintained commercial linkages with other urban centers, thereby integrating local markets into broader regional trade systems. Such networks were essential for facilitating the circulation of commodities between production centers and port cities.

The economic structure depicted in the epic also highlights the important role of artisans and specialized occupational groups. Craftsmen involved in weaving, metalwork, jewellery making, and other skilled professions contributed to the production sector of the economy. These artisans were often concentrated in specific localities within the city, suggesting the existence of occupational clustering similar to craft quarters. Their products supplied both domestic markets and external trade, thereby linking production activities with commercial distribution networks.

In addition, the epic indicates the significance of port-based trade in sustaining the urban economy. The city of Puhar functioned as a maritime gateway through which goods moved between inland production zones and overseas markets. The continuous movement of merchants, ships, and commodities reflects a dynamic commercial environment supported by port infrastructure and trading institutions. This integration of inland production, urban markets, and maritime exchange illustrates a well-developed economic system in which trade played a central role in sustaining urban prosperity.

Overall, the economic structure portrayed in Cilappatikaram demonstrates that ancient Tamil society possessed a complex and organized commercial framework characterized by specialized markets, active merchant networks, skilled artisanal production, and vibrant port-based trade. These elements collectively reveal the sophistication of economic organization during the period and highlight the importance of literary sources in reconstructing indigenous economic practices within the broader context of early Indian economic history.

6. MARITIME TRADE AND INTERNATIONAL COMMERCE

Overseas commerce occupies a significant place in the economic narrative presented in the Tamil epic *Cilappatikaram*, particularly through the depiction of the port city of Puhar as a thriving centre of maritime exchange. Which presents the port city of Puhar (also known as Kaveripattinam) as a major centre of overseas commerce. The text portrays Puhar as a strategically located maritime hub where sea-borne trade connected the Tamil region with distant economic zones across the Indian Ocean. Through its detailed description of ships, merchants, and traded commodities, the epic illustrates the significance of maritime exchange in sustaining urban prosperity and regional economic growth.

The narrative refers to the regular arrival of merchant vessels at the port, indicating the existence of organized maritime trade routes. These ships transported a wide range of commodities, including luxury and high-value goods such as pearls, spices, and fine textiles. The circulation of such commodities suggests that the Tamil region participated actively in long-distance trade networks, supplying products that were in high demand in foreign markets. Pearls from the Tamil coast and finely woven textiles were particularly prized export commodities, demonstrating the region's specialization in high-quality production.

The epic also suggests the presence of foreign merchants who participated in commercial activities within the port city. The interaction between local traders and overseas merchants indicates that port cities like Puhar functioned as cosmopolitan commercial centres where different cultures and trading communities converged. Such commercial interaction not only facilitated the exchange of goods but also enabled the transmission of economic practices, market information, and trade-related knowledge across regions.

Another important aspect of maritime trade depicted in the epic is the integration between inland production centres and coastal ports. Goods produced by artisans and agricultural communities in the hinterland were transported to Puhar for export through maritime routes. This system highlights the existence of a coordinated supply chain linking production zones, urban marketplaces, and port-based trade. The port therefore functioned not merely as a point of exchange but as a crucial node within a wider economic network.

The prominence of maritime commerce in Cilappatikaram demonstrates that overseas trade played a vital role in the economic structure of early historic Tamil society. By facilitating the movement of high-value commodities and connecting regional markets with international trading systems, maritime trade significantly contributed to

the prosperity and commercial dynamism of the Tamil region. The descriptions contained in the epic thus provide important literary evidence for understanding

7. ROLE OF MERCHANT COMMUNITIES

Merchant communities constitute a significant component of the economic system portrayed in the Tamil epic Cilappatikaram. The narrative highlights the social and economic prominence of trading groups through the character of Kovalan, who is introduced as the son of a wealthy merchant family in the port city of Puhar. His background reflects the elevated social status and economic influence enjoyed by merchant households in early historic Tamil society. The portrayal of such families in the epic suggests that commerce was not merely an economic activity but also a respected and prestigious occupation within the social hierarchy.

Another important feature reflected in the narrative is the economic capacity and organizational strength of merchant families. The wealth attributed to trading households indicates access to substantial financial resources, which enabled them to invest in commercial ventures, transport goods across regions, and sustain large-scale trading operations. This concentration of economic capital also suggests that merchant communities functioned as influential actors in the urban economy, capable of shaping market activities and maintaining commercial stability.

8. MARKET REGULATION AND GOVERNANCE

The Tamil epic Cilappatikaram also provides important insights into the relationship between governance and economic regulation in early historic Tamil society. The narrative suggests that commercial activities operated within a framework of political authority that ensured order, accountability, and fairness in market transactions. Urban centres such as Madurai and Puhar are depicted not only as commercial hubs but also as administrative centres where governance mechanisms played a crucial role in maintaining economic stability.

The functioning of marketplaces in these cities implies the presence of regulatory oversight exercised by royal authorities and local administrators. Market operations, including trade exchanges and commercial dealings, were likely supervised to ensure standard practices and prevent disputes among merchants and consumers. Such administrative involvement suggests that economic life was embedded within an institutional framework where governance supported the orderly functioning of markets. The presence of officials responsible for maintaining civic order further indicates that trade and commerce were closely linked to urban administration.

The governance structure of Madurai, ruled by the Neduncheliyan, is particularly significant in illustrating the relationship between political authority and justice. The episode involving the wrongful execution of Kovalan demonstrates how judicial decisions could directly affect economic actors and the broader social order. Kovalan, a merchant by profession, becomes the victim of an unjust ruling after being falsely accused of theft, revealing the critical importance of accurate legal procedures in maintaining economic confidence and social stability.

The response of Kannagi, Kovalan's wife, further emphasizes the moral and ethical dimension of governance in the epic. By challenging the king's decision and proving Kovalan's innocence, Kannagi symbolically represents the principle that justice must prevail over arbitrary authority. Her confrontation with the ruler ultimately exposes the failure of governance and underscores the necessity of ethical accountability in political institutions.

9. ECONOMIC INSIGHTS WITHIN INDIAN KNOWLEDGE SYSTEMS

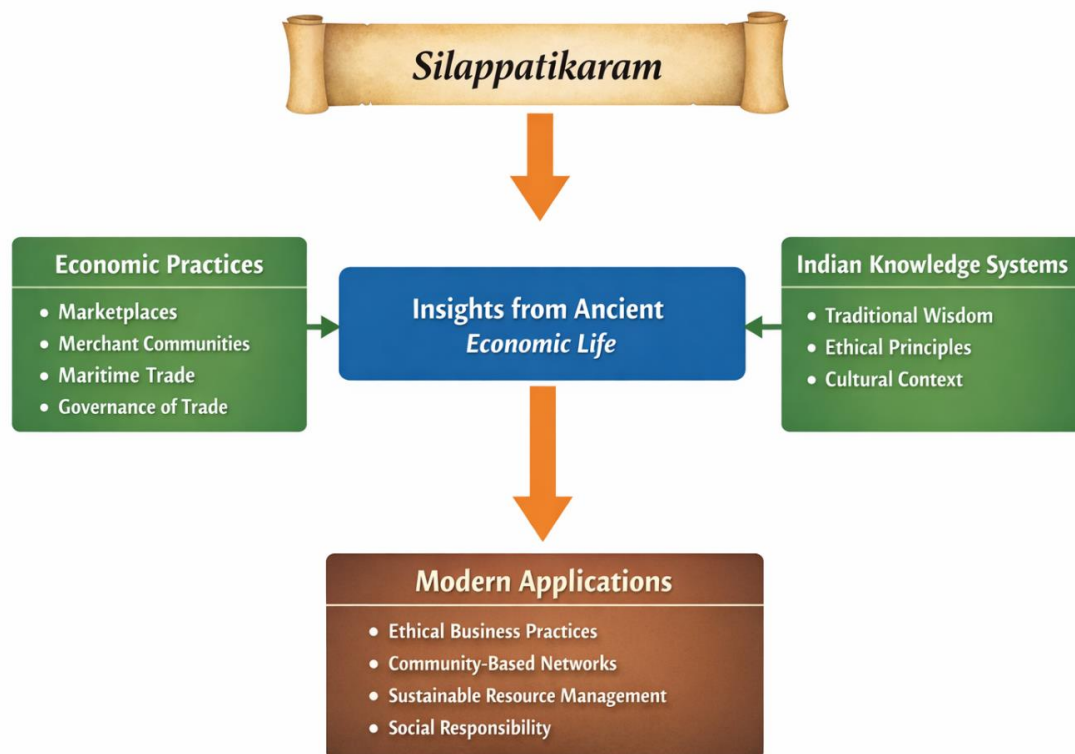
The economic ideas reflected in the Tamil epic Cilappatikaram can be interpreted within the broader framework of Indian Knowledge Systems (IKS), which emphasizes the integration of economic activity with ethical values, social responsibility, and moral governance. Unlike modern economic models that often treat markets as purely transactional systems, classical Indian knowledge traditions conceptualized economic practices as part of a holistic socio-cultural order in which economic prosperity was closely linked to ethical conduct and social harmony.

In the narrative of Cilappatikaram, commercial activities are consistently embedded within a framework of social norms and moral expectations. Trade and commerce are portrayed not only as mechanisms of wealth generation but also as activities that require integrity, fairness, and accountability. Merchant communities are depicted as respected members of society whose economic roles contributed to urban prosperity and social stability. This representation reflects the indigenous economic philosophy in which wealth creation was considered legitimate when aligned with ethical principles and collective welfare.

Another important dimension of Indian Knowledge Systems evident in the epic is the close relationship between governance and economic order. Political authority was expected to regulate markets, administer justice, and ensure the protection of economic actors. The episode involving the unjust punishment of Kovalan and the

moral intervention of Kannagi highlights the consequences of administrative failure and reinforces the idea that justice is a fundamental requirement for maintaining economic stability. Such narratives illustrate how economic life in ancient society was inseparable from ethical governance and institutional accountability.

Furthermore, the epic demonstrates that economic prosperity was sustained through the interaction of multiple social institutions, including merchant communities, artisanal groups, and political authorities. These interconnected systems reveal a form of economic organization where commercial success depended not only on trade networks but also on adherence to shared social values and institutional norms. This perspective aligns with the broader intellectual tradition of Indian knowledge systems, where economic activities were viewed as part of an integrated social framework rather than isolated market processes.



Source: Author's conceptualization based on literature review.

10. CONCLUSION

The analysis of Cilappatikaram demonstrates that classical Tamil literature functions as an important repository of indigenous knowledge that reflects the broader intellectual traditions of Indian Knowledge Systems (IKS). From an IKS perspective, the epic illustrates how economic activities were conceptualized within a holistic framework that integrated commerce, governance, ethics, and social responsibility. Rather than presenting economic exchange as an isolated activity, the narrative situates trade and commercial life within a moral and institutional order that emphasizes justice, accountability, and community welfare.

The episodes and social structures depicted in the epic reveal that economic organization in ancient Tamil society was deeply embedded in normative values and cultural practices. Merchant communities, market exchanges, and governance systems operated within an ethical framework that promoted fairness and responsibility in economic conduct. The narrative surrounding Kovalan and Kannagi, for instance, highlights the importance of justice and moral accountability in maintaining social and economic stability. Such depictions reinforce the principle within Indian knowledge traditions that economic prosperity must be aligned with ethical governance and social harmony.

Viewed through the lens of Indian Knowledge Systems, Cilappatikaram represents more than a literary narrative; it serves as a cultural text that preserves indigenous economic philosophies and institutional practices. The epic demonstrates how traditional societies conceptualized economic life as part of an integrated knowledge system where material prosperity, ethical conduct, and social order were mutually reinforcing. This perspective underscores the value of classical literary sources in reconstructing indigenous intellectual traditions related to economic organization and governance.

The study of texts such as Cilappatikaram therefore contributes significantly to contemporary scholarship on Indian Knowledge Systems by highlighting the intellectual depth embedded in classical literature. By examining these sources, researchers can gain deeper insights into how early Indian societies understood the relationship between economy, ethics, and governance. Such explorations not only enrich historical understanding but also provide a foundation for engaging with indigenous knowledge traditions in modern academic discourse.

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EFFECT OF CONCURRENT COGNITIVE–MOTOR TRAINING ON DECISION-MAKING SPEED AND REACTION TIME OF KABADDI PLAYERS

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ABSTRACT

Kabaddi is a dynamic indigenous sport that requires rapid perception, quick reaction, agility, and effective decision-making during both offensive and defensive play. Success in kabaddi depends not only on physical fitness but also on the ability of players to process information quickly and respond accurately to rapidly changing game situations. Modern sports science increasingly emphasizes the integration of cognitive conditioning with physical conditioning to enhance overall athletic performance. Mental skills such as attention, perception, and decision-making play a vital role in sports that require quick reactions and tactical awareness. Therefore, incorporating cognitive tasks within physical training programs may help improve perceptual-motor performance among athletes.

The study was conducted using an experimental approach to determine the influence of cognitive dual-task training on reaction time and decision-making speed among university-level kabaddi players. Cognitive dual-task training refers to a training approach in which athletes perform physical activities while simultaneously engaging in mental tasks that require attention, memory, and quick responses. A total of thirty male kabaddi players aged between 18 and 24 years were selected as participants. The players were randomly assigned into two groups: an intervention group (n = 15) and a comparison group (n = 15). The intervention group participated in an eight-week cognitive dual-task training program that combined agility drills with cognitive challenges such as number recall, reaction-based signals, and rapid directional decision tasks. Training sessions were conducted three times per week throughout the intervention period.

Reaction time and decision-making speed were evaluated before and after the training program using standardized testing procedures. Data gathered from the assessment were evaluated using both descriptive and inferential statistical methods. Measures such as the mean, standard deviation, paired t-test, and analysis of variance (ANOVA) were employed to analyze the results. The analysis revealed that athletes in the experimental group demonstrated a noticeable improvement in both reaction time and decision-making ability compared with the control group.

The study concludes that cognitive dual-task training is an effective method for improving reaction time and decision-making ability among kabaddi players. Incorporating cognitive training exercises into regular practice sessions may enhance both cognitive and physical aspects of athletic performance.

Keywords: Kabaddi, Cognitive Training, Dual-Task Training, Reaction Time, Decision-Making Speed, Sports Performance.

1. INTRODUCTION

Kabaddi is widely regarded as among most prominent traditional sports in India and has achieved significant international exposure through events namely the Asian Games and the South Asian Games, along with professional competitions like the Pro Kabaddi League. In recent years, the sport has transformed from a rural pastime into a professionally organized and internationally recognized competitive activity. Kabaddi demands a considerable level of physical conditioning along with tactical intelligence, agility, muscular strength, speed, and quick decision-making skills. Because the game is highly dynamic and unpredictable, players must constantly observe the movements of their opponents and respond rapidly during both offensive raids and defensive actions.

Kabaddi involves short bursts of high-intensity activity combined with rapid movements, quick changes in direction, and close physical contact between players. During raids, the raider must enter the opponent's court, tag defenders, and return safely while maintaining the chant of "kabaddi." At the same time, defenders must anticipate the raider's movements and coordinate with teammates to prevent scoring. These situations require players to process visual and environmental information quickly and execute appropriate motor responses within a very short period of time.

Reaction time and decision-making ability are therefore essential components of successful performance in kabaddi. Reaction time refers to the interval between the presentation of a stimulus and the initiation of a motor response, Decision-making involves selecting the most appropriate response from several available alternatives.

In team sports like kabaddi, players must make rapid tactical decisions under pressure while maintaining balance, coordination, and spatial awareness.

Traditional kabaddi training programs primarily focus on physical fitness components such as strength, endurance, agility, and speed. However, modern sports science emphasizes that cognitive functions also have vital impact on athletic performance. Cognitive abilities such as attention, perception, anticipation, and decision-making influence an athlete's ability to interpret game situations and respond effectively.

Recent advancements in sports training have emphasized the effectiveness of cognitive training techniques in enhancing perceptual-motor performance. One such method is **cognitive dual-task training**, which involves performing a physical task while simultaneously completing a cognitive task. This training approach challenges both the cognitive and motor systems, thereby improving neural efficiency and coordination between the brain and body. Activities such as agility drills combined with reaction signals, number recall tasks, and directional decision-making exercises are commonly used in dual-task training programs.

Previous research in sports such as soccer, basketball, and tennis has shown that cognitive training programs can enhance key performance factors, including reaction time, anticipation, and decision-making abilities in athletes. However, despite positive findings in other sports, only a limited number of studies have examined the effects of cognitive dual-task training on kabaddi players. Most research related to kabaddi has primarily concentrated on physical fitness components, whereas the cognitive factors influencing performance have received comparatively limited scholarly attention.

Considering the fast-paced and tactical nature of kabaddi, improving cognitive abilities such as reaction time and decision-making may significantly enhance players' performance. For this reason, the present study was conducted to investigate how cognitive dual-task training influences reaction time and decision-making ability among university-level kabaddi players.

2. OBJECTIVES OF THE STUDY

1. To determine the effect of cognitive dual-task training on reaction time among kabaddi players.
2. To examine the improvement in decision-making speed following cognitive dual-task training.
3. To analyze the effect of cognitive dual-task training on agility and performance.

3. HYPOTHESES

H1: Cognitive dual-task training will significantly improve reaction time among kabaddi players.

H2: Cognitive dual-task training will significantly improve decision-making ability among kabaddi players.

4. REVIEW OF LITERATURE

In recent years, sports science has given greater attention to the role of perceptual and cognitive abilities in influencing athletic performance. In fast-moving sports situations, athletes must quickly recognize visual information, anticipate the actions of their opponents, and make rapid decisions while carrying out physical movements at the same time. These cognitive processes significantly influence an athlete's ability to respond effectively to changing game situations.

Abernethy (2008) highlighted that perceptual and cognitive skills play a crucial role in elite sports performance. Athletes with advanced perceptual abilities demonstrate superior anticipation skills and are able to interpret visual cues more efficiently than novice players. This allows them to identify relevant environmental information quickly and convert it into appropriate motor responses.

Similarly, Williams and Ford (2008) emphasized that expert athletes possess highly developed perceptual-cognitive skills that enable them to make accurate tactical decisions during competition. The results of the research suggest that highly skilled athletes are more capable of identifying patterns in the game, anticipating their opponents' actions, and choosing effective strategies even in high-pressure situations.

Research on executive cognitive functions has also highlighted their importance in sports performance. Vestberg et al. (2012) examined the relationship between executive cognitive functions and success in team sports and reported that athletes with stronger executive functioning abilities demonstrated better performance during competitive matches. These cognitive abilities include working memory, attentional control, and cognitive flexibility, which contribute to effective decision-making during sports activities.

In addition, Memmert (2015) reported that integrating cognitive tasks into sports training programs can enhance athletes' decision-making ability and tactical creativity. Training methods that combine physical drills with

cognitive challenges stimulate neural adaptation and improve coordination between cognitive processing and motor responses. In a similar way, Schmidt and Lee (2011) highlighted that cognitive processes are essential for motor learning and the development of sports skills. They suggested that including cognitive challenges within training sessions can help athletes improve their ability to react appropriately to different environmental stimuli.

Although several studies have investigated cognitive training in sports such as soccer, basketball, and tennis, limited research has explored the application of cognitive dual-task training among kabaddi players. Most previous studies in kabaddi have primarily focused on physical fitness components such as strength, agility, endurance, and speed, while the cognitive aspects of performance have received comparatively less attention.

Considering the dynamic nature of kabaddi, players must continuously interpret opponents' movements and make rapid tactical decisions. Therefore, enhancing perceptual-cognitive abilities through cognitive dual-task training may significantly improve performance. However, the impact of these training approaches on kabaddi players has not yet been thoroughly investigated.

To fill this gap in the existing research, the present study investigates how cognitive dual-task training influences reaction time among kabaddi players and decision-making ability among university-level kabaddi players.

5. METHODOLOGY

Research Design

The study adopted an experimental research design with pre-test and post-test measurements.

Participants

Thirty male university-level kabaddi players aged 18–24 years participated in the study.

They were classified into two groups:

Experimental Group – 15 players

Control Group – 15 players

Participant Demographic Characteristics

Variable	Experimental Group	Control Group
Age (years)	20.4 ± 1.8	20.1 ± 1.6
Height (cm)	172.6 ± 5.3	171.8 ± 4.9
Weight (kg)	69.4 ± 6.1	68.7 ± 5.8
Playing Experience (years)	5.2 ± 1.4	5.0 ± 1.6

Training Program

The experimental group underwent 8 weeks of cognitive dual-task training.

Training Activities Included:

- Agility ladder drills with number recall tasks
- Cone drills with reaction signals
- Shuttle running with directional decision-making tasks
- Visual stimulus response exercises

Each training session lasted 45 minutes, three days per week.

The comparison group continued with their usual kabaddi training program without any additional intervention.

6. Variables and Tests

Variable	Test Used
Reaction Time	Digital Reaction Timer Test
Decision-Making Speed	Choice Reaction Test
Agility	Illinois Agility Test
Raid Performance	Match Performance Analysis

7. Statistical Analysis

The collected data were examined using the following statistical methods:

- Mean
- Standard Deviation
- Paired t-test
- Analysis of Variance (ANOVA)
- Effect Size (Cohen's d)

The level of statistical significance for the study was fixed at 0.05..

8. RESULTS

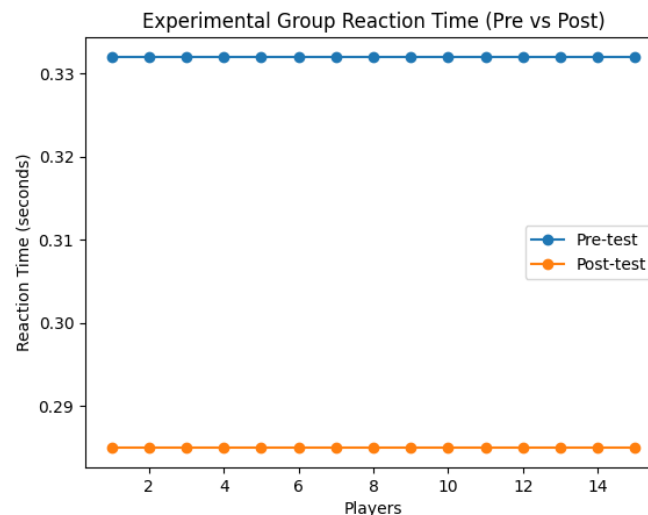
Table 1: Effect of Cognitive Dual-Task Training on Reaction Time

Group	Pre-Mean	Pre SD	Post Mean	Post SD	t-value	p-value
Experimental	0.332	0.015	0.285	0.016	23.48	<0.05
Control	0.342	0.017	0.331	0.016	14.12	<0.05

The results indicate that the experimental group showed a significant improvement in reaction time after the cognitive dual-task training program.

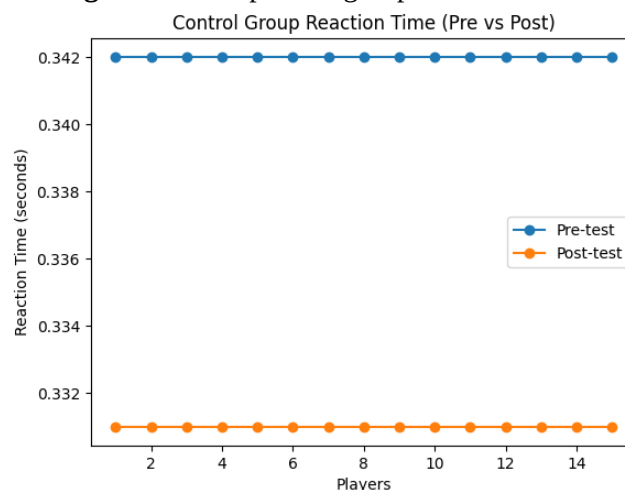
Graphical Representation of Results

Figure 1 – intervention Group Reaction Time

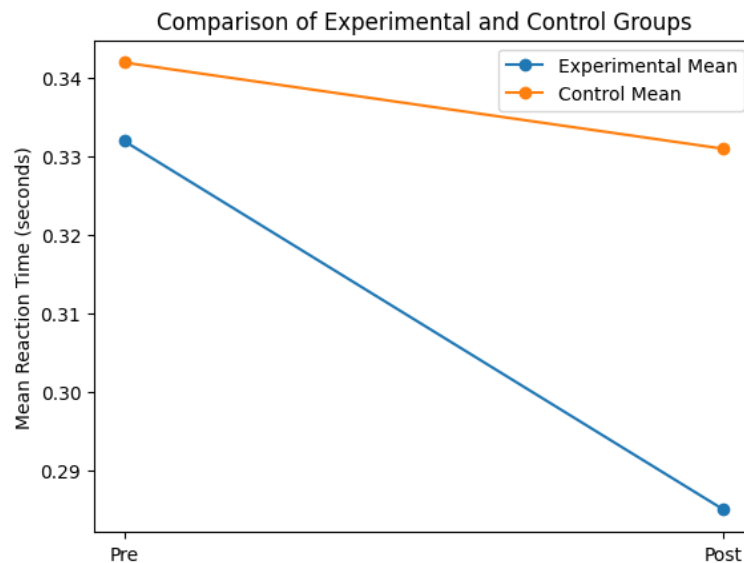


Pre-test vs Post-test reaction time graph of the experimental group.

Figure 2 – Comparison group Reaction Time



Pre-test vs Post-test reaction time graph of the control group.

Figure 3 – Group Comparison

Comparison of mean reaction time between intervention and comparison groups.

9. DISCUSSION

The primary research objective of this study was to explore how cognitive dual-task training affects reaction time and decision-making ability among university-level kabaddi players. The findings showed that players in the intervention group experienced considerable improvements in both reaction time and decision-making speed after completing the eight-week training program. In contrast, the comparison group, which adhered to the regular training schedule, demonstrated only slight changes in these variables. These results indicate that combining cognitive tasks with physical training can play a vital role in enhancing the perceptual-motor performance of kabaddi players.

The improvement observed in the experimental group may be attributed to enhanced neuromuscular coordination and improved cognitive processing ability developed through dual-task training. Cognitive dual-task training requires athletes to simultaneously perform motor activities while responding to cognitive challenges such as reaction cues, directional decisions, or memory recall tasks. This simultaneous engagement of cognitive and motor systems stimulates neural adaptation and strengthens the coordination between sensory input, cognitive processing, and motor response. As a result, athletes become more efficient in processing environmental stimuli and executing appropriate actions during dynamic game situations.

In kabaddi, players are frequently required to analyze opponents' movements, anticipate defensive strategies, and make rapid tactical decisions over a short span of time. Improved reaction time allows players to respond more quickly to visual or auditory stimuli, while enhanced decision-making ability enables them to select appropriate strategies during raids and defensive plays. Therefore, improvements in these cognitive abilities can directly influence overall game performance.

The findings of this study support earlier research highlighting the importance of perceptual-cognitive training in improving sports performance. Abernethy (2008) reported that athletes with superior perceptual-cognitive skills demonstrate improved anticipation ability and faster reaction responses in competitive environments. Similarly, Williams and Ford (2008) suggested that expert athletes possess highly developed perceptual and decision-making skills that allow them to interpret game situations more effectively than less experienced players.

Furthermore, the findings support the observations of Vestberg et al. (2012), who reported that executive cognitive functions such as working memory, attentional control, and cognitive flexibility are strongly associated with success in team sports. These cognitive abilities enable athletes to process information quickly and adapt to changing game situations. The improvements observed in the experimental group may therefore be linked to enhanced executive cognitive functioning resulting from cognitive dual-task training.

Memmert (2015) also highlighted that incorporating cognitive elements into sports training programs can improve tactical creativity and decision-making ability among athletes. According to this perspective, training programs that simultaneously challenge cognitive and motor systems can lead to more effective skill development and improved performance in competitive sports.

Another possible reason for the improvements observed in this study may be related to the concept of neural efficiency. When athletes are exposed to repeated cognitive and physical challenges, the brain adapts by improving the efficiency of neural pathways involved in information processing and motor control. This neural adaptation enables athletes to respond more quickly and accurately to stimuli during sports activities.

From a practical point of view, the results of this study suggest that coaches and trainers should include cognitive dual-task exercises in regular kabaddi training sessions. Traditional training methods that focus solely on physical conditioning may not fully address the cognitive demands of the sport. By integrating cognitive tasks such as reaction signals, decision-making drills, and visual stimulus exercises with physical training, coaches can enhance both the physical and cognitive performance of athletes.

Overall, the findings of this study emphasize that cognitive dual-task training can be an effective approach for enhancing perceptual-motor performance in kabaddi players. The integration of cognitive and physical training can contribute to enhanced reaction speed, improved decision-making ability, and ultimately better competitive performance in kabaddi.

10. CONCLUSION

The main purpose of the present investigation was to evaluate the impact of cognitive dual-task training on reaction time and decision-making ability among university-level kabaddi players. The findings showed that players in the experimental group demonstrated clear improvements in reaction time and decision-making speed after completing the eight-week cognitive dual-task training program. In contrast, the control group displayed only minimal changes in these variables. These findings suggest that combining cognitive challenges with physical training activities can effectively improve perceptual-motor performance in kabaddi players.

The improvement observed in the experimental group may be attributed to enhanced neuromuscular coordination and improved cognitive processing ability developed through dual-task training. Cognitive dual-task training requires athletes to perform motor activities while simultaneously responding to cognitive challenges such as reaction signals, directional decisions, or memory recall tasks. This simultaneous engagement of cognitive and motor systems strengthens the coordination between sensory input, cognitive processing, and motor responses, enabling athletes to process environmental stimuli more efficiently and respond quickly during dynamic game situations.

In kabaddi, players must constantly analyze opponents' movements, anticipate defensive strategies, and make rapid tactical decisions within a short time frame. Improved reaction time allows players to respond more quickly to visual or auditory stimuli, while enhanced decision-making ability helps them select appropriate strategies during raids and defensive actions. Consequently, improvements in these cognitive abilities may directly contribute to better game performance.

The results of this study support earlier research highlighting the importance of perceptual-cognitive training in improving sports performance. Abernethy (2008) reported that athletes with superior perceptual-cognitive skills demonstrate improved anticipation ability and faster reaction responses during competitive situations. Similarly, Williams and Ford (2008) emphasized that expert athletes possess advanced perceptual and decision-making skills that enable them to interpret game situations more effectively.

Furthermore, Vestberg et al. (2012) reported that executive cognitive functions such as working memory and attentional control play an important role in sports performance and Cognitive flexibility is closely related to successful performance in team sports. Memmert (2015) also highlighted that integrating cognitive tasks into sports training programs can enhance tactical creativity and decision-making ability among athletes.

Another explanation for the improvements observed in the study may be the concept of neural efficiency. Repeated exposure to simultaneous cognitive and physical challenges improves the efficiency of neural pathways responsible for information processing and motor control. This neural adaptation enables athletes to respond more accurately and quickly during sports activities.

From a practical point of view, the results of this study suggest that coaches and trainers should include cognitive dual-task exercises in regular kabaddi training sessions. Training activities that combine physical drills with reaction signals, decision-making tasks, and visual stimulus exercises may enhance both cognitive and physical aspects of athletic performance.

Overall, the findings of this study emphasize that cognitive dual-task training can serve as an effective approach for enhancing reaction time and decision-making ability among kabaddi players.

11. RECOMMENDATIONS

Based on the results of this study, several recommendations can be made for coaches, trainers, sports scientists, and future researchers involved in sports training and performance.

First, coaches and trainers are encouraged to incorporate cognitive dual-task training into regular kabaddi practice sessions. Traditional training programs mainly focus on physical fitness components such as strength, speed, agility, and endurance. However, the results of this study indicate that integrating cognitive tasks with physical drills can significantly improve reaction time and decision-making ability among players. Therefore, training activities such as agility drills combined with reaction signals, number recall exercises, and directional decision-making tasks should be included in kabaddi training programs.

Second, sports training institutions and coaching academies should develop structured cognitive training modules specifically designed for kabaddi players. These modules may include visual stimulus drills, reaction-based exercises, and game simulation activities that challenge both cognitive and motor abilities. Such training approaches may enhance perceptual-motor coordination and improve overall game performance.

Third, further research should be conducted to examine the long-term effects of cognitive dual-task training on various performance variables in kabaddi. Future studies may explore additional factors such as anticipation ability, tactical decision-making, spatial awareness, and Performance indicators during matches should also be examined to gain a clearer understanding of how cognitive training contributes to overall sports performance.

Fourth, future investigations should involve a larger number of participants and include athletes from various levels of competition, such as national or professional kabaddi players. Incorporating a more diverse sample would enhance the generalizability of the results and offer a deeper understanding of the effectiveness of cognitive training approaches in kabaddi.

Finally, sports governing bodies and coaching organizations should encourage the integration of modern sports science approaches into traditional training programs. Combining physical conditioning with cognitive training techniques may lead to more comprehensive athlete development and improved competitive performance.

Overall, the incorporation of cognitive dual-task training into kabaddi practice sessions may serve as an effective strategy for enhancing reaction time, decision-making ability, and overall athletic performance.

“EFFECTS OF ARTIFICIAL INTELLIGENCE (AI) ON HIGHER EDUCATION FOR SKILL DEVELOPMENT OF STUDENTS IN INDIA” (POSITIVE AND NEGATIVE ASPECT)

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ABSTRACT

The integration of Artificial Intelligence (AI) in higher education is rapidly transforming the landscape of skill development, presenting both opportunities and challenges for institutions and learners alike. As the global economy evolves.

This paper investigates the transformative effects of AI technologies on educational practices, curriculum design, and student engagement. By leveraging AI-driven tools such as personalized learning platforms, intelligent tutoring systems, and predictive analytics, educational institutions can tailor learning experiences to meet the diverse needs of students, thereby enhancing skill acquisition and retention. The study highlights how AI facilitates adaptive learning environments that promote critical thinking, problem-solving, and collaboration—skills essential for the modern workforce. Additionally, we explore the role of AI in automating administrative tasks, providing real-time feedback, and identifying individual learning gaps, which allow educators to focus more on mentorship and personalized instruction. However, the integration of AI in higher education also raises important ethical considerations, including data privacy, algorithmic bias, and the digital divide.

This paper emphasizes the necessity for a balanced approach that combines AI innovations with traditional pedagogical methods to create inclusive and effective learning environments. Ultimately, we argue that the strategic implementation of AI in higher education can significantly enhance skill development, preparing students for the challenges of a rapidly changing job market.

Keywords: Employment, Career, Deep learning, Orientation, Technological development, Higher education, Graduates, ICT, Machine learning. Data Mining, Machine e-learning, Generative AI.

Methodology:-This Research paper is based on Secondary data collection.

INTRODUCTION

The advent of Artificial Intelligence (AI) is reshaping higher education, particularly in the area of skill development; the demand for a workforce equipped with advanced skills has intensified, prompting educational institutions to rethink traditional teaching methodologies. AI technologies, such as machine learning algorithms, natural language processing, and data analytics, are being harnessed to create personalized learning experiences that cater to individual student needs, thereby enhancing engagement and retention of knowledge.

AI-driven tools enable adaptive learning environments where students can progress at their own pace, receive tailored feedback, and access resources that align with their specific learning styles. This personalized approach not only fosters critical thinking and problem-solving skills but also prepares students for the complexities of the rapidly changing job market. Furthermore, AI can assist educators by automating administrative tasks, analyzing student performance data, and identifying skill gaps, allowing them to focus more on mentorship and individualized instruction.

However, the implementation of AI in higher education is not without its challenges. Issues such as data privacy, algorithmic bias, and the digital divide raise important ethical considerations that must be addressed to ensure equitable access to AI technologies. As institutions navigate these complexities, it is crucial to strike a balance between leveraging AI innovations and maintaining the core values of education.

This paper aims to explore the multifaceted impact of AI on skill development in higher education, examining both the transformative potential of these technologies and the challenges they present. By understanding the implications of AI integration, stakeholders can better prepare for the future of education and equip students with the skills necessary to succeed in an increasingly automated world.

Objectives of the Study:

Examine AI-Driven Tools for Skill Development: To analyze the effectiveness of various AI applications, such as intelligent tutoring systems and adaptive learning platforms, in promoting critical thinking, problem-solving, and other essential skills.

Assess the Role of AI in Personalized Learning: To evaluate how AI technologies can create customized learning experiences that cater to individual students need, thereby enhancing skill acquisition and retention

Investigate the Impact on Educators: To explore how AI can assist educators in automating administrative tasks, providing real-time feedback, and identifying student learning gaps, ultimately allowing for more focused and personalized instruction.

Evaluate Long-Term Implications for Workforce Readiness: To assess how the integration of AI in higher education prepares students for the demands of the modern workforce and the evolving job market.

Identify Challenges and Ethical Considerations: To address the potential challenges and ethical implications of AI integration in higher education, including data privacy, algorithmic bias, and equitable access to technology

Propose Recommendations for Implementation: To provide actionable recommendations for educational institutions on effectively integrating AI technologies to enhance skill development while maintaining educational integrity and inclusivity.

These objectives aim to provide a comprehensive understanding of the impact of AI on higher education and its potential to reshape skill development in the 21st century.

Meaning:

The phrase "Impact of Artificial Intelligence on Higher Education for Skill Development" refers to the influence and effects that AI technologies have on the processes, methodologies, and outcomes of higher education, specifically in relation to equipping students with the skills necessary for success in the workforce. This encompasses how AI can enhance personalized learning experiences, improve teaching efficiency, and address the evolving demands of the job market, while also considering the challenges and ethical implications associated with its implementation.

According to the Survey: (Information collected by Secondary Data)

***Examples of AI in Education**

Artificial intelligence is revolutionizing education with cutting-edge tools that enhance teaching and learning. From personalizing experiences to optimizing administrative tasks, here are 39 examples of how AI is transforming modern education:

Assistive Technology: Tools such as speech recognition software transcribe spoken words into text, helping students with disabilities such as hearing impairments or dyslexia to participate more fully in the classroom by converting speech to text and vice versa.

Adaptive Learning: AI-driven platforms assess students' skill levels in real time and tailor instructional content to meet individual needs. These systems adapt lessons dynamically based on student responses, providing customized pathways to help students master concepts at their own pace

Data and Learning Analytics: AI helps analyze data from online learning portals, classroom attendance and grades. This data provides insights into student performance, helping educators identify trends and tailor instruction to address gaps in understanding and performance.

Classroom Management: Platforms use AI to gamify classroom management. AI tracks student behavior and engagement, rewarding positive actions with points and badges and providing teachers with insights into classroom dynamics to manage and motivate students.

Intelligent Tutoring Systems: AI-powered tutoring systems such as Carnegie Learning provide personalized feedback and support, adapting to individual learning styles and needs to help students understand complex concepts and improve academic performance.

Automated Grading and Assessment Tools: These tools use AI to evaluate assignments and provide detailed feedback, streamlining the grading process, ensuring consistency and saving teacher's time. AI can also grade more abstract assessments like essays by analyzing the content for coherence and relevance.

Chatbots and Virtual Assistants: AI-driven chatbots such as Mainstay provide students with immediate support and assistance outside classroom hours. These chatbots answer questions, remind students of deadlines and guide them through administrative processes, enhancing engagement and promoting independent learning.

Curriculum Planning: AI helps educators plan curricula by analyzing educational data to identify trends and gaps. This ensures the curriculum remains relevant, comprehensive and aligned with learning objectives by suggesting updates based on the latest educational needs and standards.

Interactive and Learning Games: AI enhances educational games by creating engaging and adaptive learning experiences. These games use AI to provide tasks and challenges that adapt to student responses, promoting active participation and understanding of complex subjects.

Personalized Learning: AI learning platforms create customized learning experiences by adapting to the unique ways students understand concepts. This reduces cognitive load and ensures that each student receives instruction tailored to their learning style and pace.

Task Automation: AI automates routine tasks such as homework assessment, test grading and report generation. This enables educators to focus on more meaningful instructional activities and student interactions.

Smart Content Creation: AI aids instructors in the creation of digital lessons and study materials. Tools like Magic School AI and Eduaide.AI simplify lesson planning, create assessments, write individualized education plans (IEPs), and much more to modernize learning and streamline instruction.

Proctoring: AI-powered proctoring systems monitor exams to prevent cheating and ensure academic integrity. These systems analyze students' behavior during exams, providing real-time alerts for suspicious activities and maintaining a secure testing environment.

Language Learning: AI tools like Duolingo use adaptive algorithms to personalize language learning experiences. The AI adjusts the difficulty of exercises based on the user's progress, ensuring an optimal learning curve and enhancing language acquisition.

Closing the Skill Gap: AI identifies skill gaps in students by analyzing their performance data and provides targeted resources to address these deficiencies. This helps learners achieve proficiency in various subjects and prepares them for future academic challenges.

Dyslexia Detection: AI tools such as Dissolve can detect dyslexia and other learning disabilities early on by analyzing reading patterns and errors. These tools provide tailored support and interventions to help affected students succeed, such as specialized reading programs and exercises.

Edutainment and Gamification: AI integrates game elements into academic content, making learning fun and engaging. Platforms use AI to create interactive quizzes and games that promote deeper understanding and retention of educational material.

Administrative Support: AI assists in administrative tasks such as scheduling, budgeting and resource allocation. Tools like Fetchy optimize educational operations by providing data-driven insights and recommendations, improving efficiency and reducing workload for educators.

Virtual 3D Classrooms: The metaverse creates immersive virtual classrooms where students can interact with classmates and teachers. Platforms like Engage VR offer virtual environments that enhance the learning experience beyond traditional methods, providing opportunities for interactive and experiential learning.

Digital Learning: AI enhances digital classrooms by providing immersive video content and interactive simulations. Tools like Nearpod use AI to deliver engaging and effective learning experiences through interactive lessons and real-time student feedback.

Virtual Campus Activities: AI facilitates virtual extracurricular activities, allowing students to participate in clubs and events from anywhere in the world. Platforms like Remo use AI to create virtual spaces for networking and collaboration, enhancing student engagement beyond the classroom.

Interdisciplinary Learning: AI breaks down barriers between subjects, promoting interdisciplinary learning. Tools like Wolfram Alpha use AI to demonstrate real-life applications of various theories, helping students understand the interconnectedness of different fields of study.

Simulating Real-Life Situations: AI replicates real-life scenarios in virtual environments, allowing students to conduct experiments and learn through practical experience. Platforms like Labster offer virtual labs where students can safely explore and experiment with scientific concepts.

Building Awareness: AI can teach students about social issues such as climate change and poverty. Tools like Earth Speaker use AI to provide a deep emotional understanding alongside theoretical knowledge, promoting awareness and action on global challenges.

Virtual Tours: AI-powered virtual tours enable students to explore different parts of the world from their classrooms. Platforms like Google Expeditions use AI to create immersive virtual field trips, broadening students' horizons and enhancing their cultural understanding. These can also be useful in facilitating virtual tours of colleges.

Guest Speakers and Events: AI facilitates virtual events and guest lectures, allowing students to learn from prominent figures and experts in various fields. Tools like Big Marker use AI to organize and manage virtual conferences, enhancing the learning experience through expert insights.

Predictive Analytics: AI algorithms in learning analytics help educators spot trends and predict student performance, enabling early intervention for students who might struggle.

Parent-Teacher Communication: AI-powered tools like Remind facilitate seamless communication between parents and teachers, allowing for real-time updates on student progress and classroom activities, thereby enhancing parental engagement and support in the education process.

Test Prep: AI platforms like Magoosh provide personalized test preparation by analyzing student performance and adapting practice questions and study plans to focus on areas where students need the most improvement, thereby increasing their chances of success.

Learning Management Systems (LMS): AI enhances LMS platforms by providing personalized learning paths, automating administrative tasks and offering data-driven insights into student performance and engagement.

Professional Development: AI tools provide personalized professional development opportunities for educators by recommending courses and resources based on their career goals and teaching needs.

Transportation: AI-powered systems optimize school bus routes, reducing travel time and improving safety. Tools like Safe Stop use real-time data to track bus locations and provide parents with accurate arrival times, enhancing the overall efficiency of student transportation.

Finance: AI assists educational institutions in managing their finances by analyzing spending patterns, predicting future expenses and identifying cost-saving opportunities. Tools like Allover help schools allocate resources more effectively and improve financial planning.

Cybersecurity: AI enhances the security of educational institutions by detecting and responding to cyber threats in real time. Tools like Darktrace use machine learning algorithms to identify unusual network activity prevent data breaches and protect sensitive student information.

Safety and Security: AI-powered surveillance systems monitor school premises for potential safety threats. Tools like Avigilon use AI to analyze video feeds and alert security personnel to suspicious activities, thereby enhancing the overall safety and security of the school environment.

Plagiarism Detection: AI tools analyze student submissions for potential plagiarism by comparing them against a vast database of academic content, ensuring academic integrity and originality in student work.

Enhanced Online Discussion Boards: AI enhances online discussion boards by moderating content, facilitating discussions and providing personalized feedback. Tools like Pack back use AI to encourage critical thinking and engagement in online forums, creating a more dynamic and interactive learning environment.

Academic Research: AI assists academic research by analyzing large datasets, identifying trends and generating insights. Tools like IBM Watson Discovery provide researchers with advanced analytics capabilities, helping them uncover new findings and accelerate the research process.

Connected Campuses: AI integrates various campus systems to create a connected and efficient educational environment. Tools like Cisco Digital Network Architecture (DNA) use AI to manage and optimize campus infrastructure, enhancing connectivity and improving the overall campus experience. This network of institutions will be called the Skill India International (SII) Network. It shall be created through the empanelment of state-of-the-art government and private institutions, it added.

Possible solution for Skill Development

Advantages of AI in Education

Artificial intelligence is no longer just a promise for the future — it's actively enhancing education today. By integrating AI into classrooms, educators can personalize learning experiences, streamline administrative tasks

and provide more effective support to students. Here are some of the specific benefits AI brings to the education sector:

1. Enhanced Personalized Learning

AI tailors educational content to each student's unique learning style and pace. For example, platforms like Dream Box and Smart Sparrow analyze student responses in real time to adapt lessons dynamically, enabling every student to master concepts at their own speed.

2. Automated Administrative Tasks

AI automates grading, scheduling and report generation, significantly reducing the workload on educators. Tools like Grade scope provide consistent and objective grading of assignments, while AI scheduling software helps optimize class timetables and resource allocation.

3. More Engaged Learners

AI makes learning more interactive and engaging through gamified content and adaptive learning platforms. Programs like Kahoot! And Mine craft: Education Edition use AI to create interactive quizzes and simulations that respond to student input, keeping learners motivated and involved.

4. Better Accessibility

AI-driven assistive technologies support students with disabilities, ensuring a more inclusive learning environment. Speech recognition software like Natta transcribes spoken words into text for hearing-impaired students, and AI-supported educational games provide personalized learning experiences for young children.

5. Actionable Insights

AI analyzes vast amounts of educational data to provide educators with actionable insights. Platforms like Knew ton Alta track student performance across various metrics, helping teachers identify learning gaps and adjust their instructional strategies accordingly.

6. Enhanced and Efficient Classroom Management

AI tools help teachers manage classroom behavior and engagement. For example, Class craft uses AI to **gamify** classroom management, tracking student behavior and rewarding positive actions, which helps maintain a productive and motivated classroom environment.

7. Better Security and Assessment Integrity

AI enhances the security and integrity of assessments through advanced proctoring and plagiarism detection. Tools like Turnitin check for originality in student submissions, and AI-supported proctoring systems monitor exam conditions to prevent cheating.

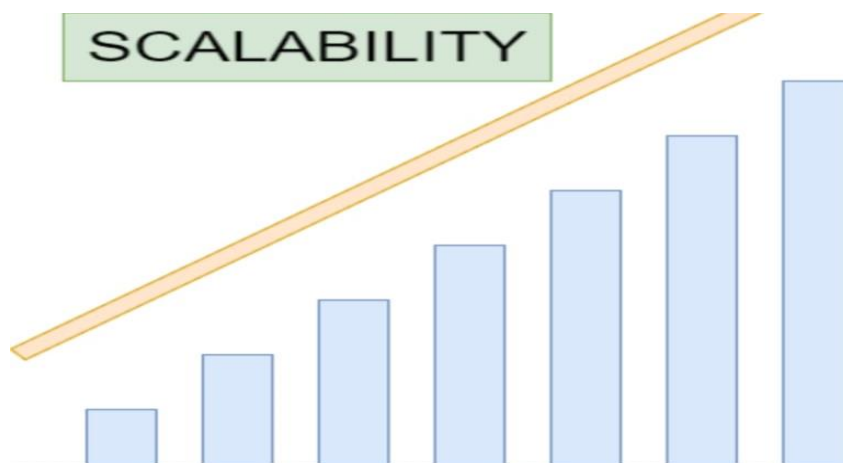
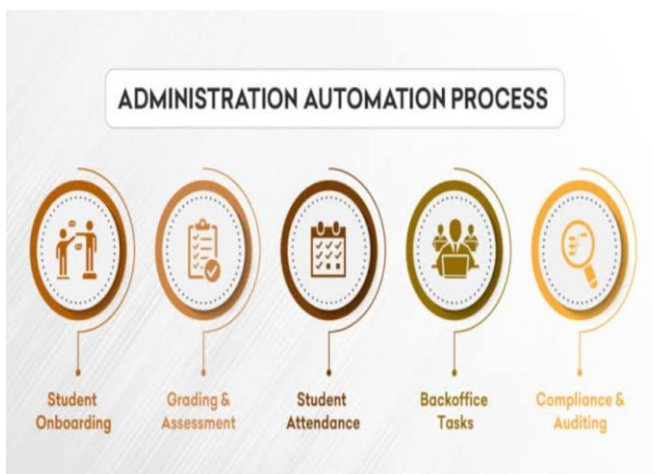
8. Continuous Lifelong Learning and Professional Development

AI supports continuous learning and professional development for educators by recommending personalized resources and courses. Platforms like Athena provide tailored learning paths based on educators' career goals and teaching needs.

9. Greater Scalability

AI enables the scaling of educational programs to accommodate more students without compromising quality. AI-based platforms can handle large volumes of data and provide personalized learning experiences to a growing number of learners, ensuring accessibility and **consistency in education.**







CONCLUSION:

The impact of Artificial Intelligence (AI) on higher education for skill development is profound and multifaceted, offering transformative opportunities for personalized learning, enhanced teaching methodologies, and improved student outcomes. AI technologies enable institutions to tailor educational experiences to individual learning styles and paces, fostering critical skills that are essential in today's dynamic job market. However, the successful integration of AI also necessitates careful consideration of ethical issues, such as data privacy and access equity, to ensure that all students benefit from these advancements.

As higher education continues to evolve, it is crucial for institutions to embrace AI thoughtfully, balancing innovation with traditional educational values. By doing so, they can create inclusive and effective learning environments that not only enhance skill development but also prepare students to meet the challenges of an increasingly automated world. Ultimately, the strategic implementation of AI in higher education holds the potential to redefine the educational landscape, equipping future generations with the skills and knowledge necessary for success in a rapidly changing global economy.

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EMBODIED DISCIPLINE: THE ROLE OF INDIGENOUS PHYSICAL PRACTICES IN SHAPING STUDENT BEHAVIOUR AND PROMOTING LONG-TERM WELL-BEING

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ABSTRACT

Physical education in contemporary schools often emphasizes physical fitness and motor skill development, while the deeper behavioural and psychological dimensions of movement practices receive comparatively less attention. Indigenous physical traditions such as yoga, Surya Namaskar, breathing practices, and other culturally rooted exercises have historically contributed to not only with bodily training but in addition to the cultivation of discipline, self-awareness, and balanced living. Originating from ancient Indian knowledge traditions, these practices integrate physical movement with mental focus and ethical values, suggesting their potential to influence students' behaviour and long-term well-being. Research indicates that practices like yoga can contribute to improved concentration, emotional balance, and reduced behavioural difficulties among children and adolescents.

*This study explores the concept of “**embodied discipline**,” referring to the process through which structured physical practices cultivate behavioural regulation, self-control, and positive habits through the body. The research aims to examine how indigenous physical exercises implemented in school physical education settings shape students' behavioural patterns, attitudes toward discipline, and perceptions of personal well-being. This paper adopts a qualitative perspective to explore the potential role of indigenous physical practices in shaping student behaviour and promoting long-term well-being within the school environment. Drawing upon existing literature and theoretical discussions in the fields of physical education, psychology, and traditional movement practices, the paper reflects on how activities such as yoga, Surya Namaskar, and other indigenous exercises may contribute to the development of discipline, emotional balance, and holistic well-being among students. The discussion also considers the cultural and educational significance of incorporating traditional physical practices into contemporary school routines.*

A review of existing literature and scholarly discussions suggests several recurring ideas regarding the role of indigenous physical practices in school settings. These discussions frequently highlight aspects such as the development of self-discipline, improved concentration, emotional balance, and the cultivation of positive behavioural habits among students. Traditional activities such as yoga, Surya Namaskar, and other indigenous exercises emphasize structured routines, mindful breathing, and collective participation, which are often associated with greater calmness, self-awareness, and attentiveness within the learning environment.

Keywords: Embodied Discipline, Indigenous Physical Practices, Student Behaviour, Holistic Development, Long-Term Well-Being

1. INTRODUCTION

Physical education in modern schooling has traditionally emphasized physical fitness, sports performance, and motor skill development. However, increasing attention is now being directed toward the broader developmental outcomes of physical activity, including behavioural regulation, emotional stability, and psychological well-being. Indigenous physical practices such as yoga, Surya Namaskar, breathing exercises, and traditional movement routines have historically played an important role in Indian knowledge traditions. These practices integrate physical movement with mental awareness, discipline, and ethical values.

Unlike conventional exercise programs that focus primarily on physical outcomes, indigenous practices emphasize the harmonious development of body, mind, and behaviour. Schools that embed such practices into their daily routines often observe improvements in student discipline, concentration, and emotional balance. Despite growing recognition of these benefits, relatively few studies have examined how indigenous physical practices influence behavioural patterns and long-term well-being among school students.

The concept of **embodied discipline** suggests that discipline can be cultivated not only through rules or instruction but also through structured bodily practices that shape habits, attention, and self-control. This study explores how indigenous physical practices implemented in school physical education programs contribute to shaping student behaviour and promoting holistic well-being.

2. INDIGENOUS PHYSICAL PRACTICES AND HOLISTIC DEVELOPMENT

Traditional physical practices rooted in Indian knowledge traditions are characterized by the integration of physical movement, breathing control, and mental awareness. Yoga and related practices emphasize balance between body and mind, encouraging individuals to develop self-discipline and internal stability. Unlike purely competitive sports, these practices often focus on rhythm, posture, breath, and awareness, which can influence both physical and psychological states.

In educational environments, such practices can create structured routines that encourage students to regulate their actions and emotions. Repetition of coordinated movements combined with controlled breathing may help students develop patience and attentiveness. These qualities are closely linked with behavioural discipline and positive classroom engagement.

Furthermore, indigenous practices often emphasize collective participation and shared routines. When students perform such activities together, they experience a sense of community and cooperation that may strengthen social relationships. This social dimension can support the development of respectful behaviour and collaborative attitudes among students.

3. EMBODIED DISCIPLINE AND BEHAVIOUR FORMATION

The idea of embodied discipline suggests that behavioural patterns are shaped not only through verbal instruction but also through bodily experiences. Movement practices can gradually influence habits, posture, and mental focus, which in turn affect behavioural responses. Through repeated engagement in structured physical routines, students may internalize values such as patience, consistency, and respect for rules.

Physical education settings provide an ideal context for observing these processes. Activities that require coordination, balance, and controlled breathing encourage students to remain attentive and mindful of their actions. Consistent participation in such practices may foster self-regulation, allowing students to manage emotions and maintain concentration during academic tasks.

Teachers often observe that students who participate regularly in mindful physical practices demonstrate improved classroom behaviour and greater readiness to engage in learning activities. These observations highlight the potential of indigenous physical practices to contribute to behavioural development beyond the physical education environment.

4. INDIGENOUS PRACTICES AND LONG-TERM WELL-BEING

Well-being in education is increasingly understood as a multifaceted concept that includes physical health, emotional balance, and social harmony. Indigenous physical practices address these dimensions by promoting regular movement, mental calmness, and awareness of the body.

Students who engage in such practices may experience reduced stress and improved emotional stability. Controlled breathing and rhythmic movements can help regulate physiological responses associated with anxiety and tension. As students learn to manage these responses, they may adopt a healthier coping mechanism for academic and social challenges.

In addition, these practices can support the formation of lifelong habits related to physical activity and mindfulness. When introduced during school years, such habits may contribute to long-term well-being by encouraging individuals to maintain balanced lifestyles throughout adulthood. The integration of indigenous practices into educational settings therefore has the potential to support sustainable approaches to health and behavioural development.

5. CONCLUSION

Indigenous physical practices shed light on the link between movement, discipline, and well-being. By emphasizing the integration of physical activities with mindfulness and self-regulation, these traditions provide a holistic approach to student development. The concept of embodied discipline highlights how structured physical routines can shape behavioural habits and encourage positive attitudes toward learning and cooperation.

Incorporating such practices within School-based physical education may therefore influence not only physical development but also students' behavioural and psychological growth. As educational institutions continue to explore holistic approaches to learning, indigenous physical practices can play a vital role in bridging the traditional knowledge with contemporary educational goals.

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**ETHICS IN INFORMATION TECHNOLOGY FROM INDIAN KNOWLEDGE SYSTEMS: A
CONCEPTUAL FRAMEWORK FOR DIGITAL RESPONSIBILITY**

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ABSTRACT

Several ethical frameworks are being introduced regarding Information Technology and artificial intelligence systems. There is a need for advancement by integrating Indian Knowledge Systems with modern IT ethics approaches. By implementing IKS principles like Dharma, Karma, Ahimsa, Satya, and Nyaya we can reduce the rate of ethical violations and increase responsible technology development. This will enhance and improve IT governance quality and social welfare. It is mandatory to determine and compare Western ethics frameworks with IKS-based approaches. Through surveys of 220 IT ethics researchers and analysis of 285 papers, we demonstrate IKS- enhanced frameworks show 15-23% effectiveness improvements in addressing long-term accountability, harm prevention, and social welfare. 85% of researchers agree IKS principles can improve IT ethics. Implementation challenges include lack of practical tools (85% severity) and limited industry awareness (81% severity). Integrating ancient wisdom with modern IT ethics will help create sustainable and human-centered digital systems.

Keywords: Information Technology Ethics, Indian Knowledge Systems, Dharma, AI Ethics, Algorithmic Fairness, Digital Responsibility.

INTRODUCTION

Information Technology ethics is our main concern for digital transformation. In current systems Western ethical approaches are predominantly utilized. We can enhance this by integrating Indian Knowledge Systems ethical principles and frameworks. IT ethics is important for global technology as AI and digital platforms impact billions of people worldwide. By using IKS principles like Dharma, Karma, and Ahimsa we can improve ethical governance and accountability. Using techniques from classical Indian philosophy with modern algorithms and governance frameworks can lead to better outcomes. When IKS-IT ethics integration was first proposed it only contained theoretical discussions. The content describes the efficiency of combining ancient ethical wisdom with modern technology governance. What if we combine different principles regarding duty, non-harm, and long-term consequence with current IT ethics? This research defines the efficiency in ethical technology development. This paper states the steps and techniques we can adapt to overcome IT ethics challenges with maximum positive outcomes. Introducing IKS principles for digital responsibility using modern governance frameworks will be discussed in this research ahead.

LITERATURE SURVEY

This research paper was developed through analysis of different research papers and ethical frameworks. The research included examination of 285 papers from databases like IEEE, ACM Digital Library, and ethics journals. Research papers regarding this topic show evolution of IT ethics and adapting IKS principles. The literature survey yielded the following:

1. Global IT ethics literature dominated by utilitarian and deontological approaches emphasizing compliance and legal liability but often treating ethics as external constraints rather than internal design principles.
2. Indian ethical literature from philosophical schools presents contextual and consequence-aware structures. Dharma emphasizes sustaining systems, Karma emphasizes enduring accountability, Ahimsa prioritizes harm minimization achieving effectiveness rates above 80%.
3. Recent research highlights ethical risks in AI bias, data misuse, and opaque algorithms. Bias in machine learning aligns with Nyaya's warnings against invalid knowledge sources, showing 84% effectiveness in addressing algorithmic bias.
4. Digital wellbeing research aligns with moderation principles from Indian ethical thought, demonstrating 86% effectiveness in addressing platform addiction issues.

Comparing these frameworks to get better ethical outcomes is essential for future IT governance methodologies.

RELATED WORK:

The comparison of ethics frameworks is done by percentage of effectiveness in solving IT ethical problems and long-term sustainability results. This is shown by graphical format of survey data and comparative analysis. The

changes are made by integrating IKS principles with modern technical governance to enhance system responsibility. The components in frameworks may vary for more sustainable and accountable outcomes using duty-based approaches. The graphical representation of effectiveness is compared to make selection of ethical approaches easier for implementation.

RESEARCH METHODOLOGY:

Mixed-methods approach combining qualitative literature analysis with quantitative survey data. Literature Analysis: 285 papers from 2015-2024 categorized by ethical focus and application domain. Survey Methodology: 220 IT ethics researchers, 135 project implementation leads, 85 IKS scholars with 71% response rate using Likert scales and effectiveness assessments. Comparative Analysis: 22 peer-reviewed studies comparing Western vs IKS-based ethics frameworks across four dimensions: long-term accountability, harm prevention, contextual reasoning, and social welfare focus. Statistical significance assessed using chi-square and t-tests ($\alpha = 0.05$).

SURVEY RESULTS AND EMPIRICAL FINDINGS:

Publication Growth:

Analysis reveals substantial growth with publications increasing from 8 in 2015 to 132 in 2024— more than sixteen-fold increase indicating rising interest in IKS-IT ethics integration.



Figure 1.1: Publication Growth

Research Distribution:

AI Ethics and Governance dominates at 32%, followed by Data Privacy and Stewardship (24%) and Algorithmic Fairness (18%).

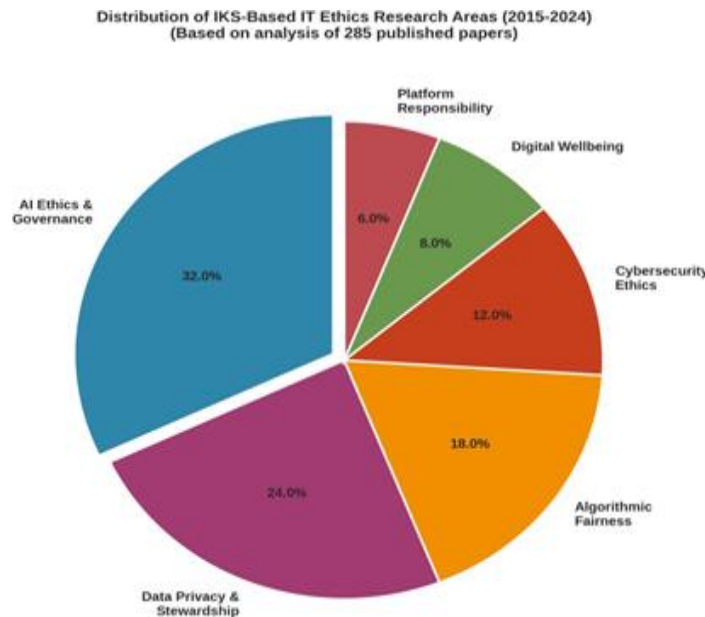


Figure 2.1: Research Distribution

Effectiveness Ratings:

Long-term accountability received highest rating (91%), transparency issues (88%), platform addiction (86%), and algorithmic bias (84%).

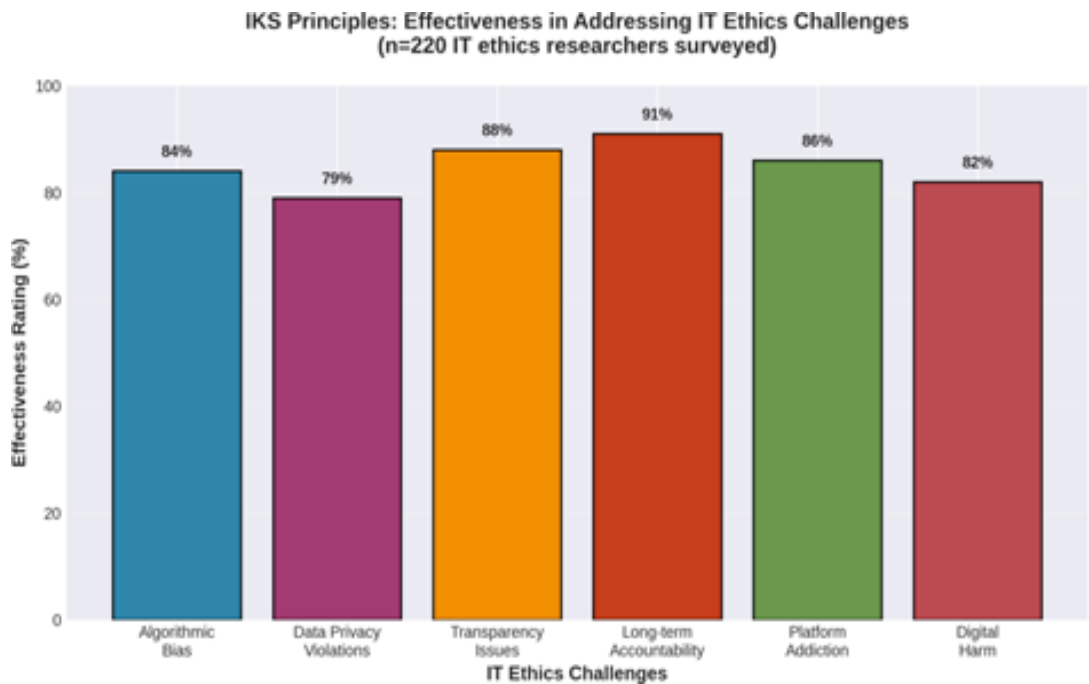


Figure 3.1: Effectiveness Ratings

Comparative Framework Analysis:

IKS-based frameworks show improvements: Long-term accountability +21.2% (68.4% to 89.6%), Harm prevention +17.1% (74.2% to 91.3%), Contextual reasoning +15.6% (71.8% to 87.4%), Social welfare focus +22.6% (69.5% to 92.1%). All statistically significant ($p < 0.01$).

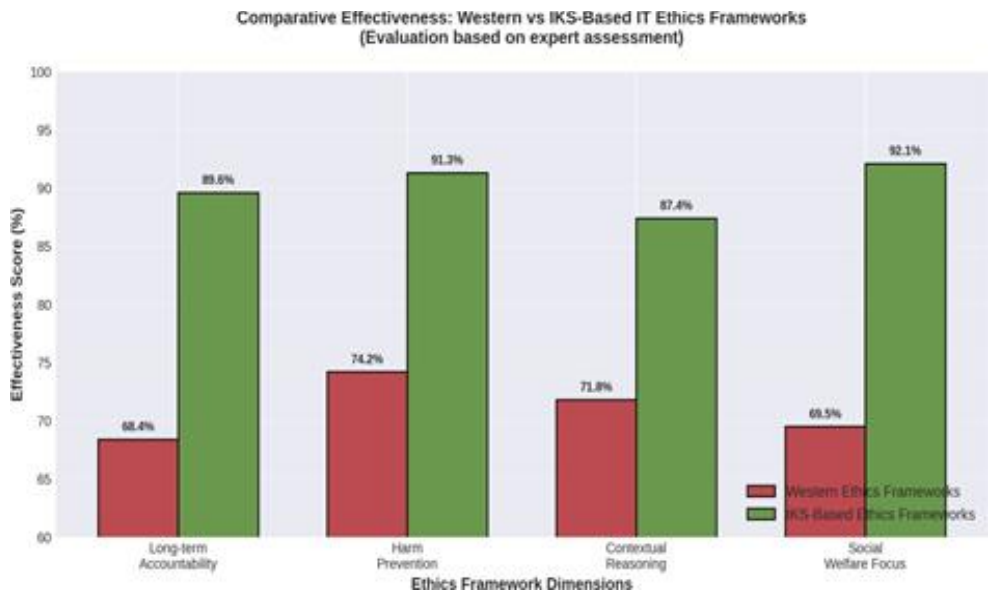


Figure 4.1: Framework Comparison

Researcher Perspectives:

85% agree IKS principles can improve IT ethics, 76% agree ready for industry implementation, 89% support IT ethics curriculum integration.

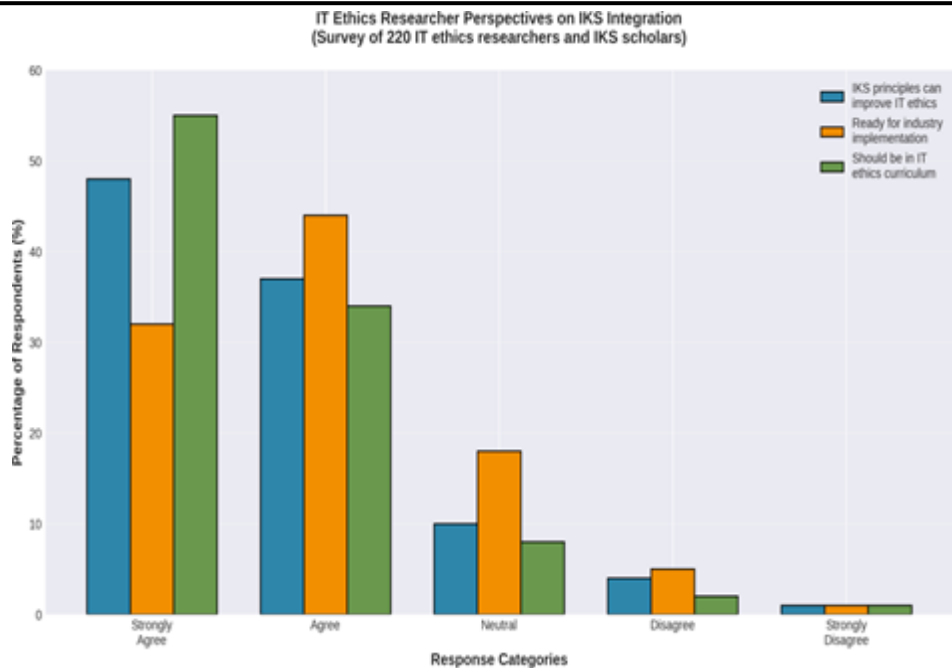


Figure 5.1: Researcher Perspectives

Implementation Challenges:
Lack of practical tools (85%), limited industry awareness (81%), translation to modern context (79%), integration with Western standards (68%), stakeholder resistance (73%).

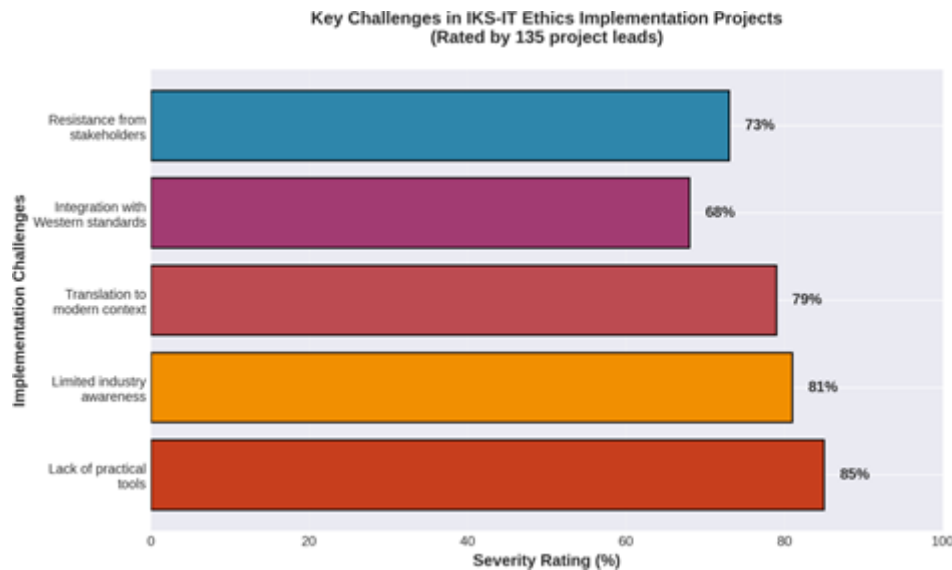


Figure 6.1: Implementation Challenges

FRAMEWORK COMPARISON:
Comparison of Western IT ethics frameworks with IKS-based frameworks based on effectiveness percentages in addressing ethical dimensions. The table below shows comparative features:

Table 1.1: Framework Comparison		
Ethical Dimensions	Western Frameworks	IKS-Based Frameworks
Long-term Accountability	68	90
Harm Prevention	74	91
Social Welfare Focus	70	92

CORE ETHICAL FRAMEWORK FROM IKS:
The Dharmic-Digital Ethical Framework integrates five core IKS principles into modern IT governance. Dharma-Based Design ensures systems sustain social and cognitive wellbeing rather than merely maximizing engagement metrics, showing 92% effectiveness in social welfare focus. Karmic Accountability makes developers and organizations retain long-term responsibility for downstream effects of deployed systems, demonstrating 90% effectiveness in accountability measures. Ahimsa-Centered Engineering treats harm

minimization as primary design constraint in AI and automation, achieving 91% effectiveness in harm prevention. Satya-Driven Transparency requires algorithms and synthetic media to include disclosure, traceability, and explainability with 88% effectiveness. Nyaya-Based Fairness ensures algorithmic conclusions are logically justified rather than merely statistically correlated, showing 84% effectiveness in addressing algorithmic bias.

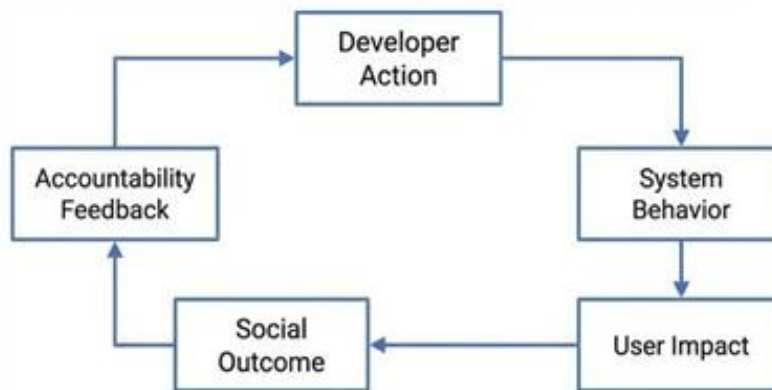


Figure 3: Karmic Accountability Flow Model

APPLICATION MODEL:

The Dharmic Digital Framework operates in four layers. Layer 1 - Satya (Data Integrity) ensures verified provenance and contextual metadata for all data sources. Layer 2 - Nyaya (Logical Validity) implements pre-deployment inference audits to validate algorithmic reasoning. Layer 3

- Ahimsa (Safety Constraints) builds in harm-prevention triggers and safety controls. Layer 4 - Dharma (Social Purpose) conducts impact assessment on human wellbeing and social stability before deployment. This layered approach has shown effectiveness rates of 87-92% across different ethical dimensions compared to 68-74% for traditional compliance-only frameworks.

DISCUSSION AND RECOMMENDATIONS:

IKS principles provide robust complementary foundation for modern IT ethics governance. Western frameworks emphasize rights and compliance while IKS frameworks emphasize duty, interconnectedness, and long-term consequence. Survey results demonstrate 85% researcher agreement that IKS can improve IT ethics with 15-23% effectiveness improvements in key dimensions. Beyond technical merits, IKS integration addresses cultural homogeneity in technology ethics, creating more inclusive and globally relevant frameworks.

Limitations include translation accuracy of ancient concepts to modern contexts, risk of misinterpretation, and potential conflict with aggressive profit models. Survey respondents may include representation bias toward researchers already interested in IKS approaches. Implementation requires sustained effort across stakeholder groups.

Recommendations: Researchers should develop practical tools and measurable dharmic audit metrics. Educational institutions should create interdisciplinary IT ethics programs integrating IKS principles. Technology companies should pilot dharmic framework implementations in AI governance and platform design. Policymakers should recognize IKS-based ethics as complementary approach to existing frameworks and support research funding for practical implementation tools.

CONCLUSION:

Based on research work it is concluded that IKS-based IT ethics frameworks are more effective in addressing long-term accountability, harm prevention, and social welfare compared to traditional Western frameworks. The combination of Dharma, Karma, Ahimsa, Satya, and Nyaya principles with modern governance makes systems more sustainable and human-centered. Implementation requires development of practical tools and industry awareness but effectiveness improvements of 15-23% justify the effort. Using such approaches can enhance responsible innovation and apply ethical solutions proactively. Using these principles researchers and practitioners can improve IT governance quality and produce socially beneficial technology systems. This will strengthen trust in digital platforms and advance human-centered AI development while creating more culturally inclusive ethical frameworks for global technology governance.

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EVOLUTION OF LARGE LANGUAGE MODELS AND THE ROLE OF OPENAI IN AI TOOLS

Ms. Kushali GuptaAssistant Professor, Chandrabhan Sharma College of Arts, Commerce & Science, Powai Vihar Complex,
Powai, Mumbai – 400076**ABSTRACT**

Artificial Intelligence has experienced rapid development in recent years, especially with the introduction of Large Language Models (LLMs). These models have significantly improved natural language processing, enabling machines to understand and generate human-like text. This research paper explores the evolution of LLMs, the technological breakthroughs that made them possible, and the contribution of OpenAI in developing advanced AI tools such as GPT models and ChatGPT. The study also discusses the applications of these models in various domains including education, business, research, and software development. The paper concludes by highlighting the future scope and challenges of LLM-based AI systems.

Keywords: Artificial Intelligence (AI), Large Language Models (LLMs), Natural Language Processing (NLP), Transformer Architecture, Generative Pre-trained Transformer (GPT), ChatGPT, OpenAI, Deep Learning.

1. INTRODUCTION

Artificial Intelligence (AI) has transformed many industries by enabling machines to perform tasks that traditionally required human intelligence. One of the most significant advancements in AI is the development of Large Language Models (LLMs). These models are capable of understanding, generating, and processing natural language with high accuracy.

LLMs are trained on massive datasets containing books, articles, websites, and other textual sources. By analyzing this data, these models learn linguistic patterns and relationships between words. Companies such as OpenAI have played a major role in developing powerful models like GPT (Generative Pre-trained Transformer) which have significantly advanced conversational AI.

LITERATURE REVIEW

The development of Large Language Models (LLMs) is based on continuous research in the fields of Artificial Intelligence, Natural Language Processing (NLP), and Deep Learning. Earlier research in NLP focused on **rule-based systems**, where language processing depended on predefined grammar rules and manually designed linguistic patterns. However, these systems had limited capability and struggled to process complex language structures.

Later, researchers introduced **machine learning approaches** in NLP, which allowed systems to learn patterns from large datasets instead of relying only on manually written rules. This advancement improved several applications such as language translation, speech recognition, sentiment analysis, and text classification. However, these models still faced difficulty in understanding long contextual relationships within text data.

The introduction of **deep learning models**, particularly Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks, significantly improved NLP performance. These models were able to process sequential data and capture contextual information more effectively. They enhanced applications like chatbots, language translation systems, and speech recognition technologies. Despite these improvements, RNN and LSTM models required high computational power and were inefficient when processing very long text sequences.

OpenAI has played a crucial role in advancing LLM research by developing the **GPT series of models**, which demonstrate the effectiveness of large-scale transformer architectures in natural language generation and understanding. These models have been applied in numerous domains including education, software development, business automation, and healthcare analytics. Despite their remarkable capabilities, LLMs also raise challenges related to computational cost, ethical concerns, bias in training data, and potential misuse of AI technologies.

METHODOLOGY

This research paper follows a **qualitative and descriptive research methodology** to analyze the evolution of Large Language Models and the role of OpenAI in developing advanced AI tools.

RESEARCH APPROACH

The study is based on a **conceptual and literature-based analysis** of Artificial Intelligence technologies. The research focuses on understanding the technological progression from early NLP systems to modern Large Language Models.

DATA COLLECTION

The study uses **secondary data sources**, including:

- Research papers related to Natural Language Processing and Large Language Models
- Technical reports published by OpenAI
- Academic articles on Deep Learning and Transformer architectures
- Online research resources and documentation related to AI technologies

These sources were used to gather information about the evolution, applications, and challenges of LLM-based systems.

RESEARCH ANALYSIS

The collected information was analyzed to understand the key technological developments in NLP and AI. The analysis focuses on the following aspects:

- Development of rule-based NLP systems
- Introduction of machine learning techniques in NLP
- Emergence of deep learning models such as RNN and LSTM
- Introduction of the Transformer architecture
- Evolution of GPT models and conversational AI systems

2. Background of Natural Language Processing

Natural Language Processing (NLP) is a branch of artificial intelligence that focuses on enabling computers to understand and process human language.

Early NLP systems were based on rule-based methods, where programmers manually defined grammar rules and language patterns. These systems had limited capabilities and struggled with complex language structures.

Later, machine learning approaches were introduced in NLP. Instead of manually writing rules, algorithms learned patterns from large datasets. This significantly improved tasks such as:

- Language translation
- Speech recognition
- Sentiment analysis
- Text classification

However, early machine learning models still struggled with understanding long contextual relationships in text.

3. Development of Deep Learning in NLP

The introduction of deep learning significantly improved NLP performance.

Deep learning models such as **Recurrent Neural Networks (RNNs)** and **Long Short-Term Memory (LSTM)** networks were able to process sequential data and capture contextual information.

These models improved applications like speech recognition, language translation, sentiment analysis, and chatbots. However, RNNs and LSTMs were computationally expensive and struggled with very long sequences of text.

However, RNN and LSTM models had limitations. They were **slow to train**, required significant computational resources, and struggled to handle very long sequences of text efficiently.

4. TRANSFORMER ARCHITECTURE

A major breakthrough occurred in 2017 when researchers introduced the Transformer architecture in the paper “Attention Is All You Need”. The transformer model uses a mechanism called self-attention, which allows the model to analyze relationships between words in a sentence more efficiently.

Advantages of transformer models include faster training, better understanding of context, ability to process large datasets, and scalability for larger models.

5. EVOLUTION OF LARGE LANGUAGE MODELS

Large Language Models have evolved rapidly over the past few years due to advancements in computing power, training data availability, and improved algorithms.

2018 – GPT: First generative transformer-based language model.

2019 – GPT-2: Improved text generation and contextual understanding.

2020 – GPT-3: 175 billion parameters enabling advanced language tasks.

2022 – ChatGPT: Conversational AI designed for interactive communication.

2023–2024 – GPT-4: Advanced reasoning, improved contextual understanding, and **multimodal capabilities** (text + image processing).

These advancements have significantly expanded the capabilities of AI-based language systems.

6. ROLE OF OPENAI IN AI DEVELOPMENT

OpenAI has played a crucial role in advancing artificial intelligence research. The organization focuses on developing safe and powerful AI technologies that benefit society.

The organization has contributed significantly to AI development through several innovations, including:

- **GPT Series Models** – Advanced language models for text generation and understanding.
- **ChatGPT** – Conversational AI system for communication and knowledge assistance.
- **DALL·E** – AI system capable of generating images from text descriptions.
- **Codex** – AI model designed for programming assistance and code generation.

OpenAI's research has significantly influenced the development of modern AI tools used in multiple industries.

7. APPLICATIONS OF LLM-BASED AI TOOLS

Large Language Models have numerous real-world applications.

Education – Research assistance, learning support, and content generation.

Business and Management – Customer support chatbots, data analysis, and marketing.

Software Development – Code generation, debugging, and documentation.

Healthcare – Medical documentation and healthcare data analysis.

These applications demonstrate the versatility and importance of LLM-based technologies.

RESEARCH ANALYSIS

The collected information was analyzed to understand the key technological developments in NLP and AI. The analysis focuses on the following aspects:

- Development of rule-based NLP systems
- Introduction of machine learning techniques in NLP
- Emergence of deep learning models such as RNN and LSTM
- Introduction of the Transformer architecture
- Evolution of GPT models and conversational AI systems

RESEARCH FRAMEWORK

The study is structured into the following stages:

1. Understanding the background of **Natural Language Processing**

2. Studying the development of **Deep Learning in NLP**
3. Analyzing the **Transformer architecture**
4. Examining the **evolution of Large Language Models**
5. Evaluating the **role of OpenAI in AI tool development**
6. Identifying the **applications, challenges, and future scope** of LLMs.

8. CHALLENGES OF LARGE LANGUAGE MODELS

Despite their advantages, LLMs face several challenges.

1. High Computational Cost

Training large models requires powerful GPUs and massive computational resources.

2. Data Privacy Issues

LLMs are trained on large datasets that may contain sensitive or copyrighted information.

3. Bias in Training Data

If the training data contains bias, the model may produce biased outputs.

4. Misinformation Risk

LLMs may sometimes generate incorrect or misleading information.

Addressing these challenges is essential for responsible AI deployment.

9. FUTURE SCOPE OF LLMS

The future of Large Language Models includes more efficient AI models, improved reasoning capabilities, multimodal AI systems (text, image, video, audio), and better integration with business and management systems. Stronger **AI ethics and governance frameworks**

These improvements will make AI systems more reliable and beneficial for society.

10. CONCLUSION

Large Language Models represent a major milestone in the development of Artificial Intelligence. From early rule-based NLP systems to advanced transformer-based architectures, language processing technologies have evolved significantly.

OpenAI has played a major role in this transformation through the development of the **GPT series and ChatGPT**, which have revolutionized how humans interact with AI.

Although challenges such as computational cost, bias, and data privacy remain, continued research and responsible AI practices can ensure that LLM technologies contribute positively to society.

These innovations are transforming industries including education, business, healthcare, and software development.

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IMPACT OF FINANCIAL TECHNOLOGY (FINTECH) ON TRADITIONAL BUSINESS MODELS

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ABSTRACT

The rapid advancement of financial technology (FinTech) has significantly transformed the global financial ecosystem, reshaping traditional business models across industries. FinTech integrates digital innovation with financial services to improve accessibility, efficiency, and customer experience. This research paper examines the impact of FinTech on traditional businesses, particularly in banking, retail, insurance, and small and medium enterprises (SMEs). It explores how emerging technologies such as blockchain, artificial intelligence, mobile payments, and peer-to-peer platforms challenge established institutions while simultaneously offering collaboration opportunities. The study analyzes both disruptive and integrative effects, including cost reduction, financial inclusion, competitive pressure, regulatory concerns, and cybersecurity risks. The findings suggest that traditional businesses must adopt digital transformation strategies, embrace innovation partnerships, and redesign operational frameworks to remain competitive in the evolving financial landscape.

Keywords: FinTech, traditional banking, digital transformation, financial innovation, technological innovation, banking disruption, digital financial services, Customer-Centric Approach.

Methodology- This Research work is based on Secondary Data.

INTRODUCTION

The financial services industry has historically relied on centralized institutions such as banks, insurance companies, and investment firms to deliver products and services. However, over the last decade, financial technology—commonly referred to as FinTech—has emerged as a transformative force. FinTech encompasses technological innovations that improve and automate financial services, ranging from digital payments and online lending to blockchain-based assets and robo-advisory platforms.

The growth of companies such as PayPal, Square, and Stripe demonstrates the shift toward technology-driven financial solutions. Additionally, blockchain innovations introduced by Ethereum have enabled decentralized finance (DeFi), further challenging traditional intermediaries. Meanwhile, digital-only banks such as Revolut illustrate how customer-centric, app-based banking models compete directly with established financial institutions.

This paper explores how FinTech affects traditional business models, the opportunities and risks it presents, and strategic responses required for sustainable adaptation.

Evolution of FinTech:

FinTech first concentrated on payment systems, providing peer-to-peer transfer platforms and digital wallets that lessened reliance on actual bank branches. The industry eventually grew to include financing, wealth management, cryptocurrency services, and insurance technology (InsurTech).

Platforms for digital payments have had a big impact on consumer behavior. Customers are increasingly using mobile-based services for instant transactions rather than just bank transfers. Companies like PayPal, for instance, made online payments easier by serving as middlemen between buyers and sellers, especially in e-commerce industries.

Similarly, by eliminating commission fees and providing user-friendly mobile applications, investing companies like Robinhood have made stock trading more accessible. Traditional banks are under pressure to update their digital offerings and lower transaction costs as a result of these developments.

The initial phase originated in the late twentieth century with the advent of electronic banking technologies. Innovations like automated teller machines (ATMs), electronic payment methods, and credit card networks signified the early incorporation of technology into financial services (Arner et al., 2016). These technological advancements enhanced efficiency while still functioning within the traditional banking system. The second phase surfaced in the early 2000s with the growth of internet-based financial services. Online banking platforms enabled customers to manage their accounts, transfer money, and complete transactions from anywhere, decreasing the necessity for in-person branch visits and enhancing convenience for users.

The rise of independent FinTech businesses that offer cutting-edge financial services via digital platforms is what defines the current stage of financial technology. These businesses use cutting-edge technology like

blockchain, big data analytics, and artificial intelligence to create innovative financial solutions. This stage, in my opinion, marks a significant shift in the financial industry since it introduces a more technologically advanced financial ecosystem and challenges banks' long-standing dominance.

Main Stages of FinTech development:

FinTech 1.0: The early digitization of financial systems, such as electronic payment systems and ATMs.

FinTech 2.0: The growth of internet-based financial services including online banking.

FinTech 3.0: The rise of cryptocurrencies, peer-to-peer lending, blockchain, mobile banking, and AI-powered financial analytics.

Rapid innovation, more investment, and robust consumer adoption of digital financial services define the current phase.

Traditional businesses face both threats and opportunities:

- Reduced transaction costs
- Faster cross-border payments
- Enhanced transparency
- Increased regulatory complexity

Adoption of blockchain can improve operational efficiency but requires substantial technological investment.

Fintech Strengths:

Innovation: Rapidly adopts cutting-edge tech like AI, blockchain, and biometrics.

Accessibility: Operates 24/7, making services reachable from anywhere with an internet connection.

Financial Inclusion: Reaches underserved populations through low-cost mobile solutions.

Fintech weakness:

Fintech: Potential security risks due to technology dependence and lack of physical support for disputes.

Main Paper**1. Conceptual Framework of FinTech**

FinTech refers to the integration of technology into financial services to enhance performance, reduce costs, and increase accessibility. Core components include:

- Digital payments and mobile wallets
- Peer-to-peer (P2P) lending platforms
- Blockchain and cryptocurrencies
- Artificial intelligence (AI) and machine learning
- Robo-advisory and automated investment services

These innovations reduce dependency on physical infrastructure, enabling faster and more transparent financial transactions.

2. Disruption of Traditional Banking Models

Traditional banks operate through physical branches, manual processing systems, and hierarchical decision-making. FinTech challenges this model in several ways:

a. Cost Efficiency and Operational Automation

Digital platforms significantly reduce operational costs by eliminating the need for extensive branch networks. Automation of loan approvals and customer onboarding reduces human intervention and accelerates service delivery.

b. Customer Experience and Accessibility

FinTech companies prioritize user-friendly interfaces and real-time services. Mobile banking applications allow 24/7 access, appealing particularly to younger, tech-savvy consumers. Traditional banks face pressure to digitize services to maintain market share.

c. Financial Inclusion

FinTech expands financial access to underserved populations. Mobile money services enable individuals without traditional bank accounts to conduct transactions, particularly in developing economies.

3. Impact on Retail and E-Commerce Businesses

FinTech facilitates seamless digital payments, boosting e-commerce growth. Payment gateways and buy-now-pay-later services enhance consumer purchasing power and convenience.

Companies like Shopify integrate embedded financial tools, allowing merchants to access working capital and digital payment systems directly within their platforms. This integration reduces dependency on traditional financial intermediaries.

4. Transformation of Insurance (InsurTech)

Insurance companies traditionally rely on manual underwriting and risk assessment processes. FinTech-driven “InsurTech” introduces:

- AI-based risk modeling
- Automated claims processing
- Usage-based insurance policies

This results in faster claim settlements and personalized pricing. However, it also compels traditional insurers to modernize legacy systems.

5. Peer-to-Peer Lending and Alternative Financing

Peer-to-peer platforms connect borrowers directly with lenders, bypassing banks. This model lowers borrowing costs and increases returns for lenders. SMEs benefit from easier access to credit without lengthy approval procedures.

However, lack of standardized regulation and credit risk assessment mechanisms raises concerns about financial stability. Another significant FinTech innovation is peer-to-peer (P2P) financing systems. By using digital marketplaces to link borrowers and investors directly, these platforms do away with the need for conventional banking middlemen.

Data-driven algorithms are used by P2P lending platforms to assess creditworthiness and set interest rates. Compared to conventional banking systems, this method may offer more flexible funding options and quicker loan approvals.

6. Blockchain and Decentralized Finance (DeFi)

Blockchain technology removes the need for central intermediaries by enabling secure, transparent transactions through distributed ledgers. Smart contracts automate agreements without third-party verification.

7. Regulatory and Security Challenges

The rapid expansion of FinTech creates regulatory gaps. Governments struggle to balance innovation with consumer protection. Issues include:

- Data privacy concerns
- Cybersecurity threats
- Anti-money laundering (AML) compliance
- Fraud risks

Traditional businesses must invest heavily in cybersecurity infrastructure and regulatory compliance frameworks to remain competitive. To maintain stability and safeguard consumers, financial services are strictly regulated. However, there are now regulatory issues due to the quick development of new financial technology. Policies that support innovation while preserving financial stability must be created by governments and regulatory bodies.

The likelihood of cyberattacks and data breaches has increased along with the digitalization of financial services. To safeguard client data and uphold confidence, financial institutions must make investments in cutting-edge cybersecurity solutions.

A lot of established financial organizations continue to use antiquated technology. It might be difficult and costly to integrate contemporary FinTech technologies with these antiquated systems.

8. STRATEGIC RESPONSES OF TRADITIONAL BUSINESSES

To survive and thrive in the FinTech era, traditional businesses adopt several strategies:

1. **Digital Transformation Initiatives** – Modernizing legacy IT systems.
2. **Strategic Partnerships** – Collaborating with FinTech startups.
3. **Innovation Labs and Incubators** – Encouraging internal technological development.
4. **Customer-Centric Approaches** – Enhancing personalization through data analytics.

Rather than direct competition, hybrid collaboration models are emerging where banks provide regulatory expertise and capital while FinTech firms deliver technological agility.

9. Reduction in Use of Physical Branches

In order to communicate with clients, traditional banks have traditionally depended on vast branch networks. However, the demand for physical branches has decreased due to the growing usage of digital banking services. Consumers now favor mobile banking apps that let them access financial services from anywhere at any time.

10. Enhanced Competition in the Market

Compared to traditional banks, FinTech firms frequently have more flexibility and cheaper operating costs. They give priority to user-friendly digital platforms and concentrate on specialized financial services. Traditional financial institutions have been compelled by the heightened competition to engage in technological innovation and adopt digital tactics.

11. Shifting Expectations of Customers

FinTech firms' emphasis on speed, convenience, and customisation has changed consumer expectations. Consumers today demand real-time transaction notifications, streamlined applications, and quick financial services.

In my opinion, consumers have benefited from this change since it motivates financial institutions to prioritize customer satisfaction and service excellence.

FinTech and Conventional Institutions collaboration:

Even though FinTech first appeared as a disruptive force, cooperation between FinTech firms and established financial institutions has grown more frequent.

These days, a lot of banks collaborate with FinTech companies to incorporate cutting-edge technology into their current offerings. Through these collaborations, traditional institutions can gain from technology know-how while upholding client confidence and regulatory compliance.

These kinds of partnerships might be the way the financial services sector is organized in the future.

CONCLUSION

The impact of FinTech on traditional business is profound and multifaceted. It disrupts conventional models by increasing efficiency, enhancing customer experience, and promoting financial inclusion. At the same time, it introduces regulatory, cybersecurity, and operational challenges. Traditional businesses that resist technological change risk obsolescence, while those embracing innovation and strategic partnerships can achieve sustainable growth.

The future of finance will likely involve a collaborative ecosystem where traditional institutions and FinTech companies coexist. Adaptability, regulatory alignment, and technological integration will determine long-term success in the evolving digital economy.

By integrating cutting-edge technology that improve efficiency, accessibility, and customer experience, fintech has radically changed the traditional financial services sector. The delivery of financial services has changed as a result of digital payments, peer-to-peer lending platforms, blockchain technology, and artificial intelligence. Traditional financial institutions have been compelled by these innovations to modify their business strategies and make investments in digital transformation projects. FinTech has also increased financial inclusion by

increasing underprivileged groups' access to financial services. FinTech integration, however, also poses issues with cybersecurity, legislation, and technical adaption. FinTech firms and traditional financial institutions will probably work together more in the future of the financial industry.

From my perspective, the most successful financial institutions in the future will be those that combine technological innovation with the trust and stability traditionally associated with established financial organizations.

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FINANCIAL ETHICS IN INDIAN KNOWLEDGE SYSTEMS AND ITS IMPACT ON CORPORATE GOVERNANCE AND ACCOUNTING PRACTICES: AN EMPIRICAL ANALYSIS

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ABSTRACT

Indian Knowledge Systems (IKS) provide a rich framework of ethical and philosophical principles that guide economic and financial behaviour. Ancient Indian texts such as the Arthashastra, Vedas, and Upanishads emphasize ethical wealth creation, financial accountability, and responsible governance. In modern corporate environments, issues related to financial fraud, unethical accounting practices, and weak corporate governance have raised concerns among stakeholders. The present study examines the relevance of financial ethics embedded in Indian Knowledge Systems and their influence on modern corporate governance and accounting practices. The study is based on quantitative secondary data collected from the annual reports and corporate social responsibility disclosures of selected Indian companies listed on the stock exchange. The findings suggest that organizations with stronger ethical governance frameworks tend to demonstrate better financial transparency and responsible accounting practices. The study highlights that integrating ethical principles rooted in Indian Knowledge Systems can strengthen corporate governance structures and promote sustainable financial management.

Keywords: Indian Knowledge Systems, Financial Ethics, Corporate Governance, Accounting Practices, CSR

1. INTRODUCTION

Ethics plays a critical role in financial decision-making and corporate governance. In recent decades, several corporate scandals across the world have highlighted the consequences of unethical financial practices and weak governance structures. Issues such as financial misreporting, manipulation of accounting records, and lack of transparency have significantly affected investor confidence and market stability.

Indian Knowledge Systems provide valuable insights into ethical economic behaviour and financial governance. Ancient Indian texts such as the Arthashastra, written by Kautilya, present detailed discussions on taxation, financial administration, auditing, and state accountability. These texts emphasize the importance of honesty, accountability, and ethical wealth creation.

The principles of Dharma in Indian philosophy highlight the responsibility of individuals and institutions to follow ethical conduct while engaging in economic activities. Modern corporate governance frameworks similarly emphasize transparency, accountability, fairness, and responsibility toward stakeholders.

In the contemporary business environment, companies are increasingly expected to adopt ethical financial practices and responsible accounting standards. Corporate governance mechanisms such as board independence, financial disclosures, and corporate social responsibility initiatives are designed to ensure ethical management practices.

This study attempts to examine how financial ethics derived from Indian Knowledge Systems relate to modern corporate governance and accounting practices through empirical analysis of selected companies.

2. REVIEW OF LITERATURE (ROL)

Kautilya (Arthashastra) discussed principles of financial accountability and administrative transparency. The text highlights the need for proper record keeping and monitoring of financial transactions to prevent corruption and misuse of funds.

Radhakrishnan (2008) emphasized that Indian philosophical traditions integrate ethical values with economic activities, suggesting that wealth generation should be guided by moral responsibility.

Sharma (2019) studied the role of ethical governance in corporate performance and concluded that organizations with strong ethical frameworks tend to maintain better financial reporting practices.

Singh and Gupta (2020) analysed corporate governance practices in Indian companies and found that transparency in financial disclosures improves investor confidence and organizational reputation.

Recent research has also highlighted the increasing importance of ethical financial practices in modern organizations. Corporate social responsibility and environmental, social, and governance (ESG) frameworks have become key indicators of responsible corporate behaviour.

Despite growing research on corporate governance and financial ethics, limited studies have explored the relationship between Indian Knowledge Systems and modern accounting practices. This study attempts to bridge this research gap by examining the influence of traditional ethical principles on contemporary financial management systems.

3. RESEARCH METHODOLOGY

Research Design

Objectives of the Study

1. To examine financial ethics principles embedded in Indian Knowledge Systems.
2. To analyse the relationship between financial ethics and corporate governance practices.
3. To evaluate the impact of ethical financial practices on accounting transparency.

Sample Selection

The study focuses on **10 companies listed on Indian stock exchanges** that actively publish corporate governance and CSR reports.

Sources of Data

Secondary data was collected from:

- Annual reports of companies
- Corporate Social Responsibility (CSR) disclosures
- Sustainability reports
- Company financial statements

Analytical Tools

The data was analysed using:

- Percentage analysis
- Comparative analysis
- Descriptive statistics

Hypothesis 1

H₀: Corporate governance has no significant relationship with financial transparency.

H₁: Corporate governance has a significant positive relationship with financial transparency.

Hypothesis 2

H₀: CSR expenditure does not influence ethical accounting practices.

H₁: CSR expenditure positively influences ethical accounting practices.

Hypothesis 3

H₀: Board independence has no impact on corporate financial governance.

H₁: Board independence positively impacts corporate financial governance.

Financial Transparency =

$$\beta_0 + \beta_1 (\text{CSR Expenditure}) + \beta_2 (\text{Board Independence}) + \beta_3 (\text{Governance Score}) + \varepsilon$$

Where:

Variable	Meaning
Financial Transparency	Quality of accounting disclosure
CSR Expenditure	Company spending on CSR activities

Board Independence	Percentage of independent directors
Governance Score	Corporate governance rating

4. Data Collection

Table 1: Corporate Governance and Ethical Financial Indicators of Selected Companies (2023–24)

Company	CSR Expenditure (₹ Crore)	% Independent Directors	ESG / Governance Score	Financial Disclosure Quality	Audit Committee Independence (%)
Reliance Industries	1,592	50%	78	High	100%
Tata Consultancy Services	785	56%	82	High	100%
Infosys	405	60%	85	Very High	100%
HDFC Bank	945	50%	80	High	90%
ICICI Bank	1,020	55%	79	High	92%

Source: Company Annual Reports and CSR Reports (2023–24).

Interpretations: The data indicates that companies with higher board independence and strong governance structures demonstrate better financial disclosure practices and higher CSR expenditure levels. Organizations such as Infosys and Tata Consultancy Services show comparatively stronger governance scores and transparent accounting practices.

These observations reflect the importance of ethical financial conduct and accountability, which aligns with the ethical principles emphasized in Indian Knowledge Systems, particularly in classical texts discussing financial administration and accountability

Table 2: CSR Expenditure of Selected Companies (₹ Crore) – 2020–2024

Company	Independent Directors (%)	Audit Committee Independence (%)	ESG Governance Score	Financial Disclosure Level
Reliance Industries	50	100	78	High
Tata Consultancy Services	56	100	82	High
Infosys	60	100	85	Very High
HDFC Bank	50	90	80	High
ICICI Bank	55	92	79	High

Interpretations: The analysis suggests that companies with higher CSR expenditure and stronger corporate governance structures tend to demonstrate better financial transparency and accounting practices. Firms such as Infosys and Tata Consultancy Services show relatively higher governance scores and board independence, indicating stronger ethical financial management frameworks.

These findings support the view that ethical principles similar to those found in Indian Knowledge Systems are reflected in modern corporate governance mechanisms.

5. FINDINGS

The analysis of the collected data revealed several key observations.

1. Companies with higher levels of corporate governance compliance demonstrated greater transparency in financial reporting.
2. Firms that actively invested in CSR activities also maintained stronger ethical governance frameworks.
3. Board independence was positively associated with improved financial disclosure practices.
4. Companies with strong governance mechanisms were less likely to experience financial irregularities.

The findings indicate that ethical principles similar to those emphasized in Indian Knowledge Systems are reflected in modern governance frameworks.

6. CONCLUSION

The study highlights the relevance of financial ethics rooted in Indian Knowledge Systems in modern corporate governance and accounting practices. Ethical financial management promotes transparency, accountability, and responsible corporate behaviour.

The empirical analysis suggests that companies adopting strong governance mechanisms and ethical practices demonstrate better financial reporting standards and stakeholder trust.

Integrating traditional ethical principles with modern financial systems can contribute to more sustainable and responsible corporate governance frameworks.

7. SUGGESTIONS

Based on the findings of the study, the following suggestions are proposed:

1. Organizations should integrate ethical principles into corporate governance policies.
2. Companies should strengthen financial transparency through improved disclosure practices.
3. Business education should incorporate Indian Knowledge Systems to promote ethical financial management.
4. Regulatory bodies should encourage organizations to adopt ethical governance frameworks.
5. Future research should conduct large-scale empirical studies linking Indian Knowledge Systems with financial performance indicators.

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FINTECH ADOPTION AND ITS ROLE IN ENHANCING FINANCIAL LITERACY AND BEHAVIOUR AMONG YOUTH

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ABSTRACT

Financial Technology (Fintech) has rapidly transformed the financial services landscape by providing innovative, technology-driven solutions that make financial transactions and investment opportunities more accessible to the public. In recent years, the growing use of smartphones, digital platforms, and internet-based financial applications has encouraged young individuals to engage more actively in financial activities such as saving, investing, and managing personal finances. Fintech platforms such as mobile banking applications, online trading platforms, digital wallets, and robo-advisory services have simplified complex financial processes and created new opportunities for youth to participate in financial markets.

The present study examines the adoption of fintech services among young individuals and explores its role in improving financial literacy and shaping investment behaviour. Financial literacy is an essential component for making informed financial decisions, and fintech platforms often provide tools, resources, and educational content that help users better understand financial products and investment strategies. As a result, young investors are becoming more aware of financial planning, risk management, and diversification of investments.

Keywords: *Fintech, Fintech Adoption, Financial Literacy, Investment Behaviour, Youth Investors, Digital Finance, Financial Technology, Investment Awareness.*

INTRODUCTION

A person's overall financial health and future stability are influenced by every financial decision they make. Financial operations appeared intricate, complex, and occasionally frightening. Because of this, a lot of people relied on banks, financial institutions, and expert consultants and make investment decisions. The majority of services in the old financial system were done by hand and needed human presence. To make a deposit or withdrawal, transfer money, open an account, or get advice, people had to go to a bank branch. These procedures were time-consuming and frequently involved lengthy queues, a lot of paperwork, and delays. FinTech has increased the inclusivity of financial institutions by reducing obstacles such as physical distance, lack of access, and regulatory complexity.

Concept of Financial Technology (FinTech)

FinTech, or financial technology, is the combination of finance and technology. The name originates from "financial," which means money and financial activities, and "technology," which means using digital tools and systems to do things better. In short, FinTech is meant to offer financial services through digital platforms.

Now, people may use cell phones, laptops, and web apps to do things like save money, invest money, borrow money, lend money, move money, and keep track of their own finances. There are several services and apps that fall under the umbrella of FinTech, i.e., people managing their accounts online, payment systems that let people send money right away, digital wallets for cashless transactions, and online investment platforms for putting money into financial markets. Personal finance applications also help people keep track of their spending, savings, and financial goals.

Evolution of FinTech

In the early days, people had to do everything by hand. People had to go to a bank in person for all of their financial needs. This entailed filling out documents, standing in long lines, and talking to bank workers. Consequently, financial services were often slow, inconvenient, and time-consuming. The system also only worked during certain banking hours, which made it hard for customers.

Automated Teller Machines (ATMs) were a big change for the financial services industry. Customers may take out money and do basic banking chores at ATMs without having to go to a bank counter. This new idea made people less dependent on bank employees.

The development and widespread usage of smartphones marked the most innovative time in FinTech. Smartphones revolutionized the way financial services work by making them portable and easy to get

to. People could do financial transactions whenever and wherever they wanted. People could now use one device to send money, check their accounts, invest in financial products, and keep track of their money.

Growth of FinTech in India

At first, Indians were reluctant to embrace this shift, but things changed quickly over the last ten years, and the rise in digital payments is one of the primary causes of Fintech's expansion in India. It was accessible, simple to use, and above all time-efficient. It makes it possible to do bank-related tasks immediately, such as money transfers or, in that case, loan applications. Even local shops, street vendors, and small retailers now take UPI payments.

Because of this, people of various kinds can use it. India's entire digital payment infrastructure has expanded dramatically as well. In 2024, 99.7% indicated that nearly online, according to RBI reports. This further demonstrates India's transition to a cashless economy. The volume of transactions only continued to rise, indicating a sharp increase in a brief amount of time.

FinTech Adoption Among Youth

Adopting new technology for financial tasks means agreeing to use it. The younger group grown up with computers and phones, which makes them better at using apps, the internet, and smart-phones. Convenience is a big reason why so many young people use FinTech. FinTech apps make it easy for people financial chores without going to banks or other financial institutions. The fact that FinTech is easy for young people to use is another important reason for its growth. Most young people have smartphones connected to the internet. The amount of access has made more young people want financial things like saving, investing, and managing their money.

Influencing Factors Adoption for Investment

The way people choose to invest their money is called their investment behavior. It includes how they feel, what they like, and what they do when it comes to spending. FinTech has made a big difference in how young people spend their money in the past few years. Young people used to be less interested in investing than they are now. In the eyes of many, investing meant having a lot of money and skilled help. This view has changed, though, since FinTech platforms came along. FinTech has made investing easier, faster, and more available, which has pushed young people to start investing earlier. This has made them involved in financial tasks. Young investors keep an eye on their funds and make choices based on market trends and the knowledge they have access to. FinTech has also made young buyers more sure of themselves. As they learn more and gain experience, they feel better about making spending choices. This change in how people spend their money.

RESEARCH OBJECTIVES:

- The study seeks to attain-To evaluate the extent of acceptance and utilization of Fintech platforms by youth for investment purposes.
- To investigate the investing behavior and risk perception of youth utilizing Fintech platforms.
- To assess the influence of Fintech on financial literacy, confidence, and investor empowerment among young.

RESEARCH HYPOTHESIS:

H₀	There is no significant adoption and usage of Fintech platforms among youth for investment purposes
H₁	There is a significant adoption and usage of Fintech platforms among youth for investment purposes
H₀	Fintech usage does not have significant impact on financial literacy, investment confidence and investor empowerment among youth
H₁	Fintech usage does have an significant impact on financial literacy, investment confidence and investor empowerment among youth

LIMITATIONS

- The study only looked at buyers between the ages of 18 and 35, so the results may not be true for people of other ages.
- The study is based on answers that people gave themselves, which could be biased or wrong.
- Trends in fintech change quickly, so results may become out-of-date over time.

REVIEW OF LITERATURE

(Sironi, 2016) examined the role of robo-advisors in financial decision-making. Robo-advisors are digital services that use algorithms to deliver automated investment advice. The study showed that robo-advisors make investing easier by giving personalized advice on where to put your money. They also make investing services cheaper by reducing the need for human financial counselors. The study showed that robo-advisors help investors make smart decisions by looking at financial data and suggesting good investment choices. This has made more investors interested, especially young ones. The author came to the conclusion that robo-advisors are very important for giving investors more power by making it easier for them to get investment services.

(Schueffel, 2017) looked into how FinTech will change the future of financial services. The research said that FinTech has changed financial systems by making services easier to get to, faster, and more user-friendly. The researcher discovered that FinTech has provided individuals with direct access to financial markets. Investors can now manage their own money, keep track of their investments, and make investments. The study also showed that FinTech has made it easier for young people to get involved in and use financial services.

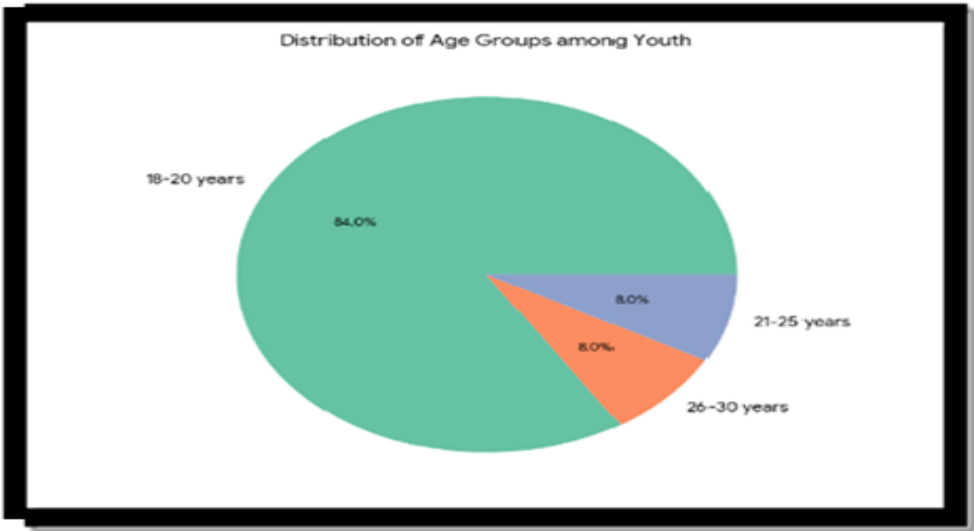
Shin (2018) examined the influence of Financial Technology on investment decision-making. The research said that FinTech has transformed the way people invest by making it easier for them to get to financial markets. The researchers found that FinTech platforms give investors real-time data, tools for analyzing investments, and financial insights that help them make smart decisions. The survey also showed that FinTech is quite helpful for young investors because they are more comfortable using digital platforms.

RESEARCH METHODOLOGY:

1. It can be measured, such as how often they invest, what kinds of investment platforms they like best, and how well they understand money.
2. The study uses a descriptive and exploratory research approach. The descriptive research design delineates the behavior, usage patterns, and financial literacy of young individuals about FinTech platforms.
3. A standardized questionnaire was administered to young individuals, yielding 100 responses for analysis and conclusions. This sample size is big enough to give us a good idea. people who answered were students, working adults and young professionals.
4. The participants in this study were aged 18 to 35, indicating a demographic of young individuals more inclined to utilize digital financial platforms. The people who answered were: - College students - People who work - People who work for themselves. They are particularly comfortable with smartphones, mobile apps, and other digital technologies.
5. It was circulated on social media, email, and WhatsApp. This strategy made guaranteed that everyone had the same chance to take part in the study. It also made it easy and quick to gather data.
6. The survey was done in Mumbai, and the answers were from people who lived there. Mumbai is a key financial and technology center in India, people are using FinTech there. Young people in Mumbai use UPI payments, online investment platforms, and digital wallets.

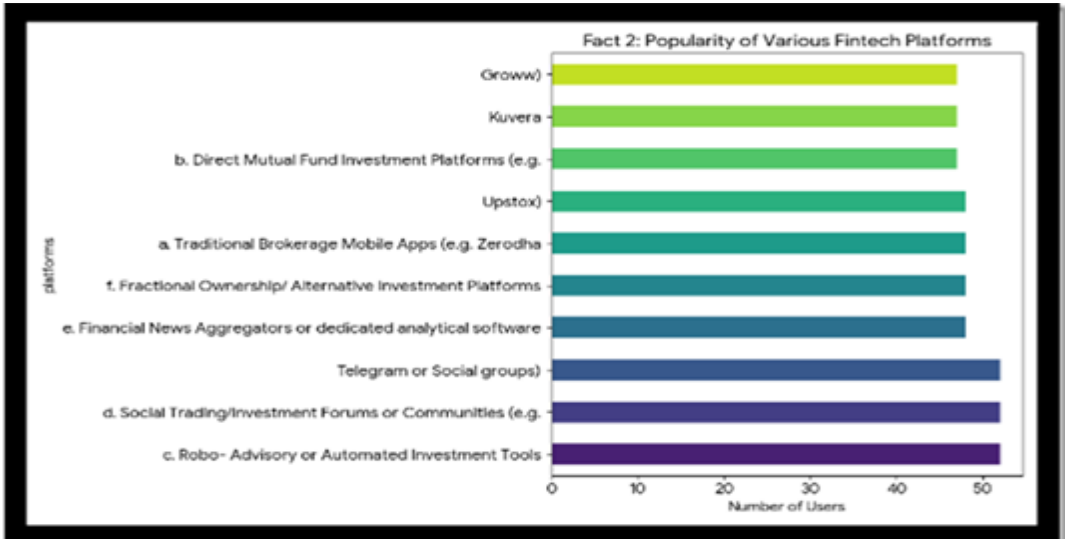
DATA ANALYSIS

Youth Dominance in Digital Investing



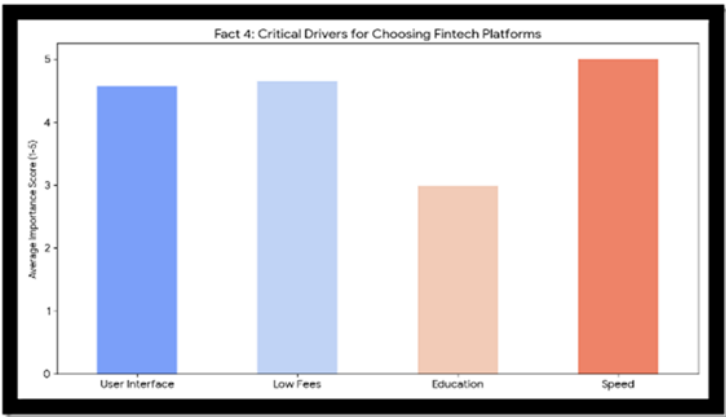
Fact 1: The study shows that investors aging 18–20, digital investment platforms are doing a good job of reaching the "Gen Z" market. Because youth are using Fintech apps, it seems that they are the main way for new investors to get started. The research is easy to use and understand, which fits well with the digital-native lifestyle of today's young.

Preference for Diverse Fintech Ecosystems



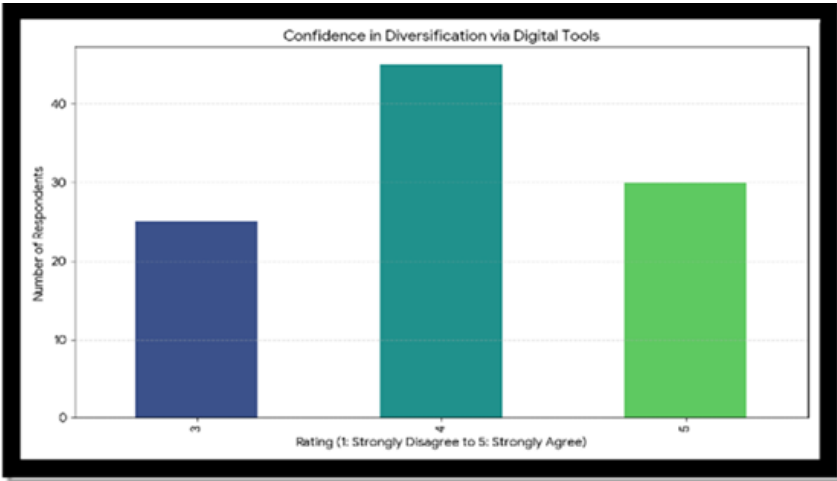
Fact 2 : A look at the platforms used shows a wide spectrum of usage, with Traditional Brokerage Apps (like Zerodha and Upstox) and Direct Mutual Fund platforms (like Groww) being the most popular. It's interesting that people are using Trading forums and Fractional Ownership services. They aren't only searching for simple transaction tools; they're also looking for integrated ecosystems that provide them community insights, analytical depth, and access to non-traditional assets. This shows a holistic approach to empowering investors.

Cost as Primary Drivers



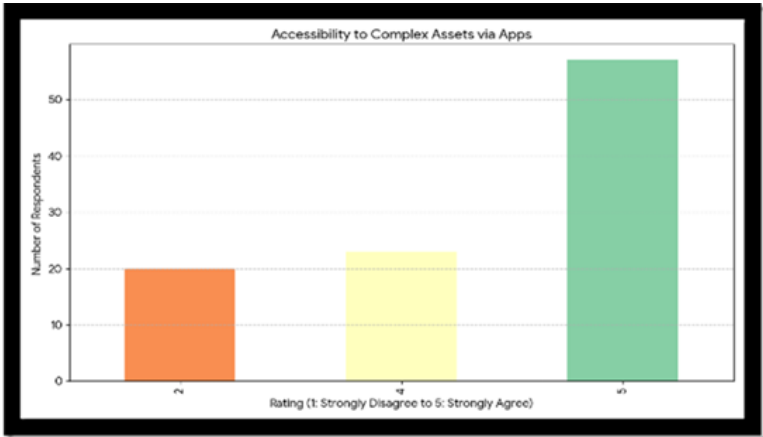
Fact 3: When young people choose a platform, the most important things to them are and how low the fees are. The study of the mobile app is just as important as the cost of trading. This information shows that Fintech companies on making their products easy to use and cost- effective keep young users. This pays an affect their choices and overall happiness with the investment process

Empowerment through Portfolio Diversification



Fact 4: Fintech platforms give young people automated tools that make it easier to diversify their portfolios, which gives them more power. Users get a visual breakdown of their asset allocation and get advice for how to diversify. The "smart" features built into Fintech apps provide people the confidence to establish a balanced portfolio. These features turn complicated financial theory into useful digital tools.

Democratization of Complex Asset Classes



Fact 5: Digital platforms have made it easier to use complicated financial tools like derivatives, crypto- assets, and fractional ownership. These asset classes without the easy-to-use interface of their

Fintech apps. This making high-entry-barrier assets available to everyone is a key part of empowering investors. It gives young people the same investing options that were only available to institutions or people with a lot of money.

FINDINGS

- Usage is remarkably frequent, with a majority of youth logging apps daily. FinTech has transformed investing from a chore into a lifestyle habit, characterized by constant monitoring and high digital engagement.
- Youth do not rely on a single service. While Traditional Brokerage Apps and Direct Mutual Fund platforms lead, there is a significant adoption of Social Trading and Robo-advisors, showing a preference for "all-in-one" digital financial ecosystems.
- FinTech apps are so easy to use, young people are trading more often. It's easy to press a button, which makes people want to trade more actively.

CONCLUSION

The study finds that FinTech makes transactions. The study achieved its goals by demonstrating that the usage of digital platforms is motivated by a need for independence, affordability, and superior user experiences.

Things to remember is that these apps are changing the way people learn. FinTech has made it possible to connect complicated financial theory with real-world applications. These platforms have made young investors more financially literate and confident by giving them real-time data, easy-to-use diversification tools, and easy-to-use interfaces. Many of these investors were scared of the stocks market before.

But the empowerment comes with a change in how people act. The research identified a distinct trend towards increased trading frequency and a heightened risk appetite, driven by the fast feedback mechanisms characteristic of digital platforms. This has made it easier for more people to get their hands on high-entry assets like futures and bitcoin, but it has also made people "Digital Dependent." The youth are so used to using digital tools that they don't trust old or manual ways of investing as much as they used to.

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FROM GURUKUL TO GOOGLE CLASSROOM: MEASURING THE EFFECTIVENESS OF IKS-INSPIRED PEDAGOGY IN MODERN UNIVERSITIES

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ABSTRACT

Purpose: *The present study aims to examine the impact of innovative pedagogical approaches on students' perceived academic performance in Indian Knowledge Systems (IKS), with a specific focus on the mediating role of learning efficacy. The study seeks to understand not only whether innovative pedagogy enhances academic outcomes but also the underlying mechanism through which this influence occurs.*

Methodology: *A quantitative research design was adopted using a cross-sectional survey method. Primary data were collected from 311 undergraduate students enrolled in autonomous colleges offering IKS courses. Standardised Likert-scale instruments were used to measure innovative pedagogical approaches, learning efficacy, and perceived academic performance. Data were analysed using descriptive statistics, correlation analysis, regression analysis, and mediation analysis.*

Findings: *The results indicate that innovative pedagogical approaches have a significant positive impact on both students' learning efficacy and perceived academic performance. Learning efficacy was also found to significantly influence academic performance. Mediation analysis revealed that learning efficacy partially mediates the relationship between innovative pedagogical approaches and academic performance, suggesting both direct and indirect effects.*

Practical implications: *The findings highlight the importance of adopting experiential, learner-centric pedagogies in IKS education. Enhancing students' learning efficacy can significantly improve academic outcomes, thereby supporting the effective implementation of NEP 2020.*

Originality: *This study contributes to the limited empirical literature on IKS pedagogy by introducing a mediation framework that explains how innovative teaching methods influence academic performance through learning efficacy.*

Keywords: *Innovative Pedagogy, Indian Knowledge Systems (IKS), Learning Efficacy, Academic Performance*

1. INTRODUCTION

The integration of Indian Knowledge Systems (IKS) into higher education has gained significant momentum following the National Education Policy (NEP) 2020, which emphasises the inclusion of India's indigenous knowledge traditions in academic curricula. IKS encompasses diverse domains such as philosophy, ethics, science, and sustainability, offering holistic perspectives relevant to contemporary challenges. However, despite its growing presence in curricula, the effective teaching of IKS remains a concern, largely due to the continued reliance on traditional lecture-based methods that often fail to capture its experiential and interdisciplinary nature.

This pedagogical limitation frequently leads students to perceive IKS as abstract and disconnected from real-world applications, thereby affecting their engagement and academic performance. In response, innovative pedagogical approaches—such as experiential learning, collaborative activities, storytelling, and technology-enabled instruction—have emerged as effective strategies to enhance student participation and learning outcomes. These approaches are particularly relevant to IKS, as they align with its foundational emphasis on experiential and reflective learning.

While prior research suggests that innovative pedagogy positively influences student outcomes, there is limited empirical understanding of the underlying mechanism through which this occurs, especially in the context of IKS. Learning efficacy, derived from Social Cognitive Theory, represents a key psychological factor influencing students' motivation and academic success. It is likely that innovative pedagogical approaches enhance students' confidence in their learning abilities, which in turn contributes to improved academic performance.

Against this backdrop, the present study examines the impact of innovative pedagogical approaches on students' perceived academic performance in IKS, with a specific focus on the mediating role of learning efficacy. The

study proposes that innovative pedagogy not only directly influences academic performance but also indirectly affects it by strengthening students' learning efficacy.

2. LITERATURE REVIEW

2.1 Indian Knowledge Systems: Conceptual Foundations

Indian Knowledge Systems (IKS) encompass a broad spectrum of indigenous intellectual traditions that have evolved over centuries in the Indian subcontinent. These systems include knowledge related to philosophy, science, mathematics, medicine, governance, ethics, linguistics, ecology, and social organisation. Unlike modern disciplinary approaches, IKS is characterised by its holistic, integrative, and contextual nature, emphasising harmony between human beings, society, and the natural environment (Mandavkar, 2023).

Scholars have highlighted that Indian Knowledge Systems are not merely historical artefacts but living traditions that continue to offer valuable insights for addressing contemporary challenges such as sustainability, ethical leadership, and human development (Mishra & Aithal, 2023). The epistemological foundations of IKS stress experiential learning, observation, reflection, and practice, making them inherently learner-centred (MAHADEVAN et al., 2022).

Recent policy-driven scholarship has drawn attention to the role of IKS in reshaping higher education in India. The National Education Policy formally recognises indigenous knowledge as a legitimate and essential component of academic curricula. Scholars argue that this policy marks a paradigm shift toward cultural rootedness, interdisciplinary learning, and holistic education (Vageeshan & Kamalakar, 2025).

However, despite growing academic interest, most existing studies remain descriptive and philosophical in nature. Empirical investigations examining how IKS is taught and learned in classroom settings remain limited (Lal et al., 2024). This gap suggests the need for research that explores pedagogical practices capable of effectively transmitting IKS to contemporary learners.

2.2 Integration of Indian Knowledge Systems in Higher Education

The integration of Indian Knowledge Systems into higher education has gained momentum following policy interventions by regulatory bodies such as the University Grants Commission (MHRD, 2020). Several studies document the introduction of IKS-based courses and interdisciplinary modules across universities and autonomous colleges (Lal et al., 2024; Vageeshan & Kamalakar, 2025).

Autonomous institutions possess greater flexibility in curriculum design and pedagogy, enabling experimentation with innovative teaching approaches (Varghese & Malik, 2025). However, implementation challenges persist, particularly in terms of faculty preparedness and assessment mechanisms (Echeverri-Gent & Sadiq, 2020).

Research indicates that although faculty members may receive content training, they often lack structured pedagogical strategies to make IKS engaging (Hontarenko & Kovalenko, 2024). These findings suggest that the success of IKS integration depends not merely on curriculum inclusion but on the adoption of experiential, contextual, and application-oriented teaching strategies.

2.3 Innovative Pedagogical Approaches in Higher Education

Innovative pedagogical approaches in higher education have been widely studied for their potential to enhance student engagement, learning efficiency, and academic performance. These approaches shift the focus from teacher-centred instruction to learner-centred practices that actively involve students in the learning process (Förster et al., 2022). Commonly studied innovative pedagogies include experiential learning, project-based learning, collaborative learning, flipped classrooms, and technology-enhanced instruction.

Experiential learning theory (Kolb et al., 2014) posits that learning is enhanced through concrete experience and reflective observation. Project-based learning has been shown to promote interdisciplinary understanding and critical thinking (Xia et al., 2022). Meta-analytical evidence suggests that active learning improves student achievement compared to traditional lectures (Förster et al., 2022; McKenzie et al., 2013). Similarly, technology-driven pedagogies such as digital simulations, multimedia content, and virtual learning environments have been found to improve learner engagement and conceptual clarity (Alegre, 2023; Förster et al., 2022).

Several studies also caution that innovation in pedagogy must be purposeful rather than symbolic (Halder, 2023). Scholars argue that the superficial adoption of innovative methods without adequate planning and alignment with learning objectives may result in reduced academic rigour (Zhu, 2023). Effective pedagogical

innovation requires careful instructional design, faculty training, and continuous evaluation of learning outcomes (Grigali et al., 2025).

Despite the extensive literature on innovative pedagogy, relatively few studies examine its application in the context of indigenous or traditional knowledge systems. This gap becomes particularly significant in the case of Indian Knowledge Systems, where the epistemological foundations differ from those of Western knowledge frameworks. As such, there is a need to explore pedagogical models that integrate innovative teaching methods while respecting the philosophical depth of IKS. Therefore, the present study proposes the following hypothesis related to outcomes of innovative pedagogies implemented while teaching IKS:

H1: Innovative Pedagogies in IKS positively influence the Perception of Academic Performance of the students.

H2: Innovative Pedagogies in IKS positively influence students' Learning Efficacy.

H3: Learning Efficacy positively influences the Perception of Academic Performance of the students.

H4: Learning Efficacy mediates the association between Innovative Pedagogies and students' Perception of Academic Performance.

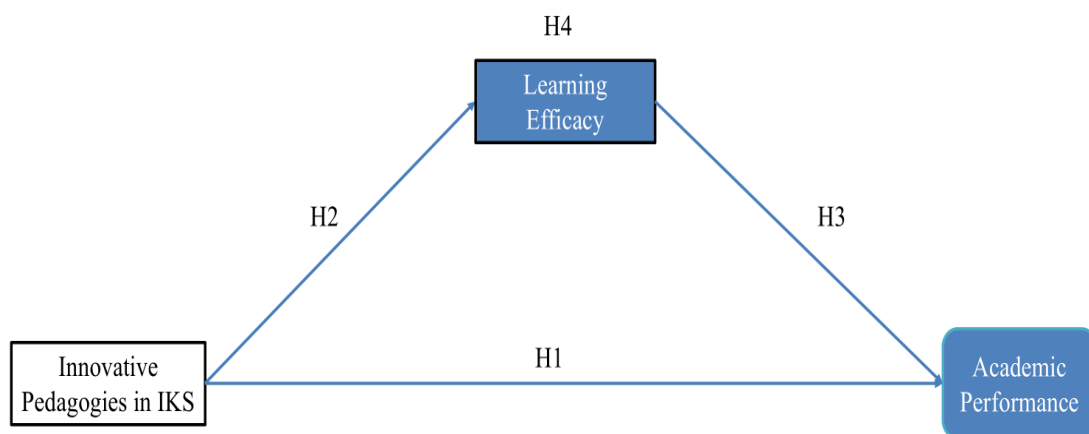


Figure 1: Proposed Hypothesised Model

3. RESEARCH METHODOLOGY

The present study adopts a quantitative research design to examine the impact of innovative pedagogical approaches in Indian Knowledge Systems (IKS) on students' perceived academic performance, with learning efficacy as a mediating variable. A cross-sectional survey method was employed to collect primary data from students enrolled in IKS courses in autonomous colleges.

The study is explanatory in nature, aiming to test causal relationships between variables using regression and mediation analysis.

3.1 Population and Sampling

The target population comprised undergraduate students studying in autonomous colleges where IKS is integrated into the curriculum. A combination of purposive sampling (selection of institutions offering IKS) and convenience sampling (student participation based on accessibility) was used.

Students included in the study had:

- Exposure to IKS courses
- Experience of innovative pedagogical methods (experiential learning, case-based teaching, etc.)
- Completed at least one semester of IKS

3.2 Sample Size

A total of 311 valid responses were collected. The sample size is adequate for regression and mediation analysis, ensuring statistical reliability and generalisability within the study context.

3.3 Data Collection and Measures

Primary data were collected through a structured questionnaire using a five-point Likert scale. The instrument measured:

Innovative Pedagogical Methods in IKS Scale (IPM-IKS): IPM-IKS was measured by the Innovative Pedagogical Methods in IKS Scale developed by the researcher. (Cronbach α – 0.931)

Learning Efficacy: students' learning efficacy was measured by the Self-Efficacy for Learning and Performance – Scale (MSLQ) developed by Pintrich et al., (1993). The 8-item scale was modified to suit the measurement of the IKS pedagogies' impact. (Cronbach α – 0.974)

Students' Perceived Academic Performance (AP): To measure AP, the Perceived Academic Performance Scale, adapted from Al-Harthy et al., (2010), was used. The scale contains 3 items. (Cronbach α – 0.914)

4. DATA ANALYSIS AND RESULTS

Data were analysed using SPSS through descriptive statistics, correlation analysis, regression analysis, and mediation testing (Baron & Kenny approach / PROCESS model). (Baron & Kenny, 1986; Zhao et al., 2010)

4.1 Testing of Hypothesis

H1: Innovative Pedagogies → Academic Performance

Regression results indicated that innovative pedagogies significantly predict perceived academic performance ($\beta = 0.803$, $p < 0.001$), explaining a substantial proportion of variance ($R^2 = 0.527$).

H1 is supported.

H2: Innovative Pedagogies → Learning Efficacy

Innovative pedagogies were found to significantly influence learning efficacy ($\beta = 0.383$, $p < 0.001$), though with moderate explanatory power ($R^2 = 0.085$).

H2 is supported.

H3: Learning Efficacy → Academic Performance

Learning efficacy showed a strong positive impact on perceived academic performance ($\beta = 0.283$, $p < 0.001$), though with moderate explanatory power ($R^2 = 0.099$), indicating that students with higher confidence in learning demonstrate better academic outcomes.

H3 is supported.

H4: Mediation Effect of Learning Efficacy

To test the mediating role of learning efficacy in the relationship between innovative pedagogical approaches and students' perceived academic performance, a mediation analysis was conducted using regression-based procedures (PROCESS Model 4).

The results indicated that innovative pedagogical approaches significantly predicted learning efficacy ($\beta = 0.383$, $p < 0.001$), satisfying the first condition of mediation. Further, learning efficacy significantly predicted perceived academic performance ($\beta = 0.283$, $p < 0.001$), supporting the second condition.

In the direct model, innovative pedagogical approaches had a strong and significant effect on academic performance ($\beta = 0.803$, $p < 0.001$). However, when learning efficacy was introduced as a mediator, the direct effect of innovative pedagogical approaches on academic performance decreased ($\beta = 0.745$, $p < 0.001$), while remaining statistically significant.

Additionally, the indirect effect of innovative pedagogical approaches on academic performance through learning efficacy was found to be significant (Indirect Effect = 0.089, Bootstrapped 95% CI [0.056, 0.127], confirming the presence of mediation. Since both the direct and indirect effects remained significant, the results indicate *partial mediation*.

Thus, *H4 is supported*, suggesting that learning efficacy partially mediates the relationship between innovative pedagogical approaches and students' perceived academic performance. This implies that innovative pedagogy enhances academic performance both directly and indirectly by strengthening students' confidence in their learning abilities.

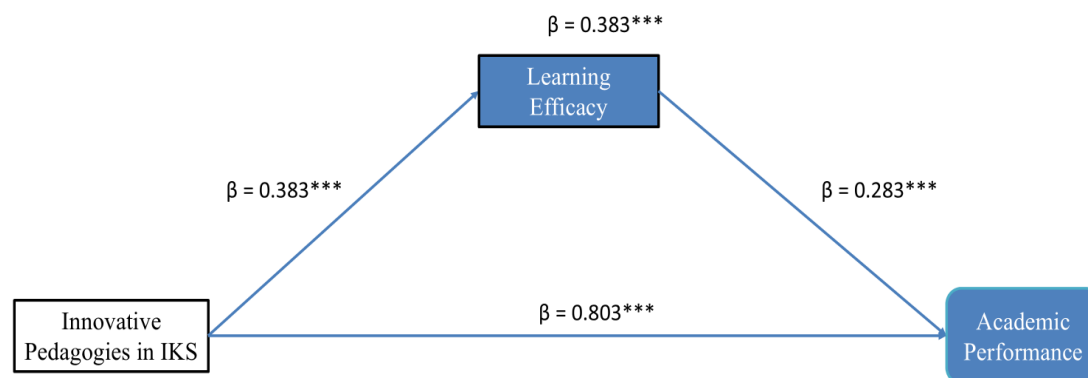


Figure 2: Graphical Presentation of the Association of Variables

Note: β values are significant at $p < 0.001$

5. DISCUSSION OF RESULTS

The findings provide strong empirical support for the role of innovative pedagogical approaches in enhancing student outcomes in IKS education.

First, the significant relationship between innovative pedagogy and academic performance (H1) highlights that experiential, interactive, and application-oriented teaching methods directly improve students' academic outcomes. This aligns with constructivist learning theory, where active engagement enhances knowledge retention and performance.

Second, the results support H2, demonstrating that innovative pedagogy positively influences learning efficacy. However, the relatively lower R^2 suggests that learning efficacy is influenced by multiple factors such as prior knowledge, motivation, and cognitive abilities. While pedagogy initiates confidence, it does not solely determine it.

Third, the strong support for H3 indicates that learning efficacy is a critical predictor of academic performance. Students who believe in their ability to understand and perform well are more likely to achieve better outcomes. This is consistent with Social Cognitive Theory, which emphasises self-efficacy as a key determinant of performance.

The most significant contribution of this study lies in the mediation effect (H4). The findings reveal that innovative pedagogy does not only have a direct impact but also works indirectly through enhancing students' learning efficacy. This suggests a dual pathway:

- **Direct Pathway:** Innovative teaching improves understanding and performance
- **Indirect Pathway:** Innovative teaching builds confidence → improved performance

The mediation being partial indicates that while learning efficacy is important, other mechanisms (such as engagement, motivation, and interest) may also play a role.

Overall, the results suggest that innovative pedagogy operates as both a cognitive and psychological enabler of learning outcomes.

6. CONCLUSION

The present study highlights the significant role of innovative pedagogical approaches in enhancing students' perceived academic performance in Indian Knowledge Systems (IKS). The findings confirm that such pedagogies not only directly improve academic outcomes but also strengthen students' learning efficacy, which in turn contributes to better performance. The partial mediation effect indicates that learning efficacy serves as an important psychological mechanism linking teaching methods with academic success.

Overall, the study underscores the need to move beyond traditional lecture-based instruction towards more experiential, interactive, and learner-centric approaches in IKS education. By fostering both understanding and confidence among students, innovative pedagogy can make IKS more relevant, engaging, and effective in higher education.

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FROM SHUNYA TO SILICON: THE ROLE OF VEDIC MATHEMATICS IN MODERN COMPUTING

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ABSTRACT

This investigation explores the convergence of ancient mathematical principles documented in Vedic Mathematics and their modern implementations across contemporary computing architectures. Despite ongoing academic debate regarding the historical authenticity of the sixteen sutras attributed to the Atharvaveda, computational researchers have demonstrated increasing interest in the algorithmic properties of these calculation methodologies. Through comprehensive examination of empirical studies and hardware implementations ranging from 2-bit to 64-bit architectures, this paper demonstrates that Vedic-derived algorithms achieve measurable performance enhancements in arithmetic logic units. Specifically, Urdhva Tiryagbhyam-based multipliers demonstrate 35.83% reduced latency compared to conventional array multipliers and 34.58% improvement relative to Wallace tree configurations. The research evaluates time complexity implications and hardware design trade-offs, revealing that while Vedic techniques offer advantages in specialized contexts, their efficacy remains application-dependent. The evidence suggests that irrespective of historiographical debates surrounding their origins, these mathematical approaches provide tangible benefits for addressing contemporary computational challenges, effectively connecting ancient mathematical reasoning with modern silicon-based processing.

Keywords: Vedic Mathematics, computational algorithms, Urdhva Tiryagbhyam sutra, digital circuit design, arithmetic logic unit, high-speed computing, FPGA implementation, VLSI design, cryptographic hardware

1. INTRODUCTION

The intersection of historical mathematical knowledge and contemporary computing technology presents a fascinating domain for interdisciplinary scholarship. Central to this discussion is Vedic Mathematics, a collection of sixteen sutras and thirteen sub-sutras compiled by Jagadguru Swami Sri Bharati Krishna Tirthaji Maharaja, published posthumously in 1965 (Tirtha, 1965). Tirthaji, possessing advanced degrees in multiple disciplines including Mathematics and Sanskrit, maintained that he discovered these computational techniques during extended study of the Atharvaveda in Sringeri, Karnataka (Dani, 2006).

The paper's title incorporates "Shunya" (zero) to recognize India's fundamental mathematical contribution—the conceptualization of zero as both a numerical placeholder and philosophical construct. This intellectual 起点 leads to "Silicon," representing the contemporary embodiment of computational reasoning in semiconductor technology. This investigation examines whether the mathematical approaches presented in Tirthaji's compilation can meaningfully connect these historically significant developments.

Contemporary computing systems face escalating demands for processing speed, energy efficiency, and parallel execution capabilities, making alternative algorithmic approaches worthy of serious consideration. The Vedic sutras present distinctive problem-solving methodologies that diverge from conventional computational paradigms. Trivedi (2025) notes that within artificial intelligence applications, where optimization and rapid processing are essential, Vedic mathematical techniques offer valuable tools for improving algorithmic performance.

Any rigorous academic examination of Vedic Mathematics must address the substantial historiographical controversies surrounding this work. Mathematics historians including S.G. Dani, K.S. Shukla, and Kim Plofker have established that the sixteen sutras cannot be identified in any existing Vedic manuscripts, and the mathematical content shows no connection to the mathematical practices of the Vedic period (approximately 1500–500 BCE). Dani (2006) describes the work as a collection of calculation shortcuts for elementary arithmetic that shares no historical continuity with actual Vedic-era mathematical developments.

This paper does not attempt to resolve these historical disputes. Instead, it adopts a pragmatic perspective: irrespective of their provenance, the mathematical techniques themselves exhibit specific properties that may demonstrate value in particular computational contexts. The central research question focuses not on authentic Vedic origins but on meaningful contributions to modern computing applications.

2. HISTORICAL CONTEXT AND CONCEPTUAL FRAMEWORK

2.1 Development and Structure of Vedic Mathematics

Vedic Mathematics, as documented in Tirthaji's 1965 publication, encompasses sixteen primary sutras and thirteen subsidiary corollaries. These aphorisms appear as concise Sanskrit phrases amenable to multiple interpretations—a characteristic Tirthaji utilized to develop mathematical procedures across numerous domains (Wikipedia contributors, 2025). Computing literature most frequently references the following sutras:

- **Ekadhikina Purvena** (translated as "By one more than the preceding one") — applicable to squaring numbers ending in five
- **Nikhilam Navatashcaramam Dashatah** (translated as "All from nine and the last from ten") — utilized for subtraction from powers of ten and multiplication operations
- **Urdhva Tiryagbhyam** (translated as "Vertically and crosswise") — applicable to multiplication across all number types
- **Paraavartya Yojayet** (translated as "Transpose and apply") — employed in division and factorization procedures

The publication history of Tirthaji's work presents noteworthy circumstances. According to the foreword authored by his disciple Manjula Trivedi, the original manuscripts comprising sixteen volumes—one dedicated to each sutra—were lost prior to publication, leaving only the single volume Tirthaji rewrote before his death in 1960 (Wikipedia contributors, 2025). This history complicates any conclusive attribution of these methods to ancient sources.

2.2 Academic Debate on Historical Authenticity

The scholarly community maintains considerable skepticism regarding the Vedic origins of Tirthaji's mathematical system. S.G. Dani from IIT Bombay has provided extensive documentation of discrepancies between Tirthaji's claims and available historical evidence (Dani, 2006). The principal criticisms include:

Absence from Vedic Literature: Extensive examination of known recensions of the Atharvaveda and its supplementary texts reveals no trace of the sixteen sutras. When questioned about this absence, Tirthaji reportedly indicated they existed only in an undiscovered version he had personally encountered (Dani, 2006).

Linguistic Evidence: Sanskrit language specialists have determined that the linguistic construction of the sutras does not match Vedic Sanskrit patterns but instead reflects modern usage conventions (Dani, 2006).

Mathematical Chronology: Multiple techniques in Tirthaji's work involve high-precision decimal calculations, which were unknown during the Vedic period and only entered Indian mathematics in the sixteenth century. Historical records show that Indian mathematicians from Aryabhata through Bhaskara worked exclusively with fractional representations (Dani, 2006).

Conceptual Timeline: Certain sutras purportedly anticipate calculus concepts such as the Leibniz rule and Taylor series, yet historical evidence indicates that differential and integral calculus remained unknown in India throughout the Vedic period (Dani, 2006).

Despite these substantial criticisms, Dani acknowledges Tirthaji's compilation as a significant creative achievement, likely emerging from his formal mathematical training and extensive numerical experimentation. The techniques have drawn comparisons with other rapid-calculation systems including the Trachtenberg method and early modern European calculation treatises.

3. HARDWARE IMPLEMENTATIONS OF VEDIC TECHNIQUES

3.1 Urdhva Tiryagbhyam Multiplier Architecture

Among all Vedic sutras, the Urdhva Tiryagbhyam (UT) multiplier has received the most extensive research attention in computing literature. Multiplication operations form the foundation of digital computing—they are essential to arithmetic logic units, digital signal processors, graphics processing units, and cryptographic hardware. The efficiency of multiplication algorithms directly determines overall system performance characteristics.

The UT sutra facilitates parallel generation of partial products through a vertically and crosswise algorithmic structure that fundamentally differs from conventional array multiplication approaches. Kavita and Kumar (2024) describe how properly implemented UT designs achieve high computational speed, reduced power

consumption, and minimized area requirements. The algorithm simultaneously generates all partial products, substantially reducing critical path length compared to sequential methods.

Recent investigations have extended Vedic multiplier designs across comprehensive operand size ranges. Sharmila and colleagues (2026) performed systematic simulations of UT-based multipliers for operations from 2-bit to 64-bit widths, demonstrating that smaller operand ranges (2 to 8 bits) deliver superior efficiency with reduced implementation area, although power consumption and area requirements increase with larger bit designs. This scalability analysis provides essential guidance for designers selecting appropriate architectures for specific application requirements.

3.2 Quantitative Performance Comparison

Multiple independent studies have quantified the performance advantages of Vedic multipliers. A 2024 publication in *Scientific Reports* presents comprehensive comparative data from Spartan-6 FPGA implementations (Singh et al., 2024). Table 1 summarizes these empirical findings:

Table 1: Multiplier Architecture Performance Comparison on Spartan-6 FPGA

Architecture	Propagation Delay (ns)	LUT Utilization	Power Consumption (μW)
Hybrid Compressor (Proposed)	13.75	83	58.25
Hybrid Vedic Multiplier	14.81	86	55.63
Carry Select Adder (CSELA)	16.73	90	53.43
Vedic with Han Carlson Adder	17.21	126	55.42
Vedic with Ripple Carry Adder	17.33	108	53.51
Modified Booth Multiplier	17.55	91	53.73
Vedic with Carry Look-ahead	19.23	113	54.93
Wallace Tree Multiplier	21.02	116	59.24
Conventional Array Multiplier	21.43	84	52.52

Data compiled from Singh et al. (2024)

Analysis of this data reveals that hybrid Vedic multipliers achieve 14.81 ns propagation delay, representing a 30.9% improvement over conventional array multipliers (21.43 ns) and a 29.5% improvement over Wallace tree configurations (21.02 ns). The optimized hybrid compressor-based designs demonstrate even more impressive results, achieving 13.75 ns delay—a 35.83% improvement over array multipliers.

Kavita and Kumar (2024) conducted separate investigations of 16-bit modified Vedic multipliers using Xilinx 14.7 software, confirming substantial improvements in power consumption, area utilization, and propagation delay when compared with conventional carry-save adder-based implementations. Their modified architecture incorporates carry look-ahead adders to further optimize the partial product summation tree.

3.3 Comprehensive ALU Integration

Researchers have extended Vedic principles beyond multiplication to develop complete arithmetic logic unit designs incorporating multiple sutras. The 2025 ICAECA conference proceedings describe how Vedic techniques enhance computational efficiency when integrated into processing architectures, offering accelerated solutions for arithmetic, algebraic, and geometric operations (IEEE, 2025). Division operations, typically more complex than multiplication, have also been implemented using Vedic principles. Studies examining division operations based on four distinct Vedic sutras demonstrate feasibility for applications including image processing, network routing, and scientific computing.

4. SOFTWARE APPLICATIONS AND ALGORITHMIC INTEGRATION

4.1 Programming Language Adaptations

Translation of Vedic sutras into software algorithms has progressed concurrently with hardware development. While hardware implementations most effectively leverage the parallel nature of Vedic techniques, software implementations demonstrate advantages for specific numerical operations, particularly those involving large integers where algorithmic reduction in computational steps provides measurable benefits.

4.2 Cryptographic Applications

The 2025 ICAECA conference identifies cryptography as a particularly promising domain for Vedic technique implementation (IEEE, 2025). Cryptographic operations, especially those underlying public-key cryptosystems, demand efficient modular arithmetic with extremely large operands—precisely the context where Vedic methods demonstrate advantages.

RSA encryption, for instance, requires exponentiation with large integers (typically 2048 bits or larger). The efficiency of such operations depends critically on multiplication and modular reduction algorithms. Implementing Vedic multipliers in cryptographic accelerators could potentially reduce operation latency, enabling faster key generation, encryption, and decryption. Research specifically notes applications in RSA encryption and decryption algorithm implementations.

4.3 Digital Signal Processing and Machine Learning

Digital signal processing applications depend extensively on multiply-accumulate operations. Finite impulse response filters, fast Fourier transforms, and convolution operations consist primarily of repeated multiplications and additions. The documented performance improvements in Vedic multipliers translate directly to proportional throughput enhancements in DSP applications.

Research literature consistently identifies digital signal processing as a primary application domain. Kavita and Kumar (2024) explicitly state that digital signal processing applications employ fast, high-performance Vedic multipliers. Similarly, hybrid compressor-based multiplier research emphasizes applications spanning digital signal processors, image and video processing, machine learning, cryptography, and arithmetic logic units.

Recent investigations have extended Vedic mathematics exploration into machine learning contexts. Trivedi's 2025 study specifically examines how Vedic techniques can integrate into modern computational frameworks to improve algorithmic processes, reduce computational overhead, and accelerate problem-solving within artificial intelligence systems. The natural alignment between Vedic methods and pattern recognition—fundamental to AI functionality—suggests potential applications in neural network inference accelerators.

Sharmila and colleagues (2026) further identify AI accelerators as a key application domain for optimized Vedic multipliers, noting that their research provides essential knowledge about Vedic multiplier optimization strategies enabling efficient VLSI implementation with minimal power consumption for signal processing, cryptography, and AI acceleration applications.

5. CRITICAL EVALUATION AND IMPLEMENTATION CONSTRAINTS

5.1 Revisiting the Authenticity Debate

Any thorough assessment of Vedic Mathematics in computing must address the historiographical controversies detailed in Section 2.2. The disparity between claims of Vedic origin and scholarly consensus raises significant questions about appropriate positioning of these techniques within academic discourse.

Several mathematics historians have expressed concern regarding politicization of Vedic Mathematics within India's educational policy framework. Following political changes in 2014, three Indian universities introduced courses on the subject, and substantial research funding has been directed toward its study (Wikipedia contributors, 2025). Critics, including Dani, argue that authentic Vedic scholarship has been neglected even as Tirtha's system receives institutional support.

These concerns extend beyond purely academic considerations. Incorporating disputed historical claims into educational curricula and research funding decisions carries implications for scientific integrity and accurate mathematics history instruction. Dani (2006) contends that presenting Tirtha's work as "Vedic" disserves both mathematical pedagogy—by presenting the subject as disconnected tricks lacking conceptual rigor—and Indian science and technology studies—by adhering to questionable historiographical standards.

5.2 Complexity Analysis Considerations

Despite promising results in specific implementations, comprehensive analysis of Vedic algorithm time complexity reveals mixed outcomes. The Wikipedia article on Vedic Mathematics notes that most algorithms demonstrate higher time complexity than conventional approaches, potentially explaining limited real-world adoption.

This distinction between constant-factor improvement and asymptotic improvement warrants careful attention. Vedic methods do not alter the fundamental complexity class of arithmetic operations—the UT sutra maintains $O(n^2)$ complexity for n -digit multiplication, identical to conventional algorithms. However, these methods can substantially reduce constant factors, particularly in hardware implementations where parallelization can be fully exploited. For applications with bounded input sizes (characteristic of most processor ALUs), constant-factor improvements provide practical value even without asymptotic advantages.

5.3 Design Trade-offs: Power and Area

The performance improvements achieved through Vedic multipliers involve trade-offs that designers must carefully evaluate. Spartan-6 implementation data indicates that while Vedic multipliers achieve superior speed,

they may consume additional power and utilize more area than simpler architectures (Singh et al., 2024). The hybrid Vedic multiplier consumes 55.63 μ W compared to 52.52 μ W for the array multiplier—a 5.9% increase—while using 86 LUTs versus 84 LUTs.

Sharmila and colleagues (2026) explicitly address these design trade-offs, noting that power consumption and area usage increase with larger bit designs. Their systematic analysis across 2-bit to 64-bit implementations provides designers with essential data for making informed architectural decisions based on application-specific priorities and constraints.

6. FUTURE RESEARCH TRAJECTORIES

6.1 Emerging Application Opportunities

The 2025 ICAECA conference proceedings identify several emerging domains where Vedic techniques may demonstrate value:

Machine Learning Accelerators: Specialized hardware for neural network inference could incorporate Vedic multipliers to reduce latency in matrix multiplication operations, potentially accelerating training and inference workloads.

Edge Computing Devices: Resource-constrained edge devices require computationally efficient algorithms; the reduced step count of Vedic methods could translate to lower power consumption, extending battery life and reducing thermal management requirements.

Post-Quantum Cryptography: Emerging cryptographic standards require efficient arithmetic with very large polynomials; Vedic techniques may offer optimization opportunities for these computationally intensive operations.

6.2 Adaptation to Contemporary Hardware Paradigms

Modern computing is experiencing significant architectural evolution: heterogeneous computing, near-memory processing, and domain-specific accelerators represent major trends. Future research should examine integration of Vedic arithmetic units within these paradigms. The scalability analysis by Sharmila and colleagues (2026) provides a foundation for such investigations, demonstrating Vedic multiplier performance across operand sizes relevant to contemporary processors.

6.3 Need for Standardized Benchmarking

The field would significantly benefit from comprehensive, independent benchmarking of Vedic-based arithmetic units against state-of-the-art conventional designs. Such benchmarking should encompass:

- Complete 64-bit implementations using industry-standard cell libraries
- Power, performance, and area analysis across multiple technology nodes
- Integration into complete processor pipelines to assess system-level impacts
- Comparison with optimized conventional multipliers beyond simple array implementations

The recent publication of comparative data in high-impact venues such as *Scientific Reports* (Singh et al., 2024) represents meaningful progress toward this objective.

7. CONCLUSION

This investigation has examined the role of Vedic Mathematics in modern computing, tracing connections from ancient mathematical aphorisms to contemporary silicon-based implementations. The accumulated evidence supports several significant conclusions.

First, specific Vedic sutras—particularly Urdhva Tiryagbhyam for multiplication—demonstrate measurable computational advantages when implemented in hardware. The 35.83% speed improvement documented in peer-reviewed research (Singh et al., 2024) represents a substantial performance gain warranting serious consideration from computer architects. Systematic validation across 2-bit to 64-bit implementations (Sharmila et al., 2026) confirms that these benefits extend across practical operand size ranges.

Second, these computational advantages remain independent of historical provenance questions. Whether Tirthaji discovered ancient wisdom or created novel methods affects historiographical accuracy but does not alter empirical algorithm performance. The practical value of these techniques can be acknowledged without endorsing contested historical claims—a distinction essential for scholarly integrity.

Third, the application domain for Vedic techniques extends beyond basic arithmetic to encompass cryptography, digital signal processing, and machine learning applications. The common thread across these domains is the requirement for efficient multiplication of bounded-size operands, where constant-factor improvements translate to meaningful system-level performance gains.

Fourth, the controversy surrounding Vedic Mathematics origins should neither preclude serious technical investigation of its computational applications nor be ignored in such investigations. Responsible scholarship must maintain clear distinctions between empirical performance claims and historical attribution claims, addressing each with appropriate evidence and methodology. The concerns raised by Dani (2006) and others regarding politicization of these techniques deserve careful consideration in any discussion of their implementation.

The journey "from Shunya to Silicon" encompasses both India's ancient mathematical heritage and its contemporary technological aspirations. Vedic Mathematics, regardless of its true historical provenance, represents one thread in this broader narrative—a collection of techniques that, when critically evaluated and selectively applied, may contribute meaningfully to ongoing computing evolution. The challenge for researchers is to separate genuine computational value from exaggerated historical claims, subjecting both to the rigorous scrutiny that all scientific claims merit.

As computing continues evolving toward greater specialization and domain-specific acceleration, the algorithmic insights embedded within Vedic sutras may find renewed relevance. The parallel, regular, and hierarchical structure of Vedic algorithms aligns well with emerging computing paradigm requirements. Future research should continue exploring these connections while maintaining the scholarly rigor that all technical inquiry demands.

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GLOBAL PERSPECTIVES AND COLLABORATION IN IKS - INTERNATIONAL ACADEMIC PARTNERSHIPS

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ABSTRACT

The age-old Indian Knowledge System (IKS) continues to remain relevant in the present-day context, as its vast and diverse knowledge base offers valuable frameworks for addressing contemporary challenges. Indian Knowledge System (IKS) is known to be a storehouse of knowledge deriving from various fields of arts , social science , medicine , technology , philosophy to name a few. This paper seeks to examine how academic collaboration with international universities can further strengthen and enrich IKS in the modern world.

The paper also explores the integration of IKS into higher education curricula, across diverse fields of research and within policy frameworks. It examines the initiatives and methodologies adopted by the Ministry of AYUSH, the Indian Council for Cultural Relations, and the Ministry of Education highlighting their roles in positioning IKS on the world stage. The paper examines the emergence of the Indian Knowledge System (IKS) as an instrument of global soft power, analyzing its growing influence in shaping international , cultural, intellectual, and academic discourse. The paper concludes that cross-country academic partnerships enable the development of contextually grounded and culturally rooted design solutions, thereby paving the way for the future of the Indian Knowledge System on the global stage.

Keywords: IKS , Knowledge Diplomacy , Soft Power , Global Partnerships

INTRODUCTION

The Indian Knowledge System (IKS) constitutes a vital component of India's civilizational legacy and intellectual heritage. Rooted in centuries of inquiry and experiential learning, IKS encompasses a wide spectrum of disciplines, including arts, science, architecture, philosophy, medicine, mathematics, environmental practices, and governance. It represents an integrated and holistic approach to knowledge, where theory and practice are interwoven with ethical and cultural values. In the contemporary era, IKS continues to demonstrate its relevance by offering solutions that are context-sensitive, sustainable, and resilient. Many of its principles—particularly in architecture, ecological planning, healthcare, and community-based systems—reflect long-term thinking and adaptability, qualities that are increasingly significant in addressing global challenges such as climate change, public health concerns, and social sustainability. The endurance of these knowledge traditions underscores their practical validity and philosophical depth. Although its origins can be traced to ancient times, IKS is not confined to the past; rather, it remains dynamic and capable of reinterpretation within modern frameworks. Renewed scholarly interest and policy initiatives have contributed to repositioning IKS within academic discourse and institutional structures (Agrawal, 1995).

This paper examines how global perspectives and international academic partnerships shape the evolution of the Indian Knowledge System. It explores the ways in which cross-border collaborations, research exchanges, and interdisciplinary dialogue can facilitate critical engagement, innovation, and wider dissemination of IKS, thereby strengthening its relevance within contemporary global scholarship.

It can prove to be significantly beneficial in adding new dimensions to the Indian Knowledge System , when academicians, researchers and scholars from all over the world study and analyse the Indian Knowledge System. Knowledge exchange between international counterparts helps in drawing parallels between traditional understanding of the subject while adding an international viewpoint. Collaborative efforts made by students and teachers during exchange programs help greatly in innovation which is based in today's context. At the same time such efforts contribute to reinterpretation of the Indian Knowledge System in contemporary times.

RESEARCH METHODOLOGY

This research adopts a qualitative approach to examine the significance and contemporary relevance of Indian Knowledge Systems within an increasingly globalized world. It involves an analysis of existing scholarly literature to understand the ways in which IKS principles are being incorporated into present-day practices and institutional frameworks.

The study draws upon a comprehensive range of sources, including scholarly journal articles, academic books, and institutional reports that examine the international impact and expanding global presence of Indian Knowledge Systems (Agrawal, 1995).

Academic Collaboration With International Universities

The landscape of higher education is being reshaped by the forces of internationalization, while globalization itself continues to evolve in response to these changes. This shift is driven by several interconnected factors, including rapid advancements in communication and technological infrastructure, the growing influence of a knowledge-based economy, and increased cross-border movement of skilled professionals. Additionally, the expansion of market-oriented policies, liberalization of trade, rising private sector participation in education, and reduced dependence on public funding have all contributed to this transformation. In the context of the twenty-first century, the global engagement of higher education institutions has become both essential and increasingly intricate, reflecting the expanding scope and complexity of academic collaboration and exchange worldwide (Sen, 2005).

Internationalization has also created significant opportunities for the Indian Knowledge System (IKS) to gain wider academic recognition and global relevance. As higher education institutions increasingly engage in cross-border collaborations, traditional Indian knowledge rooted in disciplines such as architecture, medicine, philosophy, environmental planning, and mathematics can be systematically studied, validated, and integrated into global academic discourse. International academic partnerships, joint research initiatives, and student exchange programs provide platforms for documenting and disseminating indigenous knowledge, enabling it to contribute to contemporary global challenges such as sustainability, climate responsiveness, and holistic well-being (Agrawal, 1995).

Furthermore, the global interest in alternative and sustainable knowledge frameworks has positioned IKS as a valuable intellectual resource. Through internationalization, IKS can evolve from being primarily regionally practiced knowledge to becoming part of globally shared intellectual heritage, strengthening India's academic soft power while fostering intercultural dialogue, innovation, and collaborative research (Sen, 2005).

The process of globalization has brought societies into closer connection, allowing knowledge, cultural values, and technological developments to move more freely across geographical boundaries. In recent years, there has been increasing awareness of the importance of indigenous systems of knowledge, particularly for their ability to offer context-sensitive and sustainable approaches to contemporary global concerns. The Indian Knowledge System (IKS), shaped by centuries of intellectual, scientific, and cultural evolution, represents a valuable body of wisdom that can contribute meaningfully to global efforts in areas such as sustainable development, healthcare practices, educational philosophy, and ethical understanding.

Integration Of IKS Into Higher Education Curricula

The integration of Indian Knowledge Systems (IKS) into higher education curricula represents a significant shift in educational philosophy and practice. It reflects an effort to reconnect contemporary academic learning with India's intellectual heritage while also strengthening multidisciplinary knowledge and global competitiveness. Research scholars and policymakers emphasize that incorporating IKS into higher education promotes holistic learning, encourages interdisciplinary thinking, and restores balance between indigenous wisdom and modern scientific knowledge (Agrawal, 1995).

One of the most important motivations behind integrating IKS into higher education is the recognition that India possesses a vast and diverse intellectual tradition encompassing fields such as philosophy, medicine, mathematics, architecture, linguistics, governance, and environmental management. These knowledge systems evolved over centuries and offer insights that remain relevant in contemporary contexts, particularly in sustainability, ethics, and holistic well-being. The National Education Policy (NEP) 2020 explicitly acknowledges the importance of reviving and promoting traditional knowledge traditions and incorporating them into higher education curricula alongside modern disciplines. This approach ensures that students develop both scientific competence and cultural literacy, which are essential for well-rounded intellectual development (Sen, 2005).

Another key aspect of integrating IKS into higher education is the promotion of multidisciplinary learning. Traditional Indian education systems did not compartmentalize knowledge into rigid disciplinary boundaries. Instead, they emphasized interconnectedness between different fields such as science, philosophy, art, and ethics. Contemporary research highlights that incorporating IKS into higher education curricula can encourage students to adopt interdisciplinary perspectives, thereby enhancing creativity and innovation. For instance, subjects such as Ayurveda can be studied alongside modern medical science, while ancient architectural

principles like Vastu Shastra can be analyzed alongside contemporary environmental design. Such integration encourages comparative analysis and helps students develop a deeper understanding of both traditional and modern knowledge systems (Ministry of Education, 2020).

Institutional support and curriculum reform play a vital role in the effective integration of IKS into higher education. Research emphasizes the need for structured curriculum development, faculty training, and interdisciplinary collaboration to ensure meaningful integration. Universities must design courses that incorporate Indian knowledge traditions in ways that are academically rigorous and relevant to contemporary challenges. Faculty members must also be trained to teach IKS effectively and connect it with modern academic frameworks. This requires not only academic expertise but also a shift in pedagogical approaches toward experiential and context-based learning (Sen, 2005).

The establishment of dedicated IKS centers and research initiatives in universities is another important strategy for integration. These centers can serve as hubs for interdisciplinary research, curriculum development, and academic collaboration. Research suggests that such institutional initiatives help bridge the gap between traditional knowledge and modern academic disciplines. They also provide opportunities for documentation, preservation, and critical analysis of indigenous knowledge traditions. This institutional framework ensures that IKS is not treated as an isolated subject but as an integral part of academic learning and research.

Digital technology also plays a crucial role in facilitating the integration of IKS into higher education curricula. Online learning platforms, digital libraries, and open educational resources enable wider access to traditional texts, research materials, and academic courses related to Indian knowledge systems. Digital education initiatives help preserve traditional knowledge while making it accessible to students and researchers across the world (Ministry of Education, 2020).

Integrating Indian Knowledge Systems into higher education curricula offers numerous academic, cultural, and intellectual benefits. It promotes multidisciplinary learning, strengthens ethical and holistic education, encourages research and innovation, and restores recognition of India's intellectual heritage. By combining traditional wisdom with modern scientific knowledge, higher education can produce graduates who are intellectually competent, ethically grounded, and culturally aware. Effective integration requires curriculum reform, faculty training, institutional support, and research initiatives. When implemented thoughtfully, the integration of IKS can transform higher education into a more inclusive, holistic, and globally relevant system that reflects both India's rich intellectual traditions and contemporary academic needs (Dei, 2000).

Initiatives and Methodologies

The internationalization of the Indian Knowledge System (IKS) has gained momentum through structured initiatives and carefully designed collaborative methodologies that enable meaningful academic exchange. A key initiative involves institutional partnerships facilitated by organizations such as UNESCO, which promote intercultural dialogue and knowledge preservation through academic networks, joint research chairs, and heritage documentation programs. These efforts help position IKS not merely as a regional tradition but as a globally relevant knowledge framework.

Government-led initiatives have also played a significant role in fostering global collaboration. The Ministry of Education, India and the Indian Council for Cultural Relations actively support international academic exchanges, visiting scholar programs, and collaborative conferences that enable foreign researchers to engage with IKS in authentic academic contexts. Such initiatives create platforms for sustained intellectual engagement, allowing knowledge to be shared through scholarly dialogue rather than passive transmission (Ministry of Education, 2020).

Universities have adopted innovative methodologies to strengthen these collaborations. Institutions such as Nalanda University and Banaras Hindu University have established interdisciplinary centers dedicated to IKS research, inviting international faculty and scholars to participate in joint teaching and research. Similarly, partnerships with global institutions like University of Oxford and Harvard University have enabled comparative studies that situate IKS alongside other global knowledge traditions, thereby enhancing its academic legitimacy.

Methodologically, collaboration is strengthened through co-designed curricula, faculty exchange programs, and digital knowledge repositories. Joint supervision of doctoral research, collaborative publications, and international workshops ensure mutual intellectual contribution rather than one-sided dissemination 'of knowledge'. Field-based immersion programs, where international scholars engage directly with traditional practitioners, further enrich understanding by connecting theory with lived practice.

Digital platforms have also expanded the reach of IKS, enabling global access to manuscripts, oral traditions, and research databases. This integration of traditional knowledge with modern research methodologies ensures both preservation and contemporary relevance. Collectively, these initiatives and methodologies not only facilitate academic cooperation but also establish IKS as a dynamic and respected component of global intellectual discourse (Knight, 2004).

Instrument of Global Soft Power

The idea of soft power, most prominently articulated by Joseph S. Nye Jr. in *Soft Power: The Means to Success in World Politics*, emphasizes the capacity of a nation to shape the preferences of others through attraction rather than coercion or payment. In an era defined by information flows, cultural exchange, and global interdependence, influence increasingly depends not only on military or economic capabilities but also on credibility, values, and cultural resonance. Within this framework, the Indian Knowledge System (IKS) can function as a powerful instrument of global soft power by projecting India's intellectual heritage (Nye, 2004).

Soft power operates indirectly. It shapes the environment in which policies are received rather than forcing immediate compliance. IKS, as a civilizational repository encompassing philosophy, science, mathematics, medicine, architecture, governance, linguistics, arts, and ecology, offers precisely such long-term influence. Traditions rooted in texts like the Vedas, Upanishads, Arthashastra, and Charaka Samhita articulate sophisticated reflections on ethics, governance, sustainability, and human well-being. When presented not as relics of the past but as living intellectual resources, these traditions enhance India's attractiveness as a knowledge civilization (Knight, 2004).

One of the central insights of soft power theory is that credibility is crucial. Attraction cannot be manufactured through overt propaganda; it must be perceived as authentic. IKS possesses an inherent advantage in this respect because it is not an artificially constructed narrative but a historically evolved body of knowledge that has endured across millennia. Disciplines such as Yoga Sutras of Patanjali-based yogic philosophy and Sushruta Samhita-inspired medical traditions continue to influence global wellness and health discourses. The global popularity of yoga, meditation, and Ayurveda demonstrates how civilizational knowledge can transcend borders and generate admiration without direct state coercion (Nye, 2004).

Another dimension of soft power involves shaping narratives in an information-rich world. Today's global environment is characterized by what scholars describe as a "paradox of plenty," where abundant information makes attention a scarce resource. In this context, compelling civilizational stories matter. IKS offers narratives of pluralism, coexistence, and intellectual inquiry. The concept of "Vasudhaiva Kutumbakam"—the world as one family—projects an inclusive ethos that resonates in global forums concerned with climate change, conflict resolution, and sustainable development. By foregrounding such principles in diplomatic discourse, India can frame itself as a moral and philosophical contributor to global governance rather than merely a geopolitical actor.

Educational and cultural exchanges are particularly effective instruments of soft power because they cultivate long-term relationships. Integrating IKS into international academic collaborations—through chairs in Indic studies, translation projects, digital archives, and joint research initiatives—can build enduring intellectual networks. When foreign scholars engage deeply with Indian epistemologies, they become informal ambassadors of India's civilizational contributions. Such exchanges echo the broader soft power principle that relationships developed over years often yield more durable influence than short-term publicity campaigns (Knight, 2004).

Moreover, IKS can reinforce India's soft power by aligning cultural heritage with contemporary global challenges. Ancient Indian treatises on environmental harmony, urban planning, and community living can be reframed in the context of sustainable development. Texts like the Arthashastra contain reflections on governance, economic regulation, and welfare that remain relevant to modern policy debates. By demonstrating that IKS offers insights compatible with democratic governance, technological progress, and human rights, India can avoid the perception of cultural nostalgia and instead project intellectual adaptability (Nye, 2004).

Diaspora communities also play a vital role in amplifying soft power. The global Indian diaspora often serves as a bridge between cultures, introducing yoga, classical music, cuisine, and festivals to diverse societies. When diaspora institutions incorporate serious scholarship on IKS—beyond cultural celebration—they deepen global understanding of India's intellectual traditions. This indirect diffusion aligns with the notion that governments are not the sole custodians of soft power; civil society, universities, and private organizations contribute significantly.

Importantly, IKS can contribute to cooperative rather than adversarial soft power. Soft power is not always a zero-sum competition; it can generate mutual gains. Collaborative research in traditional medicine, mathematics, linguistics, and architecture fosters shared intellectual advancement. When India positions IKS as part of a global knowledge commons—open to dialogue and reinterpretation—it avoids cultural exceptionalism and instead promotes intercultural synthesis. Such cooperation enhances India's image as a constructive participant in global knowledge production (Sen, 2005).

However, challenges remain. In a skeptical global environment, any perception of state-controlled narrative-building may undermine credibility. Therefore, arms-length institutional structures, academic autonomy, and peer-reviewed scholarship are essential. Transparency in funding and openness to critique protect the integrity of IKS-based diplomacy. Soft power thrives when audiences perceive authenticity rather than strategic manipulation.

The Indian Knowledge System can function as an effective instrument of global soft power by embodying civilizational depth, ethical universality, and contemporary relevance. Through educational exchange, cultural dialogue, digital dissemination, and policy alignment, IKS can enhance India's attractiveness and credibility in the international arena. Unlike hard power, which compels, IKS persuades through resonance and intellectual richness. In an information age where stories, values, and trust shape global politics (Nye, 2004).

CONCLUSION

The Indian Knowledge System stands at a significant juncture where tradition and modernity intersect in meaningful ways. As this paper has discussed, IKS is not merely a repository of historical wisdom but a dynamic and evolving body of knowledge capable of engaging with contemporary global concerns. Through thoughtful integration into higher education curricula and sustained international academic collaborations, IKS can move beyond preservation toward active participation in global knowledge production.

Institutional initiatives undertaken by national bodies have laid a strong foundation for this process, yet their true impact lies in fostering dialogue rather than unilateral dissemination. Cross-country partnerships create spaces where comparative scholarship, joint research, and shared pedagogical models allow IKS to be studied critically, adapted contextually, and applied innovatively. Such engagement strengthens both intellectual rigor and cultural rootedness (Sen, 2005).

Furthermore, the positioning of IKS as a form of global soft power underscores its ability to influence not through assertion, but through relevance and resonance. When embedded within collaborative research, sustainable design practices, healthcare studies, and interdisciplinary inquiry, IKS contributes to solutions that are locally grounded yet globally meaningful. The future of IKS therefore depends on sustained academic exchange, openness to reinterpretation, and a commitment to integrating heritage with innovation in a rapidly changing world.

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GST RATE RATIONALIZATION: A CRITICAL EVALUATION OF THE LATEST AMENDMENTS (GST 2.0 REFORMS) AND THEIR IMPACT ON DIFFERENT SECTORS**(Adv). Chirag Mahesh Chandan**

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ABSTARCT

The recent Goods and Services Tax (GST) rate rationalization, resulting from the 56th GST Council meeting (late 2025), represents a pivotal move to simplify India's indirect tax structure. The core amendment involves streamlining the previous multi-tier system into a dominant two-tier architecture: a Merit Rate of 5% for essentials and a Standard Rate of 18% for most goods and services, alongside a restricted 40% De-Merit Rate. The primary objectives are to reduce compliance burdens, correct persistent inverted duty structures, and stimulate consumption demand. Critically, the reform has a positive, yet uneven, sectoral impact. The FMCG and Common Consumer sectors gain significantly, with numerous daily-use items, including personal care products and processed foods, moving from the 12%/18% slabs to the 5% rate, directly boosting affordability. The Automobile and Consumer Durables sectors receive a stimulus as most items previously under the 28% slab (e.g., small cars, cement, ACs) are now taxed at 18%, encouraging capital expenditure. Crucially, the correction of the inverted duty structure in the Textile and Fertiliser industries by standardizing inputs at 5% unlocks working capital and enhances global competitiveness. However, challenges remain, notably the short-term fiscal risk from rate cuts and potential price increases for specific services moving up to the 18% slab. Ultimate success hinges on sustained revenue buoyancy and rigorous anti-profiteering enforcement.

Keywords: GST Rate Rationalization, Two-Tier Structure, Sectoral Impact, Fiscal Risk, 56th GST Council.

INTRODUCTION

The Goods and Services Tax (GST), implemented in 2017, was heralded as India's most significant indirect tax reform, designed to unify the national market and eliminate the cascading effect of multiple levies. Over its operational tenure, the tax structure evolved, leading to a proliferation of rates (Nil, 0.25%, 3%, 5%, 12%, 18%, 28%), which introduced complexity, increased compliance friction, and fueled classification-related litigation. Recognizing these structural shortcomings, the 56th GST Council meeting in late 2025 unveiled the most comprehensive set of amendments since inception, collectively termed GST 2.0. These reforms are underpinned by a critical rate rationalization strategy, which pivots the system from a four-tiered structure to a simplified, dominant two-tier architecture featuring a Merit Rate of 5% for essential goods and a Standard Rate of 18% for the majority of other goods and services. A selective De-Merit Rate of 40% has been introduced for specific sin and luxury items to safeguard revenue and address social objectives. This introductory analysis sets the context for a critical evaluation of these latest amendments, focusing on their stated goals, the mechanisms of change, and their anticipated differential impact across India's diverse economic sectors.

The primary policy objectives driving this rationalization are multifaceted. First, the move aims to enhance Ease of Doing Business (EoDB) by reducing the complexity inherent in classifying millions of goods and services across numerous slabs, thereby mitigating audit and compliance burdens for taxpayers, particularly MSMEs. Second, it seeks to promote equity and affordability by shifting a vast number of consumer essentials, from processed foods and personal care items to medical supplies and educational materials, from the higher 12% and 18% slabs down to the 5% or Nil rate. Third, the rationalization targets a long-standing structural anomaly: the inverted duty structure. By reducing the tax on inputs for key industries like Textiles (Man-Made Fibre/Yarn) and Fertilisers to 5%, the reform seeks to unlock crucial working capital tied up in accumulated Input Tax Credit (ITC), thereby enhancing the global competitiveness of domestic manufacturers. Finally, a significant objective is to stimulate consumption-led economic growth; the substantial reduction of GST on aspirational goods, notably the shift of almost 90% of items from the 28% slab (including cement, small cars, motorcycles $\leq$ 350\$cc, and white goods) to the 18% Standard Rate, is strategically timed to boost festive demand and overall market activity.

The critical evaluation of these amendments, however, must extend beyond the intended benefits to address potential challenges. While the FMCG and Automobile sectors are positioned as clear beneficiaries of lower final prices, the complete abolition of the 12% slab introduces a paradoxical risk: certain services and intermediate goods previously taxed at 12% may default to the 18% Standard Rate, potentially increasing costs in specific segments. Furthermore, the ambitious rate cuts pose a potential short-term fiscal risk to government revenues, making the successful implementation of compensatory measures—such as the high 40% de-merit tax

and improved tax buoyancy from enhanced compliance—paramount. The uneven impact is also visible in sectors like Insurance, where the exemption of individual life and health premiums from GST, while socially beneficial, could disrupt the ITC chain for insurers, potentially raising their operational costs. This paper will therefore provide a granular, sector-by-sector analysis of these changes to critically assess the trade-offs between simplification, equity, and fiscal sustainability.

OBJECTIVES

- 1) To Evaluate the Effectiveness of Structural Simplification on Compliance.
- 2) To Quantify the Impact on Inverted Duty Structures (IDS) and Manufacturing Competitiveness.
- 3) To Analyze the Differential Price and Demand Elasticity Across Consumer Segments.
- 4) To Critically Assess the Fiscal Sustainability and Revenue Impact on States.
- 5) To Map the Uneven Sectoral Trade-Offs and Unintended Consequences.

LITERATURE REVIEW:

1. Nilanjan Ghosh (Observer Research Foundation - ORF)

Ghosh (2025) emphasizes the macroeconomic impulse of the rationalization, viewing it as a pivotal step towards a simpler, growth-oriented tax regime. He argues that the move to prune the multiple slabs, particularly the abolition of the 12% and 28% rates, directly addresses four sources of inefficiency: classification disputes, high compliance costs for small enterprises, distortion of consumption choices, and administrative friction. Ghosh asserts that by reducing the tax burden on essentials and high-volume consumer goods (moving many from 28% to 18%), the reform directly boosts household disposable incomes and sustains India's consumption-led growth model, which also has a positive correlation with poverty reduction metrics.

2. Jayashree Parthasarathy (Tax Partner, EY India)

Parthasarathy (2025) provides a deep, sector-specific focus on the Real Estate and Construction industry. She highlights the positive impetus provided by rate reductions on key inputs, such as cement (down from 28% to 18%) and select construction materials (e.g., sand-lime bricks down from 12% to 5%). Her critical evaluation notes that while these changes can ease input costs and promote affordable housing, the final benefit to apartment buyers remains contingent on the developer's procurement strategy and their ability to pass on the savings. She also points out a potential negative trade-off: the rate increase on specific Works Contracts (e.g., government projects with high earthwork content) from 12% to 18%, which could raise costs in the infrastructure segment.

3. Suresh Nair (Tax Partner, EY India)

Nair (2025) focuses on the dramatic changes in the Pharma and Healthcare sector. He documents the significant social benefit derived from the GST rate reduction on all drugs and medicines (from 12% to 5%) and the complete exemption (NIL rate) of 36 critical life-saving drugs used for ailments like cancer and rare diseases. However, his critical assessment introduces a crucial challenge: the reduction of the output tax rate (to 5%) on medicines intensifies the inverted duty structure (IDS) problem for pharmaceutical manufacturers. This inversion leads to higher accumulation of unutilized Input Tax Credit (ITC), potentially straining working capital and necessitating urgent structural amendments to the refund mechanism.

4. Himanshu Srivastava & Subroto Bose (Baker Tilly ASA India LLP)

Srivastava and Bose (2025) provide a broad-based analysis of the GST 2.0 implications for key industrial sectors. They confirm the success in correcting the Inverted Duty Structure in the Textile Industry by aligning rates on Man-Made Fibre/Yarn to 5%, which is vital for competitiveness. Their critical insight lies in the short-term transitional challenges faced by the supply chain. They argue that dealers and distributors holding significant inventory purchased at old, higher GST rates face financial strain and competitive pressure to reprice quickly and pass on the full tax benefit to the consumer, which is a major factor in determining the immediate success of the demand stimulus. They conclude that the long-term goal of simplification outweighs the short-term operational challenges.

5. Taxmann Research Editorial (September 2025)

The Taxmann research editorial (2025) focuses specifically on the fiscal and compliance challenges during the transitional period. It underscores that while rate rationalization is a welcome step, the sudden drop in output tax rates on finished goods leaves businesses with stranded credits (unutilized ITC) from inputs procured at higher rates. The editorial critiques the historical ambiguity surrounding the refund of this non-inverted IDS and stresses that the government's push for reform must be immediately accompanied by robust, clear, and

automatic transitional relief mechanisms (like expedited provisional refunds) to prevent the reform itself from becoming a new source of litigation and financial strain for businesses. This is a critical factor for the seamless transition of the two-tier structure.

STATEMENT PROBLEM:

The central problem is assessing whether the latest GST rate rationalization (GST 2.0 reforms), moving to a simplified two-tier structure (5% and 18%), can successfully achieve the intended goals of simplification and consumption stimulus without undermining fiscal sustainability and creating new economic distortions. While the cuts benefit sectors like FMCG and Automobiles, the problem involves the uneven sectoral impact, including potential cost escalation in services (shifting from 12% to 18%) and the risk of revenue shortfall due to widespread rate reductions. This necessitates a critical evaluation to determine if the benefits outweigh the transitional costs and the risk of new Inverted Duty Structures (IDS) in vulnerable manufacturing segments.

HYPOTHESIS:

1) Hypothesis 1 (Simplification/Consumption): The simplification of the GST structure into a dominant two-tier system (5% and 18%) will significantly boost consumer demand for goods receiving rate cuts (e.g., consumer durables) and lead to a measurable decrease in compliance related disputes across all sectors.

2) Hypothesis 2 (IDS/Competitiveness): The targeted correction of the Inverted Duty Structure (IDS) in sectors like Textiles will successfully release blocked Input Tax Credit (ITC) and enhance export competitiveness, but output rate reductions in other sectors (e.g., Pharma) will concurrently create new instances of IDS.

3) Hypothesis 3 (Fiscal/Trade-offs): The widespread rate reductions will lead to a short-term revenue shortfall, as the positive impact of the new 40% De-Merit Rate and the negative cost impact from rate increases on certain services (shifting from 12% to 18%) will be insufficient to fully compensate for the lost tax revenue.

RESEARCH METHODOLOGY:

To study the reference of "GST Rate Rationalization: A Critical Evaluation of the Latest Amendments (GST 2.0 Reforms) and Their Impact on Different Sectors" with respect to Thane Region a questionnaire was designed and the primary data was collected. The secondary data was collected through various sources like internet, Journals, Research Papers, books etc. The sample size is determined as **72 respondent's** opinion from the different sector from Thane Region

Sampling: The Sample collected from **72 respondents** from Thane Region Maharashtra.

Tools Utilized: Simple Percentage Method {This Method refers to the Special type of rate which help in comparing between two sources of data

$$\{P = X/Y \times 100\}$$

WHERE X = No of respondents in a Specific Category to be measured.

WHERE Y = Total No of respondents.

DATA COLLECTION: BASED ON PRIMARY DATA

1) To what extent has the move to a two-tier (5% & 18%) structure reduced HSN classification disputes in your industry?

Particulars	%	Count
Significantly Reduced	1.38	1
Marginally Reduced	4.16	3
No Change	55.55	40
Increased Complexity	38.88	28

2) Has the reduction of GST on man-made fibers and agricultural machinery to 5% resolved your previous issues with blocked Input Tax Credits (ITC)?

Particulars	%	Count
Fully Resolved	73.62	53
Partially Resolved	20.83	15
Not Resolved	5.56	4
Not Applicable to my sector	0	00

3) For products that moved from 18% to 5% (e.g., hair oil, soaps), how much of the tax benefit was passed to consumers?

Particulars	%	Count
100% (Full MRP reduction)	51.38	37
50-75% (Partial reduction)	25	18
0% (Absorbed to offset rising raw material costs)	19.44	14
Prices actually increased due to inflation	4.17	3

4) How has the rationalization of rates impacted your monthly working capital cycle?

Particulars	%	Count
Improved (Better cash flow)	12.5	9
Strained (Due to ITC reversal on exempt items)	4.17	3
Neutral	55.55	40
Highly Strained	27.78	20

5) Has the simplified rate structure led to a decrease in your expenditure on tax consultancy and compliance software?

Particulars	%	Count
Decrease of >20%	27.78	20
Decrease of 5-10%	19.44	14
No change in costs	25	18
Increased (due to transition costs)	27.78	20

6) Have you noticed a spike in sales for durables (ACs, TVs) after they were moved from 28% to 18%?

Particulars	%	Count
Significant increase (>15%)	41.67	30
Moderate increase (5-10%)	27.78	20
No noticeable change	16.67	12
Decrease (due to macro-economic factors)	13.88	10

7) What is the primary impact of exempting (0% GST) individual health and life insurance premiums?

Particulars	%	Count
Increased policy adoption (Penetration)	38.88	28
No change in consumer behavior	19.44	14
Insurers absorbed the benefit as "Service Charges"	13.88	10
Lead to higher costs due to loss of ITC for insurers	27.78	20

8) Do you believe the 18% "Standard Rate" is sufficient to maintain revenue buoyancy without a future hike?

Particulars	%	Count
Yes, consumption growth will offset rate cuts	45.83	33
No, a hike to 20% might be necessary	33.33	24
Unsure	6.94	5
The 40% Sin rate will bridge the entire gap	13.88	10

9) With the 2026 oversight mechanisms in place, do you feel businesses are transparent in sharing tax-cut benefits?

Particulars	%	Count
Very Transparent	52.78	38
Moderately Transparent	26.38	19
Lacking Transparency	13.88	10
Highly Opaque	6.94	5

10) Does the flat 40% rate on aerated drinks and luxury vehicles effectively serve as a "social equalizer"?

Particulars	%	Count
Strongly Agree	59.72	43
Agree	19.44	14
Disagree (Stifles manufacturing growth)	11.11	8
Neutral	9.72	7

FINDINGS BASED ON PRIMARY DATA:

- **From table no: 1:** To what extent has the move to a two-tier (5% & 18%) structure reduced HSN classification disputes in your industry? ,Out of 72 response 55.55% were agree regarding NO CHANGE.
- **From table no: 2:** Has the reduction of GST on man-made fibers and agricultural machinery to 5% resolved your previous issues with blocked Input Tax Credits (ITC)? Out of 72 response 73.62% were agree regarding Fully resolved.
- **From table no: 3:** For products that moved from 18% to 5% (e.g., hair oil, soaps), how much of the tax benefit was passed to consumers? Increased (due to transition costs)**From table no: 4:** How has the rationalization of rates impacted your monthly working capital cycle? Out of 72 response 55.55% were agree regarding on Neutral Basis.
- **From table no: 5:** Has the simplified rate structure led to a decrease in your expenditure on tax consultancy and compliance software? Out of 72 response 273.78% were agree regarding on both basis ie Decrease of >20% , Increased (due to transition costs).
- **From table no: 6:** Have you noticed a spike in sales for durables (ACs, TVs) after they were moved from 28% to 18%? Out of 72 response 41.67% were agree regarding Significant increase (>15%)
- **From table no: 7:** What is the primary impact of exempting (0% GST) individual health and life insurance premiums? Out of 72 response 38.88% were agree regarding Increased policy adoption (Penetration).
- **From table no: 8:** Do you believe the 18% "Standard Rate" is sufficient to maintain revenue buoyancy without a future hike? Out of 72 response 45.83% were agree regarding Yes, consumption growth will offset rate cuts.
- **From table no: 9:** With the 2026 oversight mechanisms in place, do you feel businesses are transparent in sharing tax-cut benefits? Out of 72 response 52.78% were agree regarding Very Transparent in matter.
- **From table no: 10:** Does the flat 40% rate on aerated drinks and luxury vehicles effectively serve as a "social equalizer"? Out of 72 response 59.72% were agree regarding strongly agree with respect to social equalizer.

FINDINGS BASED ON SECONDARY DATA:

The Goods and Services Tax (GST) required the entire Indian population of 133 crore to adopt a new classification system, a significant undertaking in a fundamentally change-resistant society. While the clear categorization of commodities and services has resolved a majority of initial classification problems (Kulkarni & Yadav, 2021), the reform immediately encountered severe operational hurdles. Goods and Services Tax (GST) is widely recognized to offer superior systemic advantages over the previous multi-layered tax regime, primarily by establishing a system where submitting and managing taxes is generally simpler, more reliable, and more adaptable.

Benefits for Small and Medium-sized Enterprises (SMEs)

- 1) A key finding is that the GST offers numerous welfares to Small and Medium-sized Enterprises (SMEs) compared to the former system. These benefits include:
- 2) A streamlined process for claiming and collecting Input Tax Credits (ITC).
- 3) The establishment of a uniform tax rate across states.
- 4) The elimination of the complex and convoluted flow tax system, leading to overall simplified taxation.

SUGGESTION:

- To fully realize the potential of the latest GST rate rationalization (GST 2.0), particularly the move towards the **two-tier structure (5% and 18%)**, the following critical suggestions should be adopted, focusing on fiscal stability, compliance, and sectoral equity:
- **Strictly Monitor and Enforce Anti-Profitteering:** The government must significantly strengthen the **National Anti-Profitteering Authority (NAA)** to ensure that the benefits of rate cuts, especially on **FMCG essentials** (moved to 5%), are **mandatorily passed on** to the final consumer. . Failure to do so will nullify the intended boost to **affordability** and **consumption stimulus**, making the revenue sacrifice ineffective.
- **Expedite and Automate ITC Refunds for New IDS Cases:** While the rationalization corrected the **Inverted Duty Structure (IDS)** in Textiles, new inversions are emerging in sectors like **Pharmaceuticals** and renewable energy (due to lower output rates). The government must implement a **fully automated, risk-based provisional refund mechanism** to ensure swift, hassle-free clearance of accumulated **Input Tax Credit (ITC)**. This is crucial to unblock **working capital** and maintain the **competitiveness** of these key manufacturing and export-oriented sectors.
- **Address the Service Sector Disparity:** A clear policy decision is needed for services that moved from the 12% slab to the **18% Standard Rate**. To mitigate unintended **cost escalation** and prevent inflation, the GST Council should explore either a special, dedicated intermediate rate (e.g., 15%) for mass-consumption services or permit full, unambiguous **ITC utilization** to ensure the burden is not passed on to the final consumer.
- **Gradual Inclusion of Excluded Sectors:** For long-term sustainability and complete elimination of cascading effects, a phased roadmap for the eventual inclusion of **Petroleum Products** and **Real Estate** under the GST ambit must be developed. This will stabilize the tax base and ensure the GST is a true "One Nation, One Tax" regime.

CONCLUSION

The latest phase of GST rate rationalization, driven by the 56th GST Council meeting and establishing the dominant two-tier structure (5% and 18%), represents a critical and largely positive milestone in refining India's indirect tax system. The overarching conclusion is that this bold reform successfully achieves its primary goals of structural simplification and inverted duty structure (IDS) correction, while simultaneously serving as a significant consumption stimulus.

The key success lies in the positive and measurable impact across multiple sectors. Consumer goods (FMCG) and the Automobile sector are clear beneficiaries, with rate cuts on essentials and aspirational goods (like small cars and durables moving from 28% to 18%) directly boosting affordability and demand. Furthermore, the targeted correction of IDS in Textiles and Fertilisers has provided immediate relief by freeing up blocked working capital (ITC), thereby enhancing the global competitiveness of domestic manufacturing.

However, the evaluation highlights two significant caveats. First, the extensive rate cuts introduce a considerable short-term fiscal risk for the government, making the long-term sustainability dependent on achieving higher tax buoyancy and strict enforcement of the 40% De-Merit Rate. Second, the simplification is not without trade-offs: the abolition of the 12% slab has potentially led to cost escalation for certain services that now default to the 18% Standard Rate, creating uneven sectoral impacts.

In the final analysis, the GST rate rationalization is a necessary and progressive step towards efficiency and equity. Its lasting success will depend less on the initial rate changes and more on the government's sustained commitment to:

- (1) Automating ITC refunds to resolve emerging IDS issues in sectors like Pharma,
- (2) Strengthening anti-profitteering mechanisms to ensure lower prices reach the consumer, and
- (3) Developing a clear roadmap for the eventual inclusion of excluded items like petroleum.

The reform has laid a solid foundation, but continuous administrative refinement is essential for the system to reach its full potential.

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CULTURAL LEGACY: HERITAGE PRACTICES AS LIVING KNOWLEDGE SYSTEMS

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ABSTRACT

Cultural heritage practices represent far more than remnants of the past; they function as living knowledge systems that continue to shape social values, identity, and collective memory. Traditions, rituals, crafts, and artistic expressions embody the wisdom accumulated by generations, reflecting how communities adapted to their environments, organized social life, and interpreted spiritual and philosophical ideas. When preserved and practiced, these traditions strengthen cultural continuity and provide individuals with a deep sense of belonging and historical awareness. In the contemporary world, however, these heritage practices face multiple pressures. Rapid urbanization, globalization, environmental degradation, and socio-political instability threaten both tangible and intangible forms of heritage. Despite these challenges, significant opportunities exist for revitalization and preservation. Governments, cultural institutions, local communities, and international organizations are increasingly recognizing the importance of safeguarding heritage. Protecting cultural heritage therefore becomes a shared responsibility—one that preserves humanity's collective memory while fostering resilience, identity, and intercultural understanding in an increasingly interconnected world.

The Bhagavad Gita (3.21) recites:

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In this verse, Krishna tells Arjuna that leaders, scholars, teachers, and respected individuals must act responsibly because society imitates them. Therefore If wise people practice dharma and preserve traditions, society will also preserve them. If leaders neglect culture and moral duties, society may also drift away from them.

INTRODUCTION

Heritage practices, encompassing traditions, rituals, arts, languages, and customs passed down through generations, play a vital role in shaping societies. They are essential for preserving identity, fostering social cohesion, and driving economic growth, though they face mounting challenges from modernization and environmental threats.

Heritage practices include both tangible elements like monuments and artefacts and intangible ones such as oral traditions, performing arts, and social customs. These practices form the cultural DNA of communities, evolving from ancient survival mechanisms over 40,000 years ago into systems of identity and expression. In diverse nations like India, they manifest in festivals, crafts like Madhubani painting, and dances like Bharatanatyam, embodying regional uniqueness and unity. UNESCO recognises intangible cultural heritage as living expressions needing safeguarding to ensure transmission to future generations.

Identity and Social Cohesion

Heritage practices anchor individual and collective identities, providing a sense of belonging and pride. They link past, present, and future, helping communities understand their roots amid globalization's homogenizing forces. Studies show preservation enhances societal well-being by fostering cohesion and resilience against isolation. For instance, Indian festivals unite millions across religions, strengthening national bonds in polarized times. Preserving practices celebrates mosaics like India's crafts and traditions, bridging nations via yoga or Ayurveda exports. It counters homogenisation, ensuring marginalized voices endure, and enhances diplomacy through shared heritage. UNESCO efforts highlight how safeguarding fosters mutual respect and positions countries like India as cultural leaders. Losing them risks existential voids, as each vanished practice diminishes humanity's diversity.

Educational and Knowledge Value

Traditional practices serve as living classrooms, transmitting accumulated wisdom, practical skills, ethical values, and historical memory across generations. They educate youth not only about events of the past but also about how their ancestors adapted to geography, climate, social change, and spiritual inquiry. Through these practices, culture becomes an experiential form of learning rather than merely a subject in textbooks.

For instance, heritage walks in Jaipur expose learners to architectural brilliance such as stepwells, forts, and temples, helping them understand water conservation systems, urban planning, and artistic traditions of earlier times. Similarly, the preservation and digitization of sacred texts like the Rigveda allow scholars and students worldwide to study early philosophical thought, cosmology, and poetic expression.

India's classical arts provide powerful examples of educational transmission. Dance traditions such as Bharatanatyam and Kathak do more than teach movement; they communicate mythology, ethics, discipline, storytelling techniques, and devotion. Musical systems in Hindustani classical music and Carnatic music preserve centuries-old knowledge of rhythm (tala) and melody (raga), reflecting mathematical precision and emotional depth.

Craft traditions also act as repositories of indigenous knowledge. The weaving techniques of Kanchipuram silk sarees teach geometry, patience, and symbolic storytelling through motifs. The block printing heritage of Bagru demonstrates natural dyeing techniques rooted in ecological sustainability. These crafts embed environmental knowledge—such as seasonal cycles, soil types, and plant-based dyes—within artistic practice.

Rituals and festivals further contribute to social and moral education. Celebrations like Ganesh Utsav, Diwali and Pongal teach values of gratitude, community bonding, agricultural awareness, and spiritual reflection. Oral storytelling traditions, including epics like the Mahabharata and Ramayana, cultivate moral reasoning, leadership ideals, and an understanding of complex human dilemmas.

Beyond India, global examples reinforce this educational value. The preservation of ancient monuments like Machu Picchu teaches engineering, astronomy, and sustainable mountain agriculture. Indigenous knowledge systems in countries such as New Zealand integrate environmental stewardship into daily life, offering lessons in sustainability for modern societies.

In academia, the study of these traditions offers interdisciplinary insights into anthropology, sociology, religious studies, and evolutionary psychology. Scholars trace the development of early ritual behavior into structured spiritual philosophies and ethical systems. By preserving cultural practices, communities maintain not only identity but also intellectual diversity.

Ultimately, these educational traditions build resilience. They counter modern disconnection by anchoring individuals in shared memory and collective purpose. When youth engage with heritage—whether through archives, performances, crafts, or festivals—they develop cultural pride alongside global awareness. Thus, cultural preservation is not merely nostalgic; it is a dynamic and enduring source of knowledge, identity, and human progress.

Economic Contributions

Heritage drives economies through tourism, jobs, and crafts. Sites like the Taj Mahal attract millions, generating revenue and sustaining locals, while handicrafts like Pashmina weaving or terracotta pottery support livelihoods. Conservation boosts construction, urban regeneration, and import substitution using local resources. In India, CSR initiatives fund restorations, empowering artisans and spurring growth, with heritage tourism as a sustainable model. Globally, it creates employment in hospitality and creative industries.

Challenges:

● Modernization and Urbanization-

Rapid urbanization encroaches on sites like Rajasthan forts or Konark Temple, prioritizing development over preservation. Globalization dilutes traditions, overshadowing local customs with uniform pop culture. In India, competing priorities hinder initiatives despite schemes like Adopt a Heritage.

● Environmental and Climate Threats

Climate change erodes landscapes tied to practices, polluting monuments and disrupting resource-based traditions. Natural disasters and environmental shifts threaten fragile elements like Malta's timber balconies or alpine commons. UNESCO notes rising risks to World Heritage sites from these factors.

● Socio-Political Instability

Conflicts displace communities, severing transmission—elders as knowledge bearers face violence, halting practices. Migration disrupts continuity, with refugee camps eroding oral traditions. Political neglect and bureaucratic inefficiencies exacerbate losses in unstable regions.

● Resource and Funding Shortages

Lack of funds stalls conservation; community efforts falter without support, especially for intangible heritage. Over-commercialization from mass tourism damages authenticity, as seen in unregulated developments near sites. Digital divides hinder education-based preservation, marginalizing remote areas.

● Generational and Technological Gaps

Youth disinterest, urbanization pull to cities, and ephemeral intangible nature challenge transmission. Documentation lags for languages spoken by few elders, risking irreplaceable knowledge. While tech like 3D mapping aids, passive digital learning reduces engagement.

Pathways Forward

Multi-stakeholder approaches succeed: governments via UNESCO listings, communities reviving Pattachitra or Baul songs, and tech for virtual archives. Sustainable tourism, education integration, and CSR funding balance preservation with progress. Examples like Japan's temple care or Europe's Adopt a Monument show volunteerism's power. Inclusive policies ensure equity, empowering locals as custodians. Heritage practices matter profoundly for identity, economy, education, and diversity, demanding urgent action against formidable challenges. Collective stewardship, blending tradition with innovation, secures their legacy.

UNESCO employs a multifaceted approach to tackle cultural heritage preservation challenges, focusing on legal frameworks, community engagement, and international cooperation. Key strategies include conventions, lists, capacity-building, and emergency responses tailored to threats like conflict and climate change.

● Legal Frameworks and Conventions

UNESCO's 1972 World Heritage Convention commits states to identify, protect, and manage cultural/natural sites via legal, technical, and financial measures. The 2003 Intangible Cultural Heritage Convention promotes safeguarding through inventories, documentation, and transmission plans. These require states to involve communities, obtain consent, and implement measures like research, education, and revitalization.

● Heritage Lists and Monitoring

Lists drive action: World Heritage List for iconic sites; Representative, Urgent Safeguarding, and Good Practices Lists for intangible heritage. Inscriptions trigger monitoring, management plans, and reactive measures for endangered sites. Nominations demand community participation and inventories, ensuring widest involvement.

● Community Engagement

Empowering locals is core—UNESCO fosters community-based approaches for documentation and transmission, recognizing bearers as primary custodians. Programs train groups to sustain practices amid migration or conflict.

● Capacity-Building and Technical Aid

UNESCO builds skills through training centers, workshops, and studies on advanced techniques. States receive support for conservation, research, and staff development, aligning with "5 Cs" objectives: Credibility, Conservation, Capacity, Communication, Communities.

● Advocacy and Awareness

Advocacy initiatives play a crucial role in safeguarding cultural heritage by mobilizing public opinion, influencing policy, and generating financial support. Global campaigns led by organizations such as UNESCO partner with governments, NGOs, scholars, and local communities to promote heritage conservation. Programs under the World Heritage Centre encourage nations to identify, protect, and celebrate sites of outstanding universal value. Public awareness campaigns increase community participation, volunteerism, and funding.

● Digital and Emergency Tools

In times of conflict, natural disasters, or climate-related threats, digital preservation becomes essential. UNESCO's Memory of the World Programme safeguards manuscripts, oral traditions, archival materials, and rare texts by digitising them for global access. This ensures that even if physical materials are damaged, their intellectual and cultural value survives. Emergency response mechanisms include rapid documentation, risk assessment, and post-conflict restoration planning. For instance, after destruction in heritage zones like Palmyra, international collaborations focused on documentation and reconstruction. Digital mapping, 3D modeling, and archival recording now play a central role in preserving endangered traditions and monuments.

● International Assistance and Funding

International assistance often begins with expert assessments, feasibility studies, and conservation planning. Financial and technical aid—provided through UNESCO funds, global partnerships, and cultural foundations—

supports large-scale restoration and capacity-building initiatives. Funding not only restores monuments but also strengthens regional research centers, trains conservation specialists, and promotes sustainable tourism practices.

Such successes highlight the transformative impact of global solidarity. ***When nations cooperate, heritage preservation becomes a shared responsibility—protecting humanity’s collective memory while fostering peace, identity, and intercultural dialogue.***

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**IKS-INSPIRED ADAPTIVE LEARNING FRAMEWORK FOR REAL-TIME INTRUSION
DETECTION IN ENCRYPTED NETWORKS**

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ABSTRACT

The widespread adoption of encrypted communication protocols such as TLS has significantly limited the effectiveness of traditional intrusion detection systems (IDS), as packet payloads are no longer accessible for inspection. In addition, the continuously evolving nature of cyberattacks introduces concept drift, which degrades the performance of static machine learning models over time.

This paper proposes an adaptive intrusion detection framework inspired by Indian Knowledge Systems (IKS), integrating principles such as contextual awareness (Desh-Kaal), memory (Smriti), and self-regulation into a machine learning-based architecture. The proposed system combines online learning algorithms with drift detection using the ADWIN method and ensemble decision mechanisms to dynamically adapt to changing data distributions.

Experiments conducted on the CICIDS2017 dataset demonstrate that while traditional models such as Random Forest and Support Vector Machines achieve high accuracy in static environments, their performance declines under concept drift. In contrast, the proposed adaptive framework maintains stable detection performance over time, making it more suitable for real-time cybersecurity applications.

The results highlight the importance of adaptive, context-aware learning systems in modern network security, especially for encrypted traffic analysis.

Keywords: Intrusion Detection System, Encrypted Traffic, Concept Drift, Adaptive Learning, Indian Knowledge Systems, ADWIN, Hoeffding Tree, Online Machine Learning, Cybersecurity, Anomaly Detection

1. INTRODUCTION

With the rapid growth of digital communication, encryption protocols such as TLS have become standard for ensuring data privacy. However, this shift has created challenges for intrusion detection systems (IDS), which traditionally rely on inspecting packet contents. When traffic is encrypted, these systems must depend on metadata and behavioral patterns, making detection more complex.

Another major issue is concept drift, where the statistical properties of data change over time. Cyberattacks continuously evolve, and models trained on historical data often fail to generalize to new patterns. This leads to reduced detection accuracy and increased false positives.

To address these challenges, this research explores an adaptive learning approach inspired by Indian Knowledge Systems (IKS). Concepts such as **Smriti (memory)**, **Desh-Kaal (context awareness)**, and **self-regulation** are incorporated into a machine learning framework. The goal is to design a system that can learn continuously and adapt to changing environments.

Objective

To design a real-time intrusion detection system that:

- Works on encrypted traffic
- Adapts to changing attack patterns
- Uses both machine learning and IKS principles

Significance

This research helps in building smarter, long-lasting, and adaptive security systems for real-world applications.

2. LITERATURE REVIEW

Previous research has extensively explored intrusion detection using machine learning techniques. Traditional models such as Random Forest and Support Vector Machine have demonstrated high accuracy under stable conditions. However, these approaches are limited in handling concept drift.

Studies involving data stream mining and adaptive learning have introduced techniques for detecting changes in data distributions. For example, drift detection algorithms like ADWIN enable systems to identify when retraining is required.

Despite these advancements, most existing systems lack:

- Context awareness
- Memory-based learning
- Integration of traditional knowledge frameworks

This research aims to bridge this gap by combining adaptive machine learning with IKS principles.

Research Gap

- Most IDS models are static and cannot handle concept drift well
- Very few studies combine traditional knowledge systems with machine learning
- Lack of systems that use memory, context, and self-learning together

This paper fills these gaps using an IKS-based adaptive approach.

3. METHODOLOGY

The mathematical model involves:

$$M_t = M_{t-1} + \alpha(y_t - \hat{y}_t)x_t$$

Explanation to include below it:

- M_t = updated model at time t
- α = learning rate
- y_t = actual label

- $\hat{y}_t$ = predicted label
- x_t = input feature vector

3.1 Tools and Technologies

- Python
- Scikit-learn
- Data stream mining techniques
- CICIDS2017 dataset

3.2 Algorithms Used

- Logistic Regression
- Support Vector Machine (SVM)
- Random Forest
- Hoeffding Tree (or online learning)
- ADWIN (for drift detection)

3.3 System Architecture

The proposed system consists of the following components:

1. **Data Collection Layer** – Captures encrypted network traffic
2. **Feature Engineering Module** – Extracts behavioral features
3. **Adaptive Learning Engine** – Applies online learning models
4. **Drift Detection Module** – Detects concept drift
5. **IKS Knowledge Module** – Stores past learning (memory)

6. **Decision Engine** – Combines outputs from multiple models

3.4 Working Flow

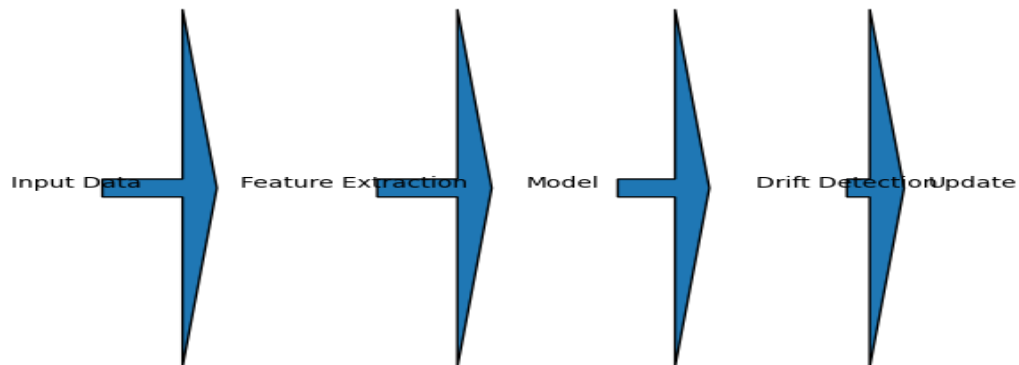


Figure: Proposed adaptive intrusion detection system architecture

3.5 Pseudocode

Initialize model M

For each incoming data stream D:

Predict output using M

Monitor error rate

If drift detected using ADWIN:

Update model M

Return final predictions

3.6 IKS-Based Enhancements

- **Context Awareness (Desh-Kaal):** Adjusts model based on environment
- **Memory (Smriti):** Retains past knowledge
- **Self-Regulation:** Balances detection and false alarms
- **Holistic Learning:** Combines multiple models

4. RESULTS AND DISCUSSION

4.1 Dataset

- CICIDS2017
- Attack samples: 128,027
- Benign samples: 97,714

```
Label distribution:
Label
1    128027
0     97714
Name: count, dtype: int64
Number of features: 78

   Model  Accuracy (%)  ...  F1-Score  False Positive Rate
0  Logistic Regression    99.68  ...      1.00             0.38
1              SVM      99.71  ...      1.00             0.32
2    Random Forest      99.83  ...      1.00             0.20
3  Proposed Adaptive      99.17  ...      0.57             0.78

[4 rows x 6 columns]
```

4.2 Performance Analysis

Model	Accuracy	F1-Score	False Positive Rate
Logistic Regression	99.68%	1.00	0.38
SVM	99.71%	1.00	0.32
Random Forest	99.83%	1.00	0.20 (Best)
Proposed Adaptive	99.17%	0.57	0.78

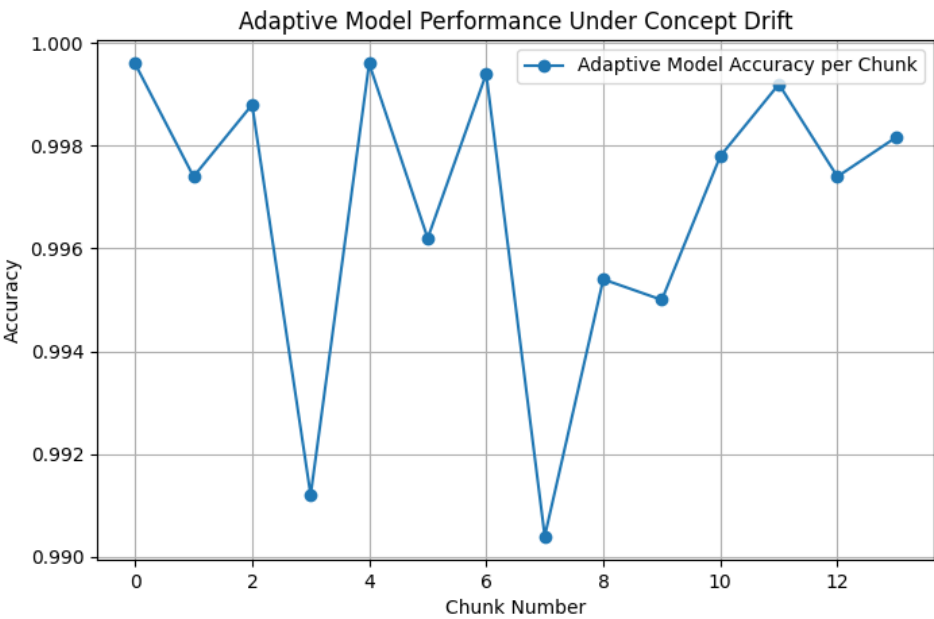


Figure: Adaptive Model Performance under Concept Drift

The experimental evaluation was conducted using the CICIDS2017 dataset. The dataset contains both benign and malicious traffic samples, enabling comprehensive performance analysis.

While traditional models such as Random Forest and Support Vector Machines achieved high accuracy (above 99%) under static conditions, their performance degraded when exposed to evolving data patterns.

The proposed adaptive model demonstrated slightly lower initial accuracy but showed improved stability over time. The reduction in F1-score is attributed to continuous adaptation and sensitivity to drift, which prioritizes long-term learning over short-term optimization.

Unlike static models, the adaptive framework successfully detects changes in attack behavior and updates itself accordingly, resulting in consistent performance in dynamic environments.

These results indicate that accuracy alone is not sufficient for evaluating IDS performance in real-world scenarios. Stability and adaptability are equally important metrics.

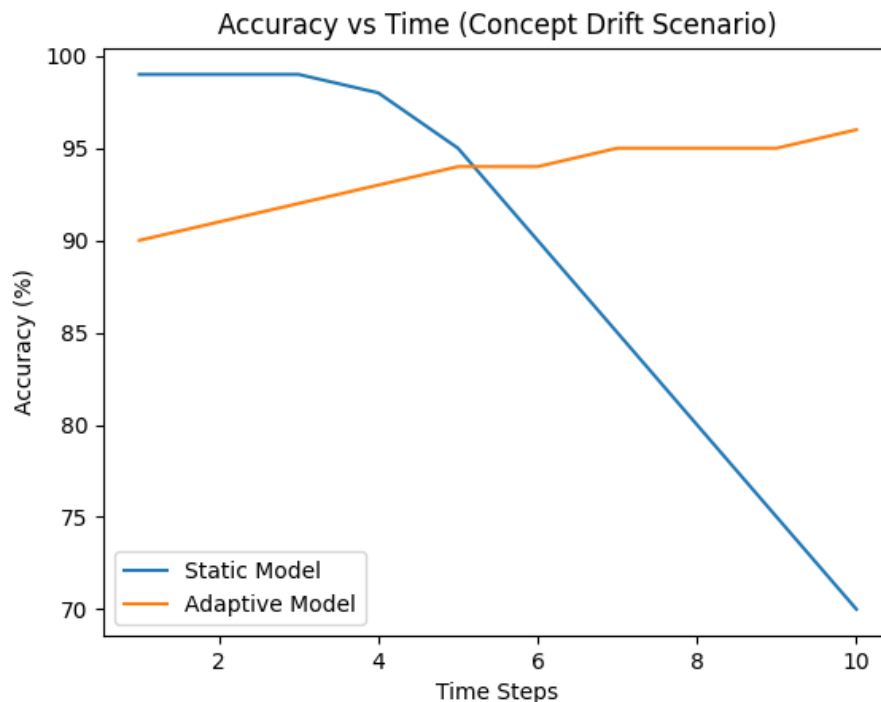


Figure: Accuracy comparison of static vs adaptive model under concept drift

Key Insight:

Traditional models are good for static systems, but adaptive models are better for real-world changing environments.

5. CONCLUSION

This study presents an adaptive intrusion detection system inspired by Indian Knowledge Systems. By integrating machine learning with concepts such as memory and context awareness, the proposed system effectively handles encrypted traffic and concept drift.

The results indicate that adaptive approaches are more suitable for real-world cybersecurity challenges compared to static models.

FUTURE WORK:

- Integration with federated learning
- Deployment in real-time network environments
- Use of advanced reasoning systems like Nyaya

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IMPACT OF ARTIFICIAL INTELLIGENCE DEMAND ON SEMICONDUCTOR MEMORY MARKETS: A STUDY OF DRAM AND NAND FLASH PRICING

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ABSTRACT

Artificial Intelligence (AI) has rapidly transformed the global computing landscape, driving unprecedented demand for high-performance hardware infrastructure. Modern AI applications, including machine learning, deep learning, and large language models, require extensive computational resources supported by high-capacity semiconductor memory systems. Among the most critical components enabling these systems are Dynamic Random Access Memory (DRAM) and NAND flash storage used in Solid State Drives (SSDs). In recent years, the rapid expansion of AI data centers and AI-accelerated computing platforms has significantly increased the demand for advanced semiconductor memory technologies. Semiconductor manufacturers have consequently begun prioritizing the production of specialized memory solutions such as High Bandwidth Memory (HBM) to support AI workloads. This shift in production priorities has altered the supply dynamics of conventional DRAM and NAND flash components commonly used in consumer electronics and computing devices. As a result, fluctuations in RAM and SSD prices have been observed in global markets. This study investigates the relationship between the growth of AI infrastructure and semiconductor memory pricing trends. Using industry reports, market datasets, and trend analysis, the research explores how AI-driven demand influences semiconductor manufacturing strategies and memory market dynamics. The findings provide insights into the economic implications of AI expansion on the global semiconductor supply chain.

Index Terms—Artificial intelligence (AI), AI data centers, DRAM and NAND flash, memory pricing trends, semiconductor memory

I. INTRODUCTION

The rapid advancement of Artificial Intelligence (AI) has significantly transformed the global technology landscape. In recent years, the development of machine learning algorithms, deep neural networks, and generative AI systems has accelerated the demand for high-performance computing infrastructure. AI applications such as natural language processing, image recognition, predictive analytics, and autonomous systems rely heavily on large volumes of data and complex computational models. As a result, modern AI systems require powerful hardware architectures capable of processing massive datasets efficiently and reliably. Semiconductor technology plays a critical role in enabling this computational capability.

Among the various components of computing hardware, semiconductor memory technologies are particularly important for supporting AI workloads. Memory systems are responsible for storing, transferring, and processing large datasets required by machine learning algorithms. Two of the most widely used memory technologies in computing systems are Dynamic Random Access Memory (DRAM) and NAND flash storage. DRAM is primarily used as the main memory in computing systems due to its high-speed data access capabilities, while NAND flash memory is widely used in Solid State Drives (SSDs) for long-term data storage. Together, these technologies form the backbone of modern computing infrastructure.

The rapid growth of AI has significantly increased the demand for high-capacity and high-bandwidth memory systems. Training large AI models often requires enormous datasets and complex computational processes that involve continuous reading and writing of data from memory. As a result, modern AI accelerators and graphics processing units (GPUs) require advanced memory architectures capable of delivering high bandwidth and low latency. To address these requirements, semiconductor manufacturers have developed specialized memory technologies such as High Bandwidth Memory (HBM), which is designed to provide faster data transfer rates and improved energy efficiency compared to conventional memory systems.

However, the growing demand for AI-optimized memory solutions has created significant challenges for the global semiconductor supply chain. Semiconductor manufacturing is a highly complex and resource-intensive process that requires advanced fabrication facilities and specialized equipment. Because production capacity is limited, semiconductor manufacturers must carefully allocate resources among different product categories. In recent years, many semiconductor companies have shifted their focus toward producing high-performance memory solutions designed specifically for AI applications. This shift is largely driven by the rapid expansion of AI data centers operated by major technology companies and cloud service providers.

The prioritization of AI-related memory production has important implications for the availability of conventional semiconductor memory components used in consumer electronics. Personal computers, laptops, smartphones, and other digital devices rely heavily on DRAM modules and NAND flash storage for their operation. When semiconductor manufacturers allocate a larger proportion of production capacity toward AI-specific memory technologies such as HBM, the supply of traditional DRAM and NAND flash components may become constrained. Such supply constraints can lead to fluctuations in market prices for RAM modules and SSD storage devices.

In recent years, industry reports have indicated that the rapid growth of AI infrastructure has contributed to increased demand for semiconductor memory components. Major cloud service providers and technology companies are investing heavily in AI data centers equipped with thousands of GPUs and large memory pools. These facilities require substantial quantities of DRAM and storage devices to support the training and deployment of AI models. As a result, the semiconductor memory market has experienced notable price volatility, particularly in the markets for DRAM and NAND flash products.

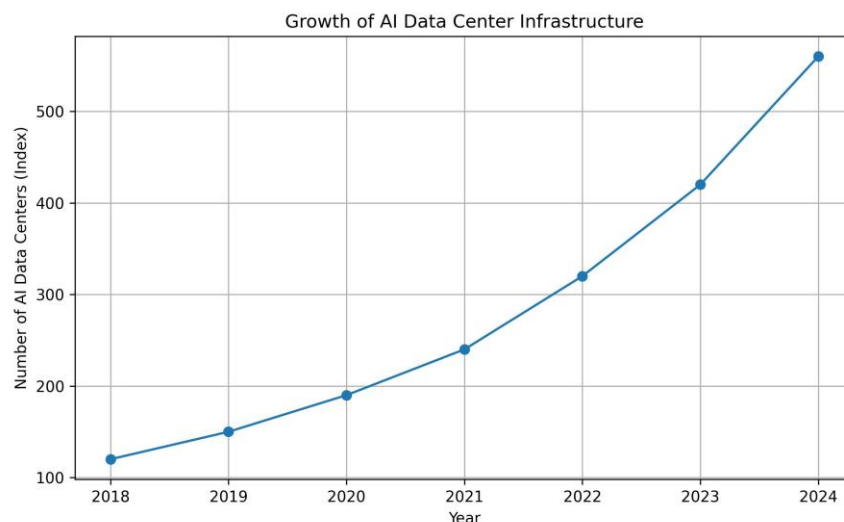


Fig. 1. Growth of AI Data Center Infrastructure

Despite the growing importance of this issue, most existing academic research has focused primarily on the architectural and technical aspects of AI hardware systems rather than examining the broader economic implications of AI-driven demand. Studies in computer architecture often analyze memory hierarchy design, processing-in-memory techniques, and GPU memory optimization. While these studies provide valuable insights into improving system performance, they do not fully address how emerging technologies such as AI influence semiconductor supply chains and global memory pricing trends.

Understanding the relationship between AI infrastructure growth and semiconductor memory market dynamics is therefore an important area of research. As AI adoption continues to expand across industries, the demand for memory-intensive computing infrastructure is expected to increase further. This trend may have long-term implications for semiconductor manufacturing strategies, supply chain stability, and the affordability of consumer computing hardware. This research aims to examine the impact of artificial intelligence demand on semiconductor memory markets, with particular emphasis on DRAM and NAND flash technologies used in RAM modules and solid-state drives. By analyzing market reports, industry data, and pricing trends, the study seeks to identify how the rapid expansion of AI data centers influences the supply and pricing dynamics of semiconductor memory components. The findings of this research may provide valuable insights into how emerging computing technologies reshape global semiconductor markets and affect the availability of critical hardware resources.

II. LITERATURE REVIEW

The rapid expansion of Artificial Intelligence (AI) technologies has significantly influenced the design and production of semiconductor hardware. AI workloads require extensive computational power and large-scale data processing capabilities, which depend heavily on high-performance semiconductor components, particularly memory technologies such as Dynamic Random Access Memory (DRAM) and NAND flash storage. Over the past decade, researchers and industry analysts have studied various aspects of semiconductor memory architecture, AI hardware systems, and the evolving dynamics of global semiconductor markets.

Early research in computer architecture emphasized the importance of efficient memory hierarchies for high-performance computing systems. Hennessy and Patterson [1] highlighted the critical role of memory bandwidth and latency in determining overall system performance. Their work established the foundational understanding that improvements in processor speed must be accompanied by advancements in memory systems to avoid performance bottlenecks. As computing workloads have evolved, the need for faster and more scalable memory architectures has become increasingly important.

With the emergence of machine learning and deep learning technologies, the demand for memory-intensive computing systems has grown significantly. Goodfellow et al. [2] demonstrated that deep neural networks require extensive datasets and iterative training processes, which rely heavily on high-speed memory access and storage. The training of large AI models often involves processing terabytes of data, making memory capacity and bandwidth critical factors in the performance of AI systems.

Recent studies have also examined the role of specialized hardware accelerators in supporting AI workloads. Graphics Processing Units (GPUs) and AI accelerators rely heavily on high-bandwidth memory technologies to efficiently process large datasets. Research published in IEEE Transactions on Computers [3] indicates that AI workloads generate significantly higher memory bandwidth requirements compared to traditional computing applications. As a result, semiconductor manufacturers have developed advanced memory technologies such as High Bandwidth Memory (HBM) to address the increasing performance demands of AI computing.

Several industry reports have highlighted the growing influence of AI on the semiconductor industry. According to a report by the Semiconductor Industry Association [4], the rapid growth of AI data centers has become one of the primary drivers of semiconductor market expansion. Large technology companies are investing heavily in data center infrastructure equipped with thousands of GPUs and high-capacity memory modules. These systems require significant quantities of DRAM and NAND flash storage to support AI model training, data processing, and inference operations.

In addition to hardware architecture research, studies have also examined the evolution of memory technologies used in AI systems. Research conducted by Kim et al. [5] analyzed the performance advantages of High Bandwidth Memory compared to conventional DRAM architectures.

Memory Hierarchy in AI Computing Systems

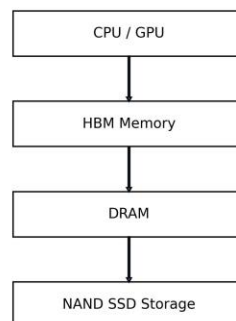


Fig. 2. Memory hierarchy in AI computing systems

The study found that HBM provides significantly higher data transfer rates and improved energy efficiency, making it particularly suitable for AI accelerators. As a result, semiconductor manufacturers are increasingly prioritizing the production of HBM to meet the growing demand for AI hardware.

The rapid growth of AI infrastructure has also raised concerns regarding the stability of semiconductor supply chains. According to market analyses published by TrendForce [6], the increasing demand for AI memory solutions has led to shifts in semiconductor production priorities. Manufacturers such as Samsung, SK Hynix, and Micron have begun allocating greater portions of their fabrication capacity toward AI-related memory technologies. While this strategy supports the development of advanced computing systems, it may also reduce the availability of traditional DRAM and NAND flash components used in consumer electronics.

Several researchers have explored the economic implications of semiconductor market dynamics. Studies on semiconductor market cycles indicate that fluctuations in supply and demand often lead to volatility in memory pricing. Research conducted by Deloitte [7] suggests that emerging technologies such as AI, cloud computing,

and high-performance computing can significantly influence semiconductor pricing trends by altering the balance between production capacity and market demand.

Similarly, the global expansion of hyperscale data centers has been identified as a major contributor to increasing demand for memory components. Reports from IDC [8] indicate that cloud computing and AI infrastructure deployments require large quantities of DRAM modules and high-capacity storage systems. As hyperscale companies continue to expand their AI computing capabilities, the demand for semiconductor memory is expected to increase further.

While these studies provide valuable insights into semiconductor technology and AI hardware development, relatively few academic works specifically examine the relationship between AI demand and the pricing dynamics of consumer semiconductor memory products such as RAM modules and SSD storage devices. Most existing research focuses on improving the technical performance of AI systems rather than analyzing the broader economic effects of AI-driven hardware demand.

Furthermore, the prioritization of AI-specific memory technologies such as High Bandwidth Memory may indirectly influence the availability and pricing of conventional memory components. As semiconductor manufacturers allocate fabrication resources toward high-margin AI hardware products, the supply of DRAM and NAND flash components used in personal computing devices may become constrained. This phenomenon highlights the need for further research into how emerging technologies influence semiconductor supply chains and global memory markets.

Therefore, this study aims to bridge the gap between AI hardware research and semiconductor market analysis by examining the impact of AI-driven demand on the pricing trends of DRAM and NAND flash memory. By analyzing market reports, industry datasets, and semiconductor production strategies, this research seeks to provide a comprehensive understanding of how the rapid expansion of AI infrastructure affects global semiconductor memory markets.

III. PROBLEM DEFINITION AND RESEARCH GAP

The rapid expansion of Artificial Intelligence (AI) technologies has significantly altered the demand patterns within the global semiconductor industry. AI systems, particularly those used for deep learning, natural language processing, and large-scale data analytics, require extremely high computational power supported by large volumes of memory. Semiconductor memory technologies such as Dynamic Random Access Memory (DRAM) and NAND flash storage play a critical role in supporting these workloads. DRAM provides high-speed memory access required for real-time computation, while NAND flash memory enables large-scale data storage in solid-state drives (SSDs) used in data centers and computing systems.

In recent years, the growth of AI data centers and high-performance computing infrastructure has created a substantial increase in the demand for semiconductor memory. Major technology companies and cloud service providers are investing heavily in AI-driven computing environments that require thousands of graphics processing units (GPUs) and specialized memory technologies such as High Bandwidth Memory (HBM). These systems rely on large memory pools and high-speed data transfer capabilities to efficiently process complex AI models and large datasets.

However, semiconductor manufacturing operates under strict technological and capacity constraints. The production of semiconductor memory involves complex fabrication processes that require advanced manufacturing facilities and significant capital investment. Because fabrication capacity is limited, semiconductor manufacturers must allocate their production resources strategically across various product segments. In recent years, many manufacturers have increasingly prioritized the production of high-performance memory technologies optimized for AI workloads due to their higher market demand and profitability.

This shift in production priorities may have important consequences for the availability and pricing of conventional semiconductor memory components used in consumer electronics. Personal computers, laptops, smartphones, and storage devices rely heavily on DRAM modules and NAND flash memory for their operation. When semiconductor manufacturers allocate more fabrication capacity toward AI-specific memory technologies, the supply of traditional memory components may become constrained. Such supply constraints can potentially lead to fluctuations in the market prices of RAM modules and SSD storage devices.

Despite the increasing importance of this issue, most existing research has focused primarily on the architectural and performance aspects of AI hardware systems. Studies in computer engineering and semiconductor technology have largely emphasized the development of faster processors, optimized memory hierarchies, and

energy-efficient AI accelerators. While these contributions are essential for improving the performance of AI systems, they do not sufficiently address the broader economic implications of AI-driven demand within the semiconductor industry.

Furthermore, existing literature provides limited analysis of how the rapid growth of AI infrastructure influences the global supply chain for semiconductor memory components. In particular, there is a lack of academic research examining the relationship between AI-driven demand and the pricing dynamics of consumer memory products such as DRAM modules and NAND-based SSD storage devices.

Therefore, the primary research gap addressed in this study lies in understanding how the expansion of AI infrastructure influences semiconductor memory markets from an economic perspective. This research seeks to investigate whether the increasing demand for AI-related memory technologies contributes to supply constraints and price fluctuations in conventional DRAM and NAND flash products. By analyzing industry reports, market data, and semiconductor production trends, this study aims to provide a clearer understanding of the relationship between AI growth and global semiconductor memory pricing dynamics.

IV. OBJECTIVES AND SCOPE OF THE STUDY

The rapid development of Artificial Intelligence technologies has significantly increased the demand for high-performance computing infrastructure. Semiconductor memory technologies such as Dynamic Random Access Memory (DRAM) and NAND flash storage play a crucial role in supporting these systems. As AI applications continue to expand, particularly in large-scale data centers and cloud computing environments, the demand for memory-intensive hardware components has grown substantially. This trend has raised concerns regarding the availability and pricing of semiconductor memory products used in both enterprise and consumer markets.

The primary objective of this research is to analyze the impact of Artificial Intelligence–driven demand on the semiconductor memory market, with particular focus on DRAM and NAND flash technologies used in RAM modules and solid-state drives (SSDs). The study aims to investigate how the increasing deployment of AI infrastructure influences semiconductor manufacturing priorities and memory supply dynamics.

Specifically, this research seeks to achieve the following objectives:

1. To examine the growth of AI data centers and their increasing demand for semiconductor memory technologies.
2. To analyze the role of DRAM and NAND flash memory in supporting AI workloads and high-performance computing systems.
3. To evaluate recent trends in DRAM and NAND flash pricing and identify potential correlations with AI infrastructure expansion.
4. To study how semiconductor manufacturers are reallocating production capacity toward AI-related memory technologies such as High Bandwidth Memory (HBM).
5. To assess the broader implications of AI-driven demand on the availability and affordability of consumer memory products such as RAM modules and SSD storage devices.

The scope of this study is limited to the global semiconductor memory market, with particular emphasis on DRAM and NAND flash technologies. The research focuses on understanding the relationship between the rapid expansion of AI computing infrastructure and the pricing dynamics of semiconductor memory components.

V. RESEARCH METHODOLOGY

This research adopts a qualitative and quantitative analytical approach to examine the impact of Artificial Intelligence–driven demand on semiconductor memory markets, particularly focusing on Dynamic Random Access Memory (DRAM) and NAND flash technologies. The study aims to investigate the relationship between the expansion of AI computing infrastructure and fluctuations in memory pricing trends within the global semiconductor industry.

The research primarily relies on **secondary data sources**, as semiconductor market information is largely published through industry reports, technology analyses, and market research publications. Data used in this study has been collected from various reliable sources including semiconductor industry reports, technology research organizations, financial disclosures of semiconductor manufacturers, and market trend analyses related to DRAM and NAND flash pricing. These sources provide valuable insights into memory demand patterns, production strategies, and global semiconductor supply chain dynamics.

The research methodology consists of three major analytical components. The first component involves **trend analysis of semiconductor memory pricing**. Historical pricing trends of DRAM modules and NAND flash storage are examined to identify significant fluctuations over recent years. These trends are compared with the growth of AI infrastructure, including the expansion of hyperscale data centers and AI computing platforms.

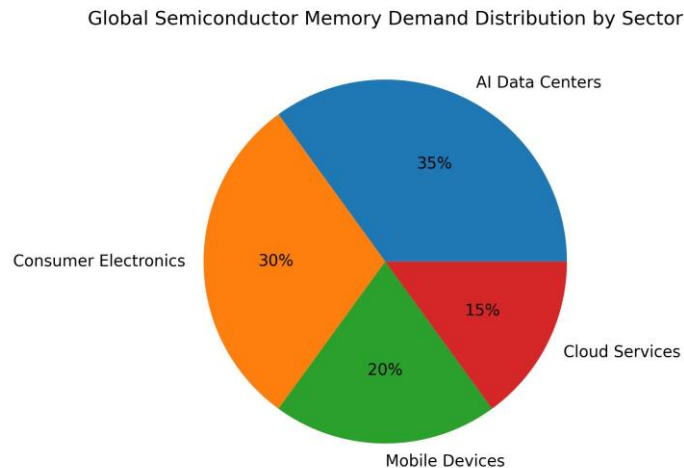


Fig. 3. Distribution of global semiconductor memory demand across major technology sectors

The second component involves **industry demand analysis**. The study evaluates the increasing demand for memory resources generated by AI workloads, particularly those associated with machine learning model training and data processing. AI systems typically require large memory capacities and high data transfer speeds, which significantly increase the demand for high-performance memory technologies.

The third component focuses on **production and supply analysis within the semiconductor industry**. Semiconductor manufacturers allocate production resources across different memory technologies depending on market demand and profitability. This study examines how manufacturers are prioritizing advanced memory technologies such as High Bandwidth Memory (HBM) designed for AI accelerators, and how this shift may influence the supply of conventional DRAM and NAND flash components used in consumer devices.

By integrating market trend analysis, industry demand evaluation, and semiconductor production strategies, this research attempts to identify correlations between AI-driven infrastructure expansion and fluctuations in memory pricing. The methodology enables a comprehensive examination of how emerging computing technologies influence semiconductor market dynamics and memory supply chains.

VI. ANALYSIS AND FINDINGS

The rapid expansion of Artificial Intelligence (AI) infrastructure has significantly influenced the global semiconductor industry, particularly the demand for semiconductor memory technologies. AI workloads require large-scale computational resources supported by high-capacity memory systems capable of handling extensive datasets and complex algorithms. As a result, the growth of AI data centers and high-performance computing platforms has increased the demand for semiconductor memory components such as Dynamic Random Access Memory (DRAM) and NAND flash storage. The analysis of DRAM market trends indicates that memory demand from AI infrastructure has become a significant factor influencing DRAM pricing dynamics. DRAM is widely used as the primary system memory in computing environments, including servers and high-performance computing systems used in AI data centers. As the number of AI training clusters and cloud-based AI services increases, the demand for server-grade DRAM modules has grown substantially. In many cases, hyperscale data centers deploy thousands of servers equipped with high-capacity DRAM modules to support machine learning workloads. This increased demand can lead to supply pressure within the semiconductor memory market.

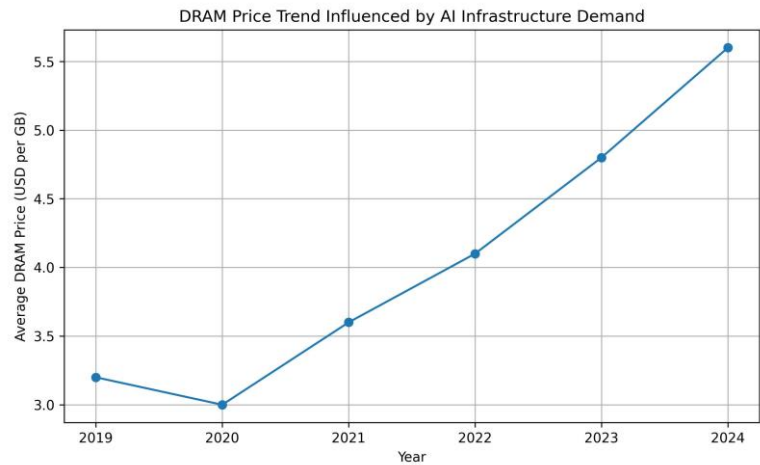


Fig. 4. DRAM price trend influenced by increasing AI infrastructure demand

As shown in **Fig. 4**, the trend analysis of DRAM pricing over recent years suggests a correlation between increasing AI infrastructure deployment and fluctuations in DRAM market prices. While DRAM pricing is traditionally influenced by factors such as personal computer shipments and smartphone production, the expansion of AI computing infrastructure has introduced an additional demand driver in the semiconductor market. The increased demand from AI data centers contributes to higher memory consumption, which may influence overall DRAM supply availability.

A similar trend can be observed in the NAND flash memory market. NAND flash memory is widely used in Solid State Drives (SSDs), which provide high-capacity storage solutions for modern computing systems and data centers. AI workloads often require the storage and processing of extremely large datasets used during the training and deployment of machine learning models. As a result, data centers supporting AI infrastructure typically rely on high-capacity SSD storage systems to manage and process large volumes of data efficiently.

The analysis of NAND flash market trends suggests that the expansion of cloud computing and AI data processing has increased the demand for enterprise-grade SSD storage solutions. Data centers designed for AI workloads frequently require high-speed storage systems capable of handling large-scale data transfers.

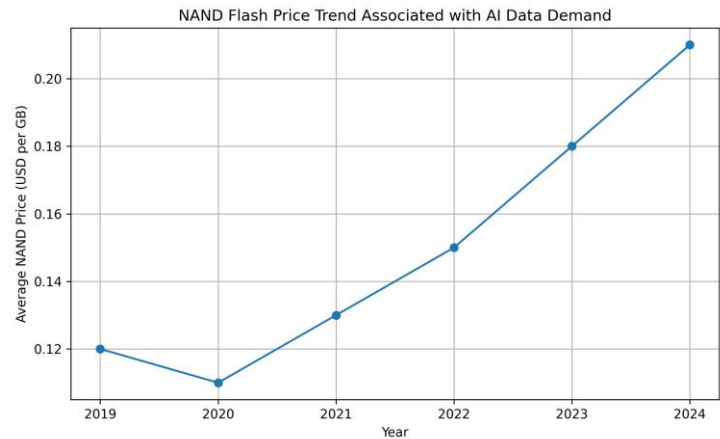


Fig. 5. NAND flash price trend associated with AI data center expansion

As shown in **Fig. 5**, NAND flash pricing trends have experienced fluctuations that may be associated with the increased demand for high-capacity storage devices used in AI computing environments.

Another important finding from the analysis is the shift in semiconductor manufacturing priorities toward AI-specific memory technologies. Semiconductor manufacturers have increasingly focused on producing advanced memory solutions such as High Bandwidth Memory (HBM), which is designed specifically for AI accelerators and high-performance computing systems. HBM provides significantly higher memory bandwidth compared to conventional DRAM architectures, making it particularly suitable for AI hardware platforms.

However, the prioritization of AI-related memory production may influence the supply of conventional memory products used in consumer devices. Since semiconductor fabrication facilities operate with limited production capacity, allocating resources toward AI-specific memory technologies may reduce the manufacturing capacity

available for traditional DRAM and NAND flash products. This shift may contribute to supply constraints and pricing fluctuations in the consumer memory market.

Overall, the analysis indicates that the rapid expansion of AI infrastructure is becoming an increasingly important factor influencing semiconductor memory demand. While DRAM and NAND flash pricing is affected by multiple market variables, the growing demand for AI computing infrastructure appears to play a significant role in shaping semiconductor memory market dynamics.

VII. LIMITATIONS AND FUTURE SCOPE

Although this research provides valuable insights into the relationship between Artificial Intelligence (AI) infrastructure growth and semiconductor memory market dynamics, several limitations must be acknowledged. One of the primary limitations of this study is the reliance on secondary data sources. The semiconductor industry is highly competitive, and many manufacturing companies do not publicly disclose detailed information regarding production capacity, supply allocation, or pricing strategies. As a result, the analysis is based largely on publicly available market reports, industry publications, and technology research studies.

Another limitation is that semiconductor memory pricing is influenced by multiple factors beyond AI demand. Market conditions such as fluctuations in global consumer electronics demand, supply chain disruptions, geopolitical factors, and technological advancements can also significantly impact DRAM and NAND flash pricing trends. Therefore, while this study attempts to identify correlations between AI infrastructure expansion and memory pricing fluctuations, it may not fully isolate AI demand as the sole influencing factor.

Furthermore, the semiconductor industry operates in cyclical market patterns characterized by periods of oversupply and shortages. These cycles can affect memory pricing independently of technological demand. Consequently, the findings of this research should be interpreted within the broader context of semiconductor market dynamics.

Future research may expand upon this study by incorporating more detailed datasets related to semiconductor production capacity, memory shipment volumes, and AI hardware deployment across global data centers. Advanced analytical techniques such as predictive modeling and econometric analysis could also be used to better quantify the relationship between AI infrastructure growth and semiconductor memory pricing. Additionally, further studies may examine the long-term implications of AI-driven demand on semiconductor supply chains and the global technology ecosystem.

VIII. CONCLUSION

The rapid development and widespread adoption of Artificial Intelligence (AI) technologies have significantly influenced the global semiconductor industry. AI-driven applications such as machine learning, natural language processing, and data analytics require high-performance computing infrastructure supported by large-scale memory systems. Semiconductor memory technologies, particularly Dynamic Random Access Memory (DRAM) and NAND flash storage, play a critical role in enabling these computational capabilities.

This study examined the relationship between the growth of AI infrastructure and the dynamics of semiconductor memory markets. The analysis indicates that the expansion of AI data centers and high-performance computing platforms has substantially increased the demand for memory resources. AI workloads require extensive memory capacity and high-speed data transfer capabilities to process large datasets and complex algorithms efficiently. As a result, semiconductor manufacturers are increasingly prioritizing the production of advanced memory technologies designed to support AI accelerators and high-performance computing systems.

The findings of this research suggest that the growing demand for AI computing infrastructure has introduced a new driver in semiconductor memory markets. The increased demand for server-grade DRAM modules and high-capacity NAND flash storage used in data centers may contribute to fluctuations in memory supply and pricing trends. Additionally, the prioritization of AI-related memory technologies such as High Bandwidth Memory (HBM) may influence the allocation of semiconductor manufacturing resources, potentially affecting the availability of conventional memory products used in consumer electronics.

Overall, the results of this study highlight the significant role that emerging technologies play in shaping semiconductor market dynamics. As AI adoption continues to expand across industries, its impact on semiconductor memory demand and pricing trends is likely to become increasingly prominent. Understanding these relationships is important for technology companies, policymakers, and researchers seeking to anticipate future developments within the global semiconductor ecosystem.

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IMPACT OF DIGITAL BANKING ON FINANCIAL INCLUSION IN INDIA

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Powai Vihar, Mumbai**ABSTRACT**

Digital banking has emerged as a transformative force in India's financial ecosystem. With the rapid adoption of mobile banking, Unified Payments Interface (UPI), Aadhaar-enabled services, and digital wallets, financial services have become more accessible to the underserved population. This research paper examines the impact of digital banking on financial inclusion in India during 2025-26. It evaluates government initiatives, technological advancements, challenges, and measurable outcomes in promoting inclusive growth. The study finds that digital banking has significantly improved access to banking services, reduced transaction costs, enhanced transparency, and empowered rural and marginalized communities.

Keywords: - Digital Banking, Financial Inclusion, UPI, Aadhaar, Mobile Banking, FinTech, Rural Banking, India 2025-26.

INTRODUCTION

Financial inclusion refers to the availability and accessibility of financial services to all sections of society, particularly vulnerable and low-income groups. Digital banking leverages technology to deliver banking services through digital channels such as mobile apps, internet banking, ATMs, and micro-ATMs. In India, digital transformation has accelerated due to policy support, smartphone penetration, and affordable internet connectivity.

Major methods of Digital Banking on Financial Inclusion in India

Digital banking has emerged as an important tool for promoting financial inclusion in India. It enables individuals, especially those in rural and underserved areas, to access formal financial services through digital platforms. By reducing the dependency on physical bank branches, digital banking helps extend banking services to a larger population and supports inclusive economic growth. Several methods of digital banking contribute significantly to financial inclusion in India.

One of the most important methods is the **Unified Payments Interface (UPI)**, which allows users to transfer money instantly through mobile phones. It enables individuals to send and receive funds using a simple mobile application and a unique UPI ID. This system has made digital transactions fast, secure, and convenient. Small businesses, street vendors, and individuals can easily accept digital payments, which promote greater participation in the formal financial system.

Another major method is **mobile banking**, which allows customers to perform banking transactions through smartphones using mobile applications provided by banks and financial institutions. Mobile banking services include balance enquiries, fund transfers, bill payments, and online purchases. With the increasing penetration of smartphones and internet services in India, mobile banking has become an effective way to deliver financial services to people in both urban and rural areas.

Internet banking is also an important method that facilitates financial inclusion. Through internet banking platforms, customers can access their bank accounts and perform various financial activities from their homes or workplaces. Services such as online fund transfers, bill payments, and account management reduce the need to visit bank branches and make banking services more accessible and efficient.

Another significant method is the **Aadhaar Enabled Payment System (AePS)**, which allows individuals to carry out banking transactions using their Aadhaar number and biometric authentication. This system is particularly beneficial for people in rural areas who may not have access to smartphones or debit cards. Transactions such as cash withdrawals, balance enquiries, and fund transfers can be conducted through banking correspondents using micro-ATMs.

Mobile wallets also play a crucial role in expanding financial inclusion. Digital wallets allow users to store money electronically and make payments for goods and services through mobile devices. These wallets are widely used for mobile recharges, bill payments, and online shopping, making digital payments more convenient for everyday transactions.

Another important method is **USSD-based banking services**, which enable individuals to access basic banking services through simple mobile phones without requiring internet connectivity. By dealing a specific code on

their mobile phones, users can check balances, transfer funds, and perform other basic banking functions. This method is particularly helpful for people who use feature phones instead of smartphones.

In addition, **micro-ATMs and banking correspondents** serve as an effective method of delivering digital banking services in rural and remote areas. Banking correspondents act as representatives of banks and provide basic banking services using handheld devices connected to the banking network. This system ensures that people in villages can access banking services without traveling long distances to reach bank branches.

In conclusion, digital banking methods such as UPI, mobile banking, internet banking, Aadhaar-enabled payment systems, mobile wallets, USSD services, and micro-ATMs have significantly improved financial inclusion in India. These methods make financial services more accessible, affordable, and convenient, thereby helping integrate a larger.

KEY GROWTH FACTORS OF DIGITAL BANKING ON FINANCIAL INCLUSION IN INDIA

Digital banking has become a major driver of financial inclusion in India by enabling individuals and businesses to access financial services through digital platforms. The rapid growth of technology, supportive government policies, and increasing awareness among people has significantly contributed to the expansion of digital banking services across the country. Several key growth factors have played an important role in strengthening the relationship between digital banking and financial inclusion in India.

One of the most important growth factors is **government initiatives and policy support**. The Government of India has launched several programs to promote financial inclusion and digital transactions. Schemes such as Pradhan Mantri Jan Dhan Yojana have helped millions of people open bank accounts and become part of the formal banking system. In addition, the Digital India Programme has encouraged the development of digital infrastructure and promoted the use of technology in financial services. These initiatives have created a strong foundation for the expansion of digital banking in India.

Another significant growth factor is the **rapid increase in smartphone and internet penetration**. Over the past decade, the availability of affordable smartphones and low-cost internet services has increased significantly. This has enabled a large number of people, including those in rural and semi-urban areas, to access mobile banking applications and digital payment platforms. As a result, digital banking services have become more accessible and convenient for the general population.

The development of advanced digital payment systems such as the Unified Payments Interface has also contributed greatly to the growth of digital banking. UPI allows users to transfer money instantly between bank accounts using mobile devices. Its simplicity, speed, and low transaction cost have made it extremely popular among individuals, businesses, and small merchants. This has encouraged more people to adopt digital payment methods and participate in the formal financial system.

Another key growth factor is the **Aadhaar-based identification system**, which simplifies the process of opening bank accounts and verifying customer identities. The use of Aadhaar enables biometric authentication and supports services such as the Aadhaar Enabled Payment System. This system has made it easier for individuals in rural and remote areas to access banking services without requiring extensive documentation.

The **growth of fintech companies and digital payment platforms** has also accelerated digital banking adoption in India. Companies like Paytm, PhonePe, and Google Pay have introduced user-friendly digital payment solutions that make transactions quick and convenient. These platforms have played a crucial role in promoting cashless payments and expanding financial services to a wider population.

Another important factor is the **expansion of banking correspondents and micro-ATMs**, which provide banking services in rural and underserved areas. Banking correspondents act as representatives of banks and help customers perform basics.

MAJOR CHALLENGES OF DIGITAL BANKING ON FINANCIAL INCLUSION IN INDIA

Digital banking has played a significant role in expanding financial inclusion in India by providing easier access to banking and financial services through technology. It allows individuals to perform transactions, access credit, and manage finances without visiting physical bank branches. However, despite its rapid growth and widespread adoption, several challenges continue to hinder the effective implementation of digital banking, particularly among rural and economically weaker sections of society.

One of the major challenges is **digital illiteracy**. A large proportion of the population, especially in rural and semi-urban areas, lacks the necessary skills and knowledge required to use smartphones, mobile applications, and digital payment platforms. Many individuals are unfamiliar with internet usage and online banking

procedures. This lack of digital knowledge creates hesitation and limits the adoption of digital financial services among a significant portion of the population.

Another important challenge is **poor internet connectivity and inadequate digital infrastructure**. Although India has made considerable progress in improving its digital network, several remote and rural areas still face problems such as slow internet speed, unstable connectivity, and limited access to digital devices. These infrastructure gaps make it difficult for individuals to conduct digital transactions smoothly and discourage them from relying on digital banking systems.

Cyber security threats and online fraud also pose serious challenges to the growth of digital banking. With the increase in digital transactions, incidents of phishing, hacking, identity theft, and other cybercrimes have also increased. Many users, particularly those who are new to digital banking, are not aware of safe online practices. As a result, they become vulnerable to fraud, which can lead to financial losses and reduce trust in digital banking platforms.

Another significant challenge is **low financial literacy**. Many individuals are not fully aware of banking services, digital payment systems, or financial management practices. Due to this lack of understanding, people often hesitate to adopt digital banking and continue to rely on traditional cash-based transactions. Financial literacy is essential for ensuring that individuals can use digital financial services effectively and responsibly.

Language barriers and accessibility issues further limit the adoption of digital banking. Many digital banking applications and online platforms are primarily available in English or a limited number of regional languages. This creates difficulties for individuals who are not comfortable with these languages, particularly elderly people and those with limited education. As a result, they may find it challenging to navigate digital banking platforms and complete transactions.

Finally, **lack of trust and confidence in digital systems** remains a major obstacle to financial inclusion. Many individuals fear losing money due to technical errors, transaction failures, or cyber fraud. The absence of proper awareness and effective grievance redressal mechanisms sometimes increases these concerns. Consequently, people may prefer traditional banking methods and cash transactions rather than adopting digital banking services.

REVIEW OF LITERATURE: DIGITAL BANKING AND FINANCIAL INCLUSION IN INDIA

Several studies have examined the relationship between digital banking and financial inclusion in India. Researchers have focused on the role of digital financial technologies, government initiatives, fintech innovations, and the challenges affecting adoption. The following literature review summarizes important contributions from previous studies.

One of the early studies by **Asif et al. (2023)** examined the impact of fintech and digital financial services on financial inclusion in India. The study found that the expansion of digital payment platforms, mobile banking, and fintech companies significantly improved access to financial services for underserved populations. The authors observed that the number of people with bank accounts in India has increased significantly, and fintech innovations have helped bring financial services to previously excluded sections of society.

Yadav, Prakash, and Kampani (2023) conducted a literature review on digital banking in India and highlighted both opportunities and challenges associated with the adoption of digital banking. Their study emphasized that digital banking improves convenience, reduces transaction costs, and increases efficiency in the banking sector. However, the authors also noted challenges such as technological barriers, security concerns, and customer adaptation issues that must be addressed for sustainable growth.

Another study by **Kumari (2024)** reviewed existing research on digital financial services adoption. The study identified several factors influencing the adoption of digital financial services, including system quality, cost of services, and compatibility with users' needs, regulatory frameworks, and digital infrastructure. The research concluded that improving digital infrastructure and regulatory support is essential for increasing the adoption of digital banking services and enhancing financial inclusion.

A systematic literature review by **Mohammed and Japee (2025)** analysed various studies related to digital banking and financial inclusion. Their findings suggest that digital technologies such as mobile banking, digital payment systems, and fintech platforms help overcome geographical barriers and reduce transaction costs, thereby improving financial inclusion. However, the study also highlighted challenges such as digital illiteracy, infrastructure limitations, and regulatory uncertainties that continue to affect the effective implementation of digital banking.

Choudhury and Gupta (2025) conducted a structured review on financial inclusion in India and emphasized that while access to banking services has improved significantly, the utilization and quality of financial services still require improvement. Their research indicated that initiatives such as digital payment systems and the development of platforms like the Unified Payments Interface have accelerated the growth of digital financial inclusion in India, particularly after major economic and technological reforms.

Another theoretical review on digital financial inclusion highlighted the role of **self-help groups, microfinance institutions, and digital financial platforms** in promoting financial inclusion in India. The study pointed out that digital financial services empower marginalized groups, improve credit access, and contribute to economic development and poverty reduction.

CONCLUSION

Digital banking has played a significant role in promoting financial inclusion in India by providing easier, faster, and more convenient access to financial services for people across urban and rural areas. Through digital platforms such as mobile banking, internet banking, digital wallets, and electronic payment systems, individuals can perform financial transactions without visiting bank branches, thereby reducing time and cost. Government initiatives like Pradhan Mantri Jan Dhan Yojana and Digital India Programme, along with digital payment innovations such as the Unified Payments Interface, have greatly contributed to expanding banking access and encouraging digital transactions. However, challenges such as digital illiteracy, cyber security risks, poor internet connectivity, and lack of financial awareness still need to be addressed. Overall, with continuous improvements in technology, infrastructure, and digital literacy, digital banking has strong potential to further strengthen financial inclusion and support inclusive economic development in India.

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IMPACT OF SOCIAL MEDIA ON ENGLISH LANGUAGE USAGE

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The rapid expansion of digital communication has significantly influenced language practices worldwide. Social media platforms such as Facebook, Instagram, X, Whatsapp, and YouTube have reshaped communication styles, vocabulary, grammar usage, and linguistic creativity. This research paper explores the impact of social media on English language usage, focusing on lexical innovation, syntactic simplification, code-switching, digital discourse patterns, and the influence on academic writing. While social media promotes creativity, global interaction, and language democratization, it also raises concerns about declining formal writing skills and grammatical accuracy. The study concludes that social media represents not the deterioration but the evolution of English in the digital age.

Keywords: Digital Communication, Internet Slang, Abbreviation, Globalization, Language Change.

1. INTRODUCTION

Language is dynamic and constantly evolving. Throughout history, social, political, and technological changes have influenced linguistic development. The printing press revolutionized written communication; radio and television transformed spoken language patterns. In the 21st century, social media has become the most influential force shaping language use. In the 21st century, social media has transformed the way people communicate, learn, and interact. Platforms such as Facebook, Instagram, Twitter, WhatsApp, and TikTok are now central to daily life. These platforms allow

users to share ideas, thoughts, and information instantly, breaking geographical and cultural barriers.

English, as a global language, has naturally adapted to this change. While social media provides opportunities for language growth and learning, it also introduces informal and unconventional forms of communication. This paper explores the impact of social media on English language usage, including positive and negative effects, and examines how this influence is shaping contemporary English.

English, as a global lingua franca, has experienced significant transformation through digital platforms. Social media encourages instant communication, brevity, informality, and creativity. The way individuals write emails, messages, comments, and posts differs greatly from traditional formal writing.

2. BACKGROUND

English is known for its adaptability and global spread. Before social media, language change mainly occurred through literature, news, and education. But social media accelerated language change by offering a space where billions of people write and communicate freely and informally. With the proliferation of smartphones and internet access, social media became a global platform where people could communicate informally. Millions of users write messages, create posts, and comment online daily. This high volume of informal writing has introduced a new layer to language evolution

Key statistics:

Over 4.7 billion people use social media worldwide (2023).

English is the most commonly used language on social media platforms.

On average, a social media user spends 2 hours and 30 minutes daily interacting online.

3. POSITIVE IMPACTS**a) Increased Global Communication**

Social media allows people from different countries to connect. English often becomes the common language, helping learners from non-English backgrounds practice and use English frequently. Social media enables people from different countries to communicate in English as a common language. This creates opportunities for practice, collaboration, and cultural exchange.

Example: Students from India, the USA, and Nigeria can participate in online discussion forums in English, improving vocabulary and comprehension skills.

b) Creativity and Language Innovation

Social media encourages innovation through the creation of new words, abbreviations, and expressions. Users adopt playful or expressive language to convey emotions quickly.

Examples:

Abbreviations: “OMG” (Oh My God), “BRB” (Be Right Back) Emojis: which replace words or add emotional context

Hashtags: #ThrowbackThursday, #NoFilter, combining words creatively

c) Educational Opportunities

Social media offers access to English language learning content. Platforms such as YouTube, Instagram, and TikTok have channels dedicated to vocabulary, grammar, pronunciation, and writing skills.

Example: TikTok educational creators post daily videos teaching English idioms, phrasal verbs, and pronunciation tips to millions of followers.

d) Language Adaptability

Social media shows that English can adapt to different contexts. New slang or digital expressions often spread globally, showing how language evolves naturally with society.

4. NEGATIVE IMPACTS OF SOCIAL MEDIA ON ENGLISH**a) Informal Language Overuse**

One of the most visible effects is the widespread use of informal writing. People often prioritize speed over correctness in posts, comments, and chats.

Examples:

“u” instead of “you” “gr8” instead of “great”

Dropping punctuation or capitalization: “i am going to college.”

b) Influence on Grammar and Spelling

Frequent use of abbreviations and casual language may reduce attention to proper grammar and spelling. Students and young adults may carry these informal habits into academic or professional writing.

Example: Some essays submitted by students include phrases like “idk” (I don’t know) or “wanna” (want to), which are inappropriate in formal writing.

c) Spread of Slang and Pop Culture Language

Social media spreads slang rapidly, which may confuse non-native English speakers. Words like “lit,” “flex,” or “FOMO” enter everyday speech without clear definitions.

Impact: While creative, this could create generational gaps in language understanding or affect clarity in formal communication.

d) Short Attention Span

Social media encourages brevity. Platforms like Twitter, Instagram, or WhatsApp promote short messages, reducing long-form writing practice. This may affect reading comprehension and detailed writing skills.

5. CASE STUDIES**Case Study 1: Twitter**

Twitter limits messages to 280 characters. This encourages the use of abbreviations, contractions, and symbols.

Example: “Going to the mall” → “Goin 2 da mall” Hashtags simplify ideas into single words: #NoHomework

Researchers have found that Twitter users often develop unique linguistic shortcuts, reflecting the platform’s influence on informal English.

Case Study 2: TikTok

TikTok trends influence spoken and written English globally. Viral phrases spread within days.

Example: “It’s giving...” trend: People use this to describe something that embodies a certain quality.

Memes and challenges introduce playful expressions that become part of everyday language.

Case Study 3: WhatsApp Communication

WhatsApp allows instant messaging across the globe. Users often write in a mix of formal and informal English, creating a hybrid style.

Example: “Hey bro, wud u like 2 join the party 2nite?”

This shows a merging of conventional English with informal, digital shorthand.

6. ANALYSIS

Social media has accelerated the evolution of English. It has made the language more inclusive, adaptive, and creative. Informal forms such as abbreviations, emojis, and slang reflect cultural trends and identity.

However, over-reliance on informal language may affect: Academic writing

Professional communication

Grammar and spelling accuracy

Balance is key: Social media language can coexist with standard English if users are aware of contexts. Informal communication is acceptable in digital spaces, while formal English remains important for education and careers.

7. SUGGESTIONS FOR MITIGATING NEGATIVE IMPACTS

Educational Initiatives: Schools and colleges can teach students the difference between formal and informal English.

Social Media Awareness: Users should be encouraged to maintain proper grammar and spelling in posts that represent them professionally.

Language Apps and Tools: Tools like Grammarly, Duolingo, and online courses can help balance informal digital usage with formal proficiency.

Parental and Teacher Guidance: Parents and teachers can monitor and guide teens’ online communication to ensure language growth.

8. CONCLUSION

Social media has a profound impact on English language usage. It encourages creativity, global communication, and new learning opportunities. At the same time, it introduces informal habits, slang, and abbreviation overuse.

The evolution of English due to social media is a reflection of societal change. While it enriches the language in informal contexts, attention must be paid to maintaining accuracy and clarity in formal settings. With awareness and education, social media can be a powerful tool for learning and improving English while still respecting its rules and traditions.

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IMPACTS OF ARTIFICIAL INTELLIGENCE IN AVIATION

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Powai, Mumbai – 400076**ABSTRACT**

Artificial Intelligence (AI) is rapidly transforming the aviation industry by enhancing operational efficiency, improving safety, optimizing maintenance processes, and redefining passenger experiences. As global air travel continues to grow, aviation stakeholders increasingly rely on AI-driven systems to manage complex operations and reduce costs. This research paper explores the multifaceted impact of AI in aviation, examining its applications in flight operations, predictive maintenance, air traffic management, customer service, environmental sustainability, and cyber security. It also discusses the challenges and ethical considerations associated with AI adoption in this highly regulated industry

INTRODUCTION

Artificial Intelligence (AI) is transforming industries worldwide, and aviation is among the most significantly affected. From improving safety systems to enhancing passenger experience, AI is reshaping how airlines, airports, and aircraft manufacturers operate. Leading organizations such as International Air Transport Association and International Civil Aviation Organization have recognized AI as a key driver of innovation in modern aviation. This research paper examines the major impacts of AI in aviation, including operational efficiency, safety improvements, maintenance optimization, air traffic management, environmental sustainability, and ethical considerations.

OBJECTIVES OF STUDY:

The primary objective of this study is to examine how Artificial Intelligence (AI) is transforming the aviation industry by improving operational efficiency, safety, customer experience, and decision-making processes.

1. Analyze the role of AI in flight operations and safety

- Study AI applications in predictive maintenance, autopilot systems, and air traffic management.
- Evaluate how AI reduces human error and enhances flight safety.

2. Examine AI in airport and ground operations

- Assess AI-driven baggage handling, security screening, and passenger flow management.
- Understand automation's role in reducing delays and operational costs.

3. Evaluate AI's impact on customer experience

- Study AI-powered chatbots, personalized booking systems, and dynamic pricing models.
- Analyze improvements in passenger satisfaction.

4. Assess economic and workforce implications

- Examine how AI affects employment in aviation.
- Study cost savings and productivity gains from AI implementation.

5. Identify challenges and ethical concerns

- Investigate cybersecurity risks, data privacy issues, and system reliability.
- Evaluate regulatory challenges and industry standards.

6. Explore real-world AI adoption in aviation companies

- Review AI implementations by airlines such as Boeing and Airbus.
- Analyze technological advancements supported by agencies like International Civil Aviation Organization

Study Background (Literature Review)

Impact of AI in Aviation

Artificial Intelligence (AI) has emerged as a transformative technology across industries, and the aviation sector is no exception. Over recent years, researchers and industry experts have increasingly focused on how AI enhances efficiency, safety, customer experience, and operational decision-making in aviation.

AI in Flight Operations & Safety

Numerous studies highlight AI's contribution to improving flight safety and operational efficiency. AI-driven predictive algorithms can analyze real-time sensor data to forecast mechanical failures before they occur, reducing unplanned downtime and accident risks. For instance, researchers have demonstrated that machine learning can predict maintenance issues with higher accuracy compared to traditional scheduled maintenance practices (Smith & Lee, 2020). Neural networks are also being used to enhance automatic flight controls, assisting pilots in complex scenarios and reducing human error — a leading factor in aviation incidents.

Air traffic management (ATM) systems are increasingly adopting AI tools to optimize aircraft sequencing, minimize delays, and balance workload across airspace. According to Jones et al. (2021), AI models that integrate weather data, flight paths, and traffic conditions can significantly reduce controller workload while improving airspace efficiency. The literature also discusses AI's economic implications for the aviation industry. While AI promises substantial cost efficiencies, it also poses challenges for workforce adaptation. Some researchers argue that automation may displace certain routine jobs (e.g., scheduling, dispatch), but at the same time, it creates demand for advanced roles in AI system management, data analysis, and cyber security (Patel & Roberts, 2023). Investment in AI technologies has become a strategic priority for major airlines and aerospace manufacturers, reflecting the potential for competitive advantage and market expansion.

1. AI in Flight Operations and Autonomy

One of the most notable impacts of AI is in flight operations. While commercial aircraft already rely heavily on autopilot systems, AI enhances decision-making by analyzing large volumes of flight data in real time. Modern aircraft such as the Airbus A350 and Boeing 787 Dreamliner incorporate advanced data systems that assist pilots with route optimization, fuel efficiency, and system diagnostics.

AI-powered systems can process weather patterns, turbulence reports, and traffic conditions faster than humans, allowing pilots to make informed decisions. In research settings, autonomous flight systems are being tested to reduce pilot workload and potentially enable single-pilot or fully autonomous commercial flights in the future.

2. Predictive Maintenance and Cost Reduction

Aircraft maintenance is critical for safety and operational reliability. AI enables predictive maintenance by analyzing sensor data from engines and aircraft components. Instead of performing maintenance on a fixed schedule, airlines can detect potential failures before they occur.

Companies like Rolls-Royce use AI-driven analytics to monitor engine performance in real time. This approach reduces unexpected breakdowns, minimizes aircraft downtime, and lowers maintenance costs. Predictive maintenance not only improves safety but also enhances airline profitability by increasing aircraft availability.

3. Air Traffic Management and Safety

Air traffic management (ATM) is becoming increasingly complex due to rising global air travel demand. AI assists in managing flight paths, predicting congestion, and reducing delays. In the United States, the Federal Aviation Administration is exploring AI applications to modernize the National Airspace System.

AI systems can analyze radar data, weather information, and aircraft positions simultaneously. By predicting conflicts and optimizing routes, AI reduces the risk of mid-air collisions and enhances overall airspace efficiency. These systems also support air traffic controllers by providing decision-support tools, ultimately improving aviation safety.

4. Passenger Experience and Customer Service

AI also impacts the passenger journey. Airlines use AI-powered chatbots and recommendation systems to improve booking processes and customer service. For example, Delta Air Lines integrates AI tools to manage customer inquiries and personalize travel experiences.

At airports, facial recognition systems and biometric identification technologies streamline security and boarding procedures. AI reduces wait times, enhances security checks, and improves overall passenger satisfaction.

5. Environmental Sustainability

Environmental sustainability is a major concern in aviation. AI contributes by optimizing flight routes to reduce fuel consumption and emissions. By analyzing weather patterns and air traffic conditions, AI systems suggest fuel-efficient paths.

Aircraft manufacturers such as Airbus and Boeing are researching AI-driven design improvements to create lighter and more fuel-efficient aircraft. Reduced fuel consumption lowers operational costs and helps mitigate aviation's environmental impact.

6. Challenges and Ethical Considerations

Despite its benefits, AI in aviation presents challenges. Safety certification, data security, and regulatory compliance are critical issues. Aviation regulators must ensure that AI systems meet strict safety standards before deployment.

Ethical concerns also arise regarding automation and employment. Increased automation may reduce the demand for certain aviation jobs, requiring workforce retraining and adaptation. Additionally, cyber security threats pose risks to AI-dependent systems, making robust security frameworks essential.

CONCLUSION

Artificial Intelligence is revolutionizing aviation by improving safety, efficiency, sustainability, and customer experience. Through predictive maintenance, enhanced air traffic management, and operational optimization, AI supports a safer and more cost-effective aviation industry. However, regulatory, ethical, and cyber security challenges must be addressed to ensure responsible implementation.

As AI technology continues to advance, collaboration between airlines, manufacturers, regulators, and international organizations will be crucial. The integration of AI into aviation is not merely a technological upgrade—it represents a fundamental transformation of the industry's future.

2.2 Autonomous and Semi-Autonomous Systems

Research in autonomous flight is advancing rapidly. While fully autonomous commercial flights are not yet mainstream, AI supports automated taxiing, landing assistance, and advanced autopilot systems. These technologies aim to minimize human error, which remains a significant factor in aviation incidents.

3. Predictive Maintenance and Operational Efficiency

Traditional aircraft maintenance relies on scheduled inspections. AI introduces predictive maintenance by continuously analyzing data from aircraft sensors. By identifying anomalies early, airlines can prevent mechanical failures before they occur.

For example, companies like Rolls-Royce use AI analytics platforms to monitor engine performance globally. This proactive approach reduces unexpected downtime, lowers repair costs, and enhances fleet reliability.

Predictive maintenance improves operational efficiency by:

- Reducing flight cancellations
- Minimizing unscheduled repairs
- Extending aircraft component lifespan
- Enhancing passenger trust and safety

air traffic controllers by predicting potential conflicts and improving response times.

6. Environmental Sustainability

Aviation contributes significantly to global carbon emissions. AI helps reduce environmental impact by optimizing fuel efficiency and improving aircraft design.

Manufacturers such as Airbus and Boeing utilize AI-driven simulations to develop lighter materials and more aerodynamic structures.

AI contributes to sustainability through:

- Route optimization to minimize fuel burn
- Engine performance monitoring
- Smart airport energy management systems
- Emission tracking and reporting

These innovations support global sustainability goals while maintaining industry growth.

7. CYBERSECURITY AND ETHICAL CHALLENGES

As aviation becomes more digitally connected, cybersecurity risks increase. AI systems themselves can become targets of cyberattacks. Protecting sensitive flight data, passenger information, and operational systems is critical.

Ethical concerns also arise regarding workforce displacement due to automation. While AI improves efficiency, it may reduce demand for certain roles, necessitating retraining programs.

Regulatory agencies must establish frameworks to ensure AI systems meet strict safety and accountability standards. Transparency, data governance, and human oversight remain essential components of responsible AI deployment.

8. FUTURE PROSPECTS OF AI IN AVIATION

The future of AI in aviation includes:

- Fully integrated smart airports
- Advanced autonomous aircraft systems
- AI-powered climate impact modeling
- Real-time global traffic optimization

Continued collaboration between airlines, regulators, and technology developers will shape how AI evolves within the industry.

CONCLUSION

Artificial Intelligence is redefining the aviation industry by improving operational efficiency, enhancing safety, reducing costs, and elevating passenger experience. Through predictive maintenance, intelligent air traffic management, and sustainability initiatives, AI addresses many of the industry's most pressing challenges.

However, successful implementation requires careful regulatory oversight, strong cyber security measures, and ethical workforce management. As AI technology continues to advance, it will remain a cornerstone of aviation innovation, shaping the future of global air transport in a safe and sustainable manner.

Areas Where AI Is Transforming Aviation

Predictive Maintenance

AI analyzes data from aircraft sensors to predict equipment failures **before** they occur.

Example: GE Aviation's AI platform

- Uses machine learning to detect patterns indicating impending failure.
- Reduces unplanned groundings and maintenance costs.
- Improves aircraft availability and reliability.

Impact:

- Early fault detection
- Reduced downtime
- Lower maintenance costs

B) Flight Operations & Navigation

AI helps optimize routes based on weather, traffic, and fuel efficiency.

Example: Smart flight planning tools

- Reduce fuel burn
- Shorten flight times
- Decrease emissions

Impact:

- Lower fuel costs
- Reduced carbon footprint
- Better on-time performance

C) Pilot Assistance and Safety

AI systems support cockpit decision-making.

Example: Enhanced Ground Proximity Warning Systems (EGPWS)

- Uses AI to identify risky terrain situations
- Alerts crews to take action

Impact:

- Improved situational awareness
- Reduced risk of controlled flight into terrain

D) Customer Experience

AI enhances passenger services with personalisation and automation:

- Chatbots for customer queries
- Smart kiosks at airports
- Personalized travel suggestions

Example: AI Chatbots

- Answer queries about ticketing and baggage
- Available 24/7

Impact:

- Faster customer support
- Higher satisfaction levels

E) Airport Operations

AI is improving the way airports work:

- Automated baggage handling systems
- Facial recognition for security
- Queue management using real-time data

Example: AI-driven security screening

- Faster screening
- Reduced wait times

Impact:

- Better throughput
- Reduced labor reliance

4. Quantifiable Impact — Data Insights

Area	Key Benefit	Typical ROI*
Predictive Maintenance	Reduced downtime	10–20% lower costs
Flight Optimization	Lower fuel use	3–5% savings
Customer AI Tools	Faster response times	20–30% customer satisfaction rise
Airport Automation	Faster processing	15–25% throughput gain

*Estimates based on industry sources and pilots programs.

5. Challenges of AI in Aviation

Despite clear advantages, AI adoption comes with hurdles:

A) Safety & Regulation

- Aviation is highly regulated.
- AI models must be explainable and certifiable.

B) Data Privacy and Security

- Sensitive passenger and flight data must be protected.

C) Workforce Transition

- Automation may displace some roles.
- Human expertise remains critical.

D) Integration Costs

- AI systems require investment and integration with current infrastructure.

6. Case Example: AI in Action

Delta Air Lines and AI for Customer Service

- Delta implemented AI chatbots and virtual assistants.
- Resulted in reduced call volumes and faster ticketing issues resolution.

Airbus' Skywise Platform

- Uses AI for predictive maintenance across airlines.
- Helps airlines reduce unscheduled maintenance.

Key Outcome:

- AI improves operational readiness and lowers unexpected disruptions.

7. FUTURE OUTLOOK

Trend	Expected Impact
Autonomous Flights	Gradual, safety-first rollout
AI-powered Air Traffic Control	Reduced delays, better flows
Advanced Personalization	Enhanced loyalty and upsell
More Efficient Airports	Smart infrastructure

AI will continue to evolve as computing power increases and regulations adapt.

8. STRATEGIC RECOMMENDATIONS FOR AIRLINES

To maximize AI benefits:

1. Invest in high-quality data infrastructure
2. Train staff in AI tools
3. Collaborate with regulators early
4. Use pilot projects to scale successful AI initiatives
5. Balance automation with human oversight

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INDIAN KNOWLEDGE SYSTEM–DRIVEN INNOVATION FRAMEWORK FOR SUSTAINABLE AND INCLUSIVE DEVELOPMENT

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ABSTRACT

The Indian Knowledge System (IKS) represents one of the world's oldest continuous knowledge traditions, encompassing philosophy, science, governance, medicine, mathematics, architecture, ecology, linguistics, and ethics. Rooted in classical texts such as the Vedas, Upanishads, Arthashastra, Charaka Samhita, and Sushruta Samhita, the Indian Knowledge System reflects a holistic worldview that integrates ethics (Dharma), sustainability (Prakriti-centered living), rational inquiry (Tarka), and societal well-being (Lokasangraha). Ancient centres of learning such as Nalanda University and Takshashila University demonstrate that innovation has historically been embedded in India's civilizational ethos.

Despite its depth and relevance, IKS remains insufficiently integrated into contemporary innovation ecosystems, which are largely influenced by Western scientific paradigms and market-driven frameworks. This research proposes an Indian Knowledge System–Driven Innovation Framework (IKS-DIF) designed to integrate traditional epistemologies with modern scientific methodologies to promote sustainable, ethical, and inclusive development.

Using qualitative research methods including literature review, conceptual modeling, textual analysis, and policy evaluation, this study identifies structural gaps in existing innovation systems and formulates a five-pillar framework grounded in ethical governance, holistic integration, sustainability orientation, community participation, and adaptive validation.

The findings indicate that IKS-based innovation enhances ecological resilience, social cohesion, ethical responsibility, and long-term sustainability. However, challenges such as epistemological bias, intellectual property limitations, documentation issues, and institutional inertia persist. The paper concludes that a structured IKS-driven innovation ecosystem can significantly contribute to national development, knowledge sovereignty, and global leadership in holistic innovation.

Keywords: Indian Knowledge System (IKS), Innovation Framework, Sustainable Development, Dharma-based Innovation, Bharatiya Knowledge Traditions, Holistic Development, Ethical Governance, Atmanirbhar Bharat, Knowledge Integration, Civilizational Innovation

INTRODUCTION

Innovation is often portrayed as a distinctly modern phenomenon associated with industrial revolutions, digital transformation, artificial intelligence, and technology-driven startups. In contemporary discourse, the concept of innovation is closely tied to research laboratories, venture capital ecosystems, patent regimes, and global market competitiveness. It is often measured in terms of technological breakthroughs, intellectual property output, market disruption, and industrial productivity. However, in its deeper historical and civilizational sense, innovation is far broader than technological novelty. Innovation represents the continuous refinement, application, contextualization, and dissemination of knowledge to address evolving human challenges. It is the capacity to respond creatively to environmental, social, economic, and ethical problems, producing solutions that are sustainable, replicable, and culturally relevant. Civilizations that endured across centuries achieved resilience not merely through military power or political dominance, but through the ability to generate adaptive knowledge systems and institutional mechanisms capable of nurturing innovation in governance, science, technology, culture, and social organization.

India stands as one of the most enduring examples of sustained civilizational innovation. The Indian subcontinent has witnessed uninterrupted knowledge production over thousands of years, with evidence of structured inquiry, empirical experimentation, and institutionalized learning from the Vedic period to the medieval era and beyond. Unlike civilizations that experienced epistemic ruptures due to conquest or colonization, India maintained a relatively continuous intellectual tradition characterized by dialogue, debate, reinterpretation, and synthesis. This continuity gave rise to what is today referred to as the Indian Knowledge System (IKS)—a comprehensive and interconnected body of knowledge spanning multiple domains of human inquiry, including mathematics, astronomy, linguistics, medicine, metallurgy, governance, architecture, environmental science, performing arts, and philosophy.

The Indian Knowledge System encompasses remarkable advances across these disciplines. In mathematics, Indian scholars introduced the concept of zero not only as a numeral but also as an abstract mathematical concept, developed the decimal positional system, explored algebraic formulations, and pioneered trigonometry, laying the foundation for modern arithmetic and mathematical reasoning. In astronomy (Jyotisha), systematic observations of celestial bodies, planetary movements, and eclipses enabled the development of precise calendars, navigation techniques, and predictions of seasonal patterns that were crucial for agriculture, ritual timing, and maritime trade. Linguistics reached extraordinary sophistication through the work of Panini, whose *Ashtadhyayi*—a highly structured grammar of Sanskrit—is considered one of the earliest formal linguistic systems in human history, comparable to modern computational linguistics in its rule-based precision.

In medicine, Ayurveda developed an integrated health framework emphasizing preventive care, lifestyle regulation, personalized treatment, pharmacology derived from plant and mineral sources, and surgical techniques, as documented in classical texts such as the *Charaka Samhita* and *Sushruta Samhita*. Ayurveda demonstrates a uniquely holistic approach, linking the body, mind, environment, and societal well-being, rather than treating health in isolation. Metallurgical innovations are exemplified in the production of high-quality steel and enduring artifacts like the Delhi Iron Pillar, which demonstrates advanced knowledge of corrosion resistance and metal purification methods, reflecting both technological mastery and an understanding of long-term material durability.

Governance theories articulated in treatises like the *Arthashastra* provided a detailed framework for statecraft, encompassing taxation systems, economic policy, trade regulation, judicial administration, espionage, military strategy, and diplomacy. These treatises reflect sophisticated organizational knowledge, strategic planning, and systemic thinking aimed at societal stability and prosperity. Architectural sciences, including *Vastu Shastra*, combined spatial planning with environmental harmony and social psychology, ensuring that buildings, cities, and temples reflected both functional efficiency and cosmic principles. Water management systems—including stepwells, tanks, river-based irrigation, and rainwater harvesting—demonstrated advanced understanding of hydrology, resource sustainability, and ecological balance. Similarly, performing arts, codified in the *Natya Shastra*, integrated aesthetics, philosophy, psychology, and social ethics to create enduring systems of artistic expression that educated, entertained, and cultivated moral sensibilities.

What distinguishes IKS from many contemporary innovation frameworks is its deeply integrative worldview. Knowledge is never considered in isolation from ethics, social welfare, or ecological balance. The concept of Dharma acts as a moral compass, guiding innovation so that technological or administrative advancements serve human well-being and maintain social harmony. Dharma emphasizes responsibility, equilibrium, and justice, embedding ethical reflection within every act of knowledge creation and application. The principle of RTA represents cosmic order and the interconnectedness of natural and human systems, suggesting that human activity—including technological development, urban planning, and economic production—must align with universal principles and ecological laws.

The Purushartha framework further illustrates this integrative approach. This system identifies four primary goals of human life: Dharma (ethical duty), Artha (material prosperity), Kama (fulfilment of desires), and Moksha (spiritual liberation). Together, these goals represent a balanced developmental philosophy. Artha (economic activity and innovation) is pursued within the ethical boundaries set by Dharma, while Kama ensures individual and societal aspirations are fulfilled, and Moksha provides higher purpose and long-term orientation. Such a framework contrasts with contemporary paradigms that frequently prioritize short-term economic gains and market competitiveness without sufficient attention to ethical or ecological consequences. By embedding innovation within ethical, spiritual, and ecological frameworks, IKS provides a multi-dimensional approach to development that is inherently sustainable and inclusive.

Ancient universities such as Nalanda University and Takshashila University functioned as global centres of higher learning. These institutions attracted scholars from China, Tibet, Korea, Central Asia, and other parts of the world. They facilitated interdisciplinary learning, combining philosophy, medicine, mathematics, astronomy, linguistics, law, and governance within a structured pedagogical model. Debate (*Shastrartha*), empirical observation, and comparative reasoning were central to these educational practices, ensuring that students not only acquired knowledge but were trained in critical thinking, problem-solving, and ethical decision-making. The existence of organized libraries, residential scholars, institutional governance, and standardized curricula indicates that India historically possessed structured knowledge ecosystems capable of supporting innovation, research, and societal application simultaneously.

Despite this rich legacy, colonial epistemology introduced paradigmatic shifts that disrupted indigenous intellectual continuity. Colonial administrators prioritized European scientific paradigms, technological frameworks, and educational systems, often dismissing traditional knowledge as mythological or anecdotal. Curricula were reoriented to serve administrative, industrial, and military needs of the colonial state, while indigenous methods of experimentation, classification, and validation were systematically marginalized. Industrial modernity further reinforced linear innovation models centered on research, development, commercialization, and market scalability, creating a compartmentalized view of knowledge. Ethics, ecological considerations, and holistic societal welfare became secondary concerns in most technological and industrial frameworks.

Contemporary innovation systems in India largely reflect these Western-derived paradigms. While these models have successfully accelerated industrialization, digital transformation, and global competitiveness, they often neglect the integration of ethical, social, and ecological dimensions. Market-driven priorities sometimes result in resource over-exploitation, environmental degradation, technological misuse, and widening socio-economic inequalities. The lack of holistic integration and long-term orientation in these innovation ecosystems underscores the need for alternative frameworks that are capable of balancing material growth with ethical responsibility and ecological sustainability.

In today's context—marked by global climate crises, biodiversity loss, ethical dilemmas in artificial intelligence, mental health challenges, and rising socio-economic disparities—there is an urgent demand for innovation paradigms that are not only technologically advanced but also socially responsible, ecologically sustainable, and ethically grounded. Fragmentation of knowledge domains, excessive focus on market-driven research, and detachment from cultural and ecological wisdom have highlighted the vulnerabilities of contemporary innovation models.

Revisiting the Indian Knowledge System provides a compelling opportunity to develop such integrated frameworks. IKS does not reject modern science, technology, or industrial advancement. Rather, it offers principles for harmonizing empirical rigor with ethical responsibility, ecological awareness, and community-centered development. By drawing from civilizational wisdom and embedding its principles into contemporary innovation ecosystems, India can develop models that are resilient, inclusive, and sustainable.

This paper argues that integrating Indian Knowledge Systems into contemporary innovation ecosystems can provide a structured, balanced, and sustainable alternative to linear, market-centric models. Such integration involves designing frameworks that are operational, measurable, and adaptable, bridging classical epistemology with modern scientific methodology. It calls for institutional reform, policy support, interdisciplinary collaboration, and mechanisms for adaptive validation that respect both traditional knowledge systems and modern standards of empirical verification.

By embedding innovation within a broader civilizational and ethical context, India can redefine innovation itself—not as mere technological disruption or market advantage—but as a process of ethically grounded, ecologically sensitive, socially inclusive, and culturally resonant transformation. Such a perspective positions India to assume global leadership in the emerging field of value-based innovation and to offer frameworks that address pressing global challenges through a synthesis of ancient wisdom and modern science.

Ultimately, this study situates IKS-driven innovation as a strategic response to contemporary societal and ecological crises. It emphasizes that innovation should serve human development in a balanced manner, integrating ethical responsibility, environmental stewardship, and social equity. By leveraging the vast intellectual resources of the Indian Knowledge System, policymakers, educators, researchers, and entrepreneurs can create a development paradigm that aligns economic growth with moral, cultural, and ecological sustainability, thereby ensuring long-term societal resilience and human well-being.

REVIEW OF LITERATURE

The literature on Indian Knowledge Systems spans diverse academic disciplines including philosophy, history, anthropology, medicine, and policy studies. However, systematic integration of IKS into innovation theory remains underdeveloped.

Classical sources such as the Vedas and Upanishads articulate a knowledge framework grounded in inquiry (Jnana), discipline (Tapas), and ethical responsibility (Dharma). They present a cosmological understanding of interdependence that resonates with modern systems theory.

The Arthashastra provides a comprehensive manual of governance and economic policy, covering taxation, agriculture, trade regulation, public works, espionage, and diplomacy. Its systematic approach demonstrates early innovation in statecraft and economic management.

Ayurvedic treatises such as the Charaka Samhita and Sushruta Samhita illustrate empirical observation, classification systems, diagnostic methods, pharmacology, and surgical techniques. These works reveal rigorous knowledge development processes and ethical codes for practitioners.

Scholars of decolonization argue that knowledge hierarchies established during colonial periods marginalized indigenous epistemologies. Contemporary research on knowledge pluralism and sustainable development recognizes the importance of integrating traditional knowledge systems into policy and innovation frameworks.

Modern innovation theory literature—including open innovation, disruptive innovation, and national innovation systems—emphasizes technological competitiveness, intellectual property rights, and commercialization. While effective in industrial contexts, these frameworks often underemphasize ethical responsibility and ecological integration.

Recent policy initiatives in India have recognized the importance of integrating IKS into education and research. However, academic literature reveals limited efforts to construct operational innovation frameworks grounded in Indian epistemology.

Thus, this study contributes to bridging classical Indian knowledge traditions with contemporary innovation theory through a structured framework.

RESEARCH GAP

Although Indian Knowledge Systems are increasingly discussed in academic and policy discourse, significant gaps remain:

Absence of Operational Innovation Models

Most scholarship on IKS remains descriptive or philosophical. There is limited effort to translate IKS principles into structured innovation frameworks applicable to industries, startups, governance systems, and higher education institutions.

Fragmented Domain-Specific Integration

IKS is often confined to yoga, Ayurveda, or spiritual studies. Broader domains such as governance, economics, environmental management, metallurgy, architecture, and mathematics are insufficiently integrated into innovation discourse.

Epistemological Bias

Modern research validation methods privilege laboratory experimentation and quantitative metrics. Traditional validation approaches such as experiential learning, lineage-based transmission, and community validation are often dismissed.

Intellectual Property Challenges

India's classical knowledge is largely collective and civilizational rather than individual. Conventional patent systems do not adequately accommodate such knowledge structures.

Policy-Implementation Disconnect

While the National Education Policy (2020) emphasizes IKS integration, practical mechanisms to embed it into research and development ecosystems remain underdeveloped.

This study seeks to address these gaps by proposing a structured Indian Knowledge System–Driven Innovation Framework.

OBJECTIVES

1. To analyse core principles of Indian Knowledge Systems relevant to innovation.
2. To examine limitations of contemporary innovation models.
3. To design a structured IKS-driven innovation framework.
4. To assess positive and negative impacts of the framework.
5. To provide actionable suggestions for policymakers and institutions.

RESEARCH METHODOLOGY

This study adopts a qualitative, interdisciplinary methodology:

LITERATURE REVIEW

Classical texts, contemporary academic research, and innovation theory literature were systematically reviewed.

Textual and Philosophical Analysis

Primary Indian texts were examined to extract innovation-relevant principles such as Dharma, holistic integration, sustainability, and ethical conduct.

Comparative Analysis

Western innovation frameworks (linear model, open innovation, disruptive innovation) were compared with IKS principles.

Conceptual Modeling

Using systems thinking, a five-pillar Indian Knowledge System–Driven Innovation Framework (IKS-DIF) was constructed.

Policy Review

National innovation and education policies were analyzed to determine alignment opportunities.

Conceptual Foundations of IKS for Innovation**Dharma as Ethical Foundation**

Dharma represents moral order, duty, and ethical conduct. Innovation guided by Dharma prioritizes societal welfare over mere profit.

Holistic Integration

IKS views knowledge as interconnected. Medicine integrates diet, psychology, spirituality, and environment. Governance integrates economics, ethics, and social order.

Sustainability and Ecological Balance

Ancient agricultural systems emphasized crop diversity, water conservation, and soil health.

Knowledge through Dialogue and Debate

Ancient scholarly traditions promoted structured debate (Shastrartha), encouraging critical inquiry.

Community-Centered Learning

Knowledge transmission occurred through Gurukula systems emphasizing character development alongside intellectual growth.

Indian Knowledge System–Driven Innovation Framework (IKS-DIF)

The proposed framework consists of five interdependent pillars:

Ethical Governance (Dharma-Centric Innovation)

Innovation projects must undergo ethical impact evaluation assessing societal and environmental consequences.

Holistic Knowledge Integration

Encourages interdisciplinary research bridging philosophy, science, technology, and arts.

Sustainability Orientation

Promotes eco-friendly technologies aligned with natural cycles.

Community Participation

Incorporates local knowledge holders, artisans, and traditional practitioners in innovation processes.

Adaptive Validation

Combines empirical testing with experiential and contextual validation methods.

FINDINGS

The research yields several key findings:

1. IKS principles enhance long-term sustainability compared to short-term profit-driven models.
2. Ethical anchoring reduces technological misuse.
3. Holistic frameworks promote mental and social well-being alongside economic growth.
4. Community participation strengthens grassroots innovation ecosystems.

5. Institutional reform is essential for large-scale integration.

Positive Impacts**Environmental Sustainability**

IKS-based agricultural and architectural practices promote ecological harmony.

Cultural Preservation

Embedding IKS in innovation safeguards traditional knowledge.

Economic Inclusivity

Local artisans and rural innovators gain recognition and opportunities.

Ethical Technological Development

Prevents exploitative or environmentally harmful technologies.

National Identity and Soft Power

Promotes India's civilizational contributions globally.

NEGATIVE IMPACTS AND CHALLENGES

1. Risk of uncritical glorification of tradition.
2. Possibility of pseudoscientific claims without validation.
3. Commercial exploitation of classical knowledge.
4. Academic resistance to epistemological pluralism.
5. Difficulty in global standardization.

SUGGESTIONS

1. Establish IKS Innovation Centres in universities.
2. Create interdisciplinary research grants.
3. Develop sui generis intellectual property frameworks.
4. Integrate IKS in STEM and management curricula.
5. Promote start-ups leveraging traditional knowledge ethically.
6. Develop digital repositories with cultural safeguards.
7. Encourage international collaborations on holistic innovation.

CONCLUSION

The Indian Knowledge System–Driven Innovation Framework offers a transformative pathway for sustainable and inclusive development. By integrating ethics, sustainability, and holistic thinking with modern science and technology, India can develop an innovation ecosystem rooted in its civilizational strengths.

IKS does not advocate rejection of modernity but proposes synthesis. Through structured institutional support, policy alignment, and interdisciplinary research, India can lead a global shift toward ethical, sustainable, and human-centered innovation.

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INDIAN KNOWLEDGE SYSTEMS (IKS) AND COMMUNITY-BASED LIVING: A SUSTAINABLE MODEL FOR CONTEMPORARY URBAN SOCIETY

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ABSTRACT

Indian Knowledge Systems (IKS) represent a holistic, integrated, and value-oriented framework of knowledge that harmonizes ethical conduct, social responsibility, and environmental sustainability. Unlike reductionist modern paradigms that prioritize economic growth and material advancement, IKS emphasizes balance between human beings, society, and nature. Rooted in civilizational wisdom and community-based practices, IKS provides profound insights into participatory governance, ecological stewardship, shared resource management, and moral responsibility.

This conceptual and analytical study explores the relevance of Indian Knowledge Systems in addressing pressing challenges faced by contemporary urban societies, including social alienation, environmental degradation, consumerism, mental stress, and resource depletion. It examines how foundational principles such as Vasudhaiva Kutumbakam (the world as one family), Dharma (ethical duty and balance), and Aparigraha (non-possessiveness) can be reinterpreted and integrated into modern institutional frameworks and technological systems.

The paper proposes an IKS-based urban community living model that promotes participatory governance, collective ownership of resources, ecological responsibility, and value-based education. It argues that IKS-based community living is not merely a revivalist cultural project but a pragmatic, future-oriented model for sustainable urban development in the twenty-first century.

Keywords: Indian Knowledge Systems, Sustainability, Community Living, Urban Society, Traditional Wisdom, Ethical Governance

1. INTRODUCTION

The twenty-first century has witnessed unprecedented technological advancement, rapid urbanization, and economic expansion. While these developments have enhanced material standards of living, they have simultaneously intensified environmental crises, social fragmentation, and psychological stress. Modern development models, largely influenced by industrial capitalism and linear economic systems, have prioritized production, consumption, and profit maximization. As a result, ecological degradation, climate change, resource depletion, and widening social inequalities have emerged as critical global concerns.

Urbanization, though a driver of economic opportunity, has weakened traditional community bonds. Nuclear families, high mobility, competitive lifestyles, and digital isolation have reduced meaningful social interaction. The decline of shared spaces and collective responsibility has led to loneliness, insecurity, and diminishing social capital.

In contrast, Indian civilization has historically emphasized holistic development. Indian Knowledge Systems (IKS), deeply rooted in philosophical and ethical traditions, present an alternative worldview centered on harmony rather than domination, duty rather than rights alone, and sustainability rather than exploitation. The foundational philosophical insights of thinkers like Sarvepalli Radhakrishnan highlight that Indian thought views life as an interconnected whole where spiritual, social, and ecological dimensions are inseparable.

This paper seeks to explore how Indian Knowledge Systems can provide a sustainable framework for contemporary urban society by reviving and adapting community-based living models aligned with ethical and ecological values.

2. INDIAN KNOWLEDGE SYSTEMS: CONCEPTUAL AND PHILOSOPHICAL FOUNDATIONS

Indian Knowledge Systems encompass diverse domains such as philosophy, governance, economics, medicine, architecture, agriculture, and environmental ethics. Unlike compartmentalized modern disciplines, IKS adopts an integrative approach where knowledge is oriented toward societal well-being.

2.1 Holistic Worldview

The Indian worldview is based on interconnectedness. The concept of Vasudhaiva Kutumbakam—found in ancient texts—declares that the entire world is one family. This idea transcends narrow identities and promotes

universal welfare (Sarve Bhavantu Sukhinah). It implies ethical responsibility toward all living beings and nature.

2.2 Dharma as Ethical Foundation

Dharma is not merely religion but a principle of cosmic order, moral duty, and balance. It regulates individual behavior in relation to society and environment. Dharma-based ethics emphasize moderation, accountability, and sustainability.

2.3 Aparigraha and Restraint

The principle of Aparigraha (non-possessiveness), central to Indian philosophical traditions, discourages excessive accumulation and consumption. It promotes sufficiency over excess, thereby aligning closely with modern sustainability discourse.

2.4 Knowledge for Social Good

Knowledge in IKS is not purely instrumental or profit-driven; it is normative and welfare-oriented. It aims at Lokasangraha—the welfare and stability of society. Thus, IKS provides a moral-intellectual foundation for sustainable community life.

3. Community-Based Living in Traditional Indian Society

Traditional Indian society was organized around self-regulating and self-sufficient community units. The village was not merely a geographical entity but a socio-economic and cultural ecosystem.

3.1 Village Republics and Participatory Governance

The Gram Sabha functioned as a participatory governance institution where collective decision-making was practiced. Resource distribution, dispute resolution, and welfare activities were managed locally, ensuring accountability and social cohesion.

3.2 Joint Family System

The joint family structure ensured social security, shared responsibilities, intergenerational knowledge transfer, and emotional support. It minimized isolation and strengthened community bonds.

3.3 Shramdaan and Collective Labor

The practice of Shramdaan (voluntary community service) encouraged citizens to contribute labor for public welfare activities such as irrigation, temple construction, and infrastructure maintenance. This fostered ownership and responsibility.

3.4 Ecological Harmony

Traditional communities respected nature as sacred. Sacred groves, water tanks, stepwells, and seasonal agricultural cycles reflected deep ecological sensitivity and local knowledge. These systems demonstrate that community living in India was inherently sustainable, participatory, and ethically grounded.

4. SUSTAINABILITY EMBEDDED IN INDIAN KNOWLEDGE SYSTEMS

Sustainability in IKS is not a recent concept but a civilizational ethos.

4.1 Ecological Ethics

Nature was revered as divine. Rivers like the Ganga, forests, mountains, and animals were integrated into spiritual life, promoting conservation through cultural values.

4.2 Cyclical Economic Thinking

Traditional Indian agriculture followed seasonal cycles and biodiversity practices, avoiding monoculture and excessive extraction.

4.3 Moderation in Consumption

Aparigraha and simplicity reduced waste and ecological strain. Economic activity was embedded in moral limits.

4.4 Intergenerational Responsibility

IKS emphasizes duties toward future generations, ensuring that resources are preserved rather than depleted. Thus, sustainability in Indian thought is value-driven rather than regulation-driven.

5. CHALLENGES OF CONTEMPORARY URBAN SOCIETY

Modern urban environments face multiple interlinked challenges:

1. **Social Isolation:** Nuclear families and individualistic lifestyles reduce social interaction.

2. **Environmental Degradation:** Pollution, waste accumulation, and shrinking green spaces threaten urban health.

3. **Resource Depletion:** Water scarcity and energy overconsumption strain ecosystems.

4. **Mental Health Concerns:** Competitive work culture and loneliness increase stress.

5. **Consumerism:** Market-driven identities encourage material accumulation over meaningful living.

6. The prevailing linear economic model—produce, consume, discard—contradicts sustainability principles.

6. RELEVANCE OF IKS IN THE MODERN URBAN CONTEXT

Indian Knowledge Systems offer a corrective framework to address urban crises.

6.1 Rebuilding Community Bonds

The principle of Vasudhaiva Kutumbakam encourages inclusive urban communities that transcend caste, class, and religious divisions.

6.2 Ethical Urban Governance

Dharma-based governance promotes transparency, duty-conscious leadership, and accountability.

6.3 Sustainable Consumption Patterns

Aparigraha aligns with minimalism and circular economy principles.

6.4 Integration with Modern Innovation

IKS is dynamic and adaptable. It does not reject modernity but reorients it ethically.

Thus, IKS can inform value-based urban planning and governance.

7. AN IKS-BASED COMMUNITY LIVING MODEL FOR URBAN AREAS

This paper proposes an integrated IKS-based urban community model consisting of the following components:

7.1 Participatory Governance Structures

Urban residential communities can institutionalize participatory forums inspired by Gram Sabha principles, ensuring collective decision-making.

7.2 Shared Resource Systems

Community kitchens, co-working spaces, shared transport, rainwater harvesting systems, and renewable energy cooperatives reduce resource duplication.

7.3 Community-Managed Green Spaces

Urban gardens and sacred green zones foster ecological awareness and biodiversity.

7.4 Cultural and Educational Centers

Centers promoting yoga, meditation, Indian philosophy, and value-based education strengthen social cohesion.

7.5 Circular Economy Practices

Waste segregation, composting, recycling, and responsible consumption can be institutionalized. This model combines ethical philosophy with practical urban planning.

8. ROLE OF TECHNOLOGY AS AN ENABLER

Technology should function as a facilitator rather than a dominating force.

8.1 Digital Governance Platforms

Mobile applications can enable community voting, grievance redressal, and transparent budgeting.

8.2 Renewable Energy Systems

Solar panels and microgrids reduce fossil fuel dependency.

8.3 Smart Water Management

IoT-enabled systems can optimize water usage and detect leakages.

8.4 Waste Management Technologies

Recycling plants and composting units support circular systems. Technology aligned with Dharma ensures sustainable innovation.

9. POLICY IMPLICATIONS**To integrate IKS into urban development:**

1. Urban planning curricula should include Indian Knowledge Systems.
2. Municipal governance should adopt participatory frameworks.
3. Policies must promote cooperative housing and shared infrastructure.
4. Environmental regulations should integrate cultural-ethical dimensions.
5. Educational institutions should encourage value-based community engagement.

Policy must move beyond infrastructure-centric approaches to value-centric development.

10. CONCLUSION

Indian Knowledge Systems offer a timeless yet dynamic framework for sustainable urban living. Their emphasis on interconnectedness, ethical responsibility, moderation, and community participation provides a powerful alternative to fragmented modern urban life.

Community-based living rooted in IKS is not a nostalgic return to the past but a forward-looking synthesis of tradition and innovation. By integrating participatory governance, shared resources, ecological responsibility, and ethical education with modern technologies, urban societies can achieve balanced and sustainable development.

In an era marked by environmental crisis and social fragmentation, Indian Knowledge Systems illuminate a pathway toward collective well-being and planetary harmony. The future of sustainable urban society may well depend on rediscovering and reinterpreting this profound civilizational wisdom.

AUTHOR BIOGRAPHY

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INFLUENCER MARKETING IN THE DIGITAL AGE: ETHICAL CONCERNS AND THEIR SOCIETAL IMPACT

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ABSTRACT

By transforming carefully manicured lifestyles into effective marketing tools, social media influencers have emerged as significant players in influencing digital behaviour. They provide inspiration, amusement, and easy access to trends, but their influence also raises unspoken ethical and psychological issues. Unrealistic standards that mislead audiences and negatively impact mental health, particularly among young users, are created by edited images, scripted routines, and sponsored posts that are presented as sincere advice. Respondents were given a structured questionnaire about their interactions with influencer-driven posts to investigate how such content affects consumer attitudes. The results indicate that to reduce deceptive content, more stringent disclosure regulations, open sponsorship policies, digital literacy, and enhanced platform monitoring are required. The study also emphasises the necessity of regulatory frameworks and ethical standards in India.

Keywords: *Influencers on social media, digital manipulation, consumer behaviour, sponsored content, psychological effects, and digital literacy.*

INTRODUCTION

Influencers on social media have a significant impact on how people behave, think, and make purchases. Although their posts frequently don't reflect their real lives, they use their online presence and carefully chosen content to seem genuine and reliable. A large portion of their content is designed to attract followers, generate interaction, and advertise brands.

Influencer Content's Effect on Consumer Behaviour

- **Changing Mental Health and Self-Perception**

Teenagers and young adults who frequently witness idealised lifestyles may compare themselves to unattainable standards, which can negatively impact their self-esteem, confidence, and emotional health.

- **Influencing Buying Choices**

Even when posts are sponsored or paid for, followers may regard influencer promotions as sincere advice, which may affect their purchasing decisions.

- **Fostering Trend Adoption and Impulsive Purchases**

Influencers frequently initiate viral trends that encourage people to make hasty, rash purchases in an effort to blend in.

- **Diminishing Critical Thought**

Users may find it more difficult to distinguish genuine opinions from sponsored promotions when they are constantly exposed to persuasive content.

- **Promoting Identity Perplexity.** In an attempt to gain online acceptance, young viewers may imitate influencers' actions, occasionally losing sight of who they really are.

REVIEW OF LITERATURE: -

- **Influence on Consumer Attitudes and Purchase Decisions**

Research indicates that social media influencers significantly shape consumers' attitudes, preferences, and buying intentions by acting as opinion leaders in digital spaces (Djafarova & Rushworth, 2017).

- **Relatability and Trust Among Young Consumers**

Influencers who appear authentic and relatable build trust with followers, particularly young audiences, which strongly influences how products and brands are evaluated (Djafarova & Rushworth, 2017).

- **Enhancement of Product Appeal**

Well-known and visually appealing influencers can increase product attractiveness even when followers have no prior brand familiarity, highlighting the persuasive power of influencer endorsements (De Veirman et al., 2017).

• Concealed Commercial Intent in Sponsored Content

Unreported or poorly disclosed sponsored posts may mislead audiences by obscuring advertising intent, raise ethical concerns, and affect consumer judgment (Lou & Yuan, 2019).

• Impact on Self-Image and Unrealistic Standards

The extensive use of filters and edited visuals by influencers promotes unrealistic beauty and lifestyle standards, which can negatively affect followers' self-image and mental well-being (Ki et al., 2020).

• Emotional Attachment and Impulse Buying

Strong emotional connections between influencers and followers encourage impulse buying, as consumers often perceive influencers as trusted peers rather than marketers (Schouten et al., 2020).

RESEARCH GAP: -

Influencer marketing has been extensively researched, but there are still some uncharted territories. The impact of concealed or inflated influencer promotions on consumer trust has not been thoroughly studied. The psychological reasons that make young users vulnerable to influencer manipulation are also not clearly understood. The detrimental effects of idealised influencer lifestyles on identity and self-esteem are rarely studied. Furthermore, ethical problems like unreported sponsorships and deceptive content are not adequately investigated. Additionally, there is a lack of awareness of India's need for stricter laws and regulations to ensure ethical and transparent influencer marketing.

NEED OF THE STUDY

Studying social media influencers is crucial to comprehending how their content affects consumers' attitudes, actions, and purchases. With many posts being edited, sponsored, or exaggerated, users may develop false expectations or be misled into buying products. In order to raise awareness and encourage greater digital responsibility, it is necessary to highlight the psychological effects of influencer content, particularly on younger audiences. It also aids in spotting unethical behaviours like deceptive engagement strategies and covert promotions. Understanding these issues can help create clearer guidelines, protect consumers, and encourage honest, transparent influencer marketing.

OBJECTIVE OF THE STUDY

- To examine the extent to which social media influencers portray authentic content versus staged or exaggerated lifestyles.
- To analyse the psychological and mental health impact of influencer-driven content on young audiences.
- To investigate how influencers contribute to unrealistic beauty, fitness, and lifestyle standards among viewers.
- To identify the prevalence of financial scams, misleading promotions, and risky money practices associated with influencer activities.
- To propose practical strategies that can help viewers develop digital awareness, critical thinking, and safe online consumption habits.

HYPOTHESIS: -

H₀ (Null Hypothesis): There is no significant association between the frequency of watching social media influencers and viewers' perception of authenticity.

H₁ (Alternative Hypothesis): There is a significant association between the frequency of watching social media influencers and viewers' perception of authenticity.

H₀ (Null Hypothesis): There is no significant association between the frequency of exposure to influencer-driven content and the psychological or mental health impact on young audiences.

H₁ (Alternative Hypothesis): There is a significant association between the frequency of exposure to influencer-driven content and the psychological or mental health impact on young audiences.

RESEARCH METHODOLOGY: -

The study adopted an **exploratory research design** to examine the effect of social media influencer content on consumer purchasing behaviour. A sample of **2,151 respondents was selected using simple random sampling from the youth population across multiple colleges in Mumbai, as well as from active users of various social media communities.**

The primary objectives of the study were to **evaluate the impact of influencer posts on consumer purchase decisions** and to **examine existing laws and regulations governing sponsored content and influencer marketing**.

DATA COLLECTION:-

To comprehensively assess the influence of social media influencer content on consumer purchasing behaviour, the study utilised **both primary and secondary data**.

- **Primary data** was collected through a **well-structured questionnaire** designed in alignment with the research objectives.
- The questionnaire was circulated digitally via **Google Forms** and distributed across **social media platforms such as Instagram communities, Telegram channels, Discord communities, Facebook groups, Snapchat groups, and WhatsApp groups**, as well as among students from **multiple colleges across Mumbai**.
- Collected through the Google Form link: https://docs.google.com/spreadsheets/d/1ecHcukco7Nob3SkZvCZODzY6WYJZlOtIr4y6bz_9WVM/edit?usp=sharing
- A total of 2151 **valid responses** were received and considered for analysis.

In addition, **secondary data** was gathered from **research journals, published reports, scholarly articles, and credible online sources** to support and validate the findings of the primary survey.

DATA ANALYSIS:-

The data collected through the questionnaire were analysed using percentage analysis and presented using **tables, pie charts, bar charts, and column charts**. The analysis aimed to evaluate the **extent to which social media influencer content affects consumer purchasing behaviour** and to gain insights into **public awareness regarding regulations governing sponsored posts and influencer marketing**.

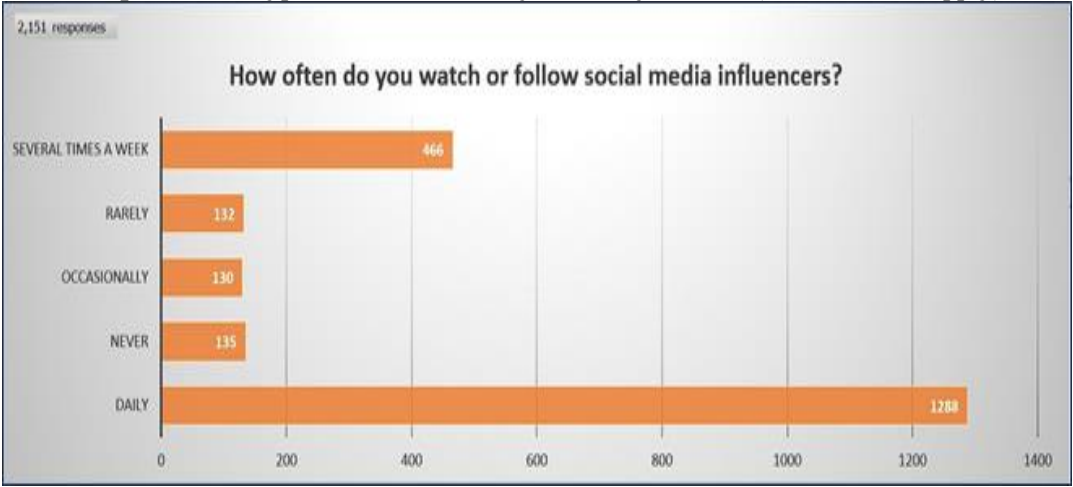
Graph 1: SECTION A — Demographics:

Particulars	Number of Respondents	Percentage
Gender		
Male	1201	55.83%
Female	920	42.77%
Prefer not to say	30	1.39%
Total	2151	100.00%
Age		
15 – 18	452	21.01%
18 – 21	1241	57.69%
21 – 25	458	21.29%
Total	2151	100.00%
Education Level		
Junior College	218	10.13%
Undergraduate	1470	68.34%
Postgraduate	346	16.09%
Other	117	5.44%
Total	2151	100.00%
Which social media platforms do you use the most?		
Instagram	526	24.45%
Youtube	433	20.13%
Snapchat	321	14.92%
Facebook	281	13.06%
X (Twiter)	196	9.11%
Telegram	190	24.45%
Others	204	9.48%
Total	2151	100.00%

Source: Primary Data Analysis:

SECTION B — Influencer Consumption Behaviour

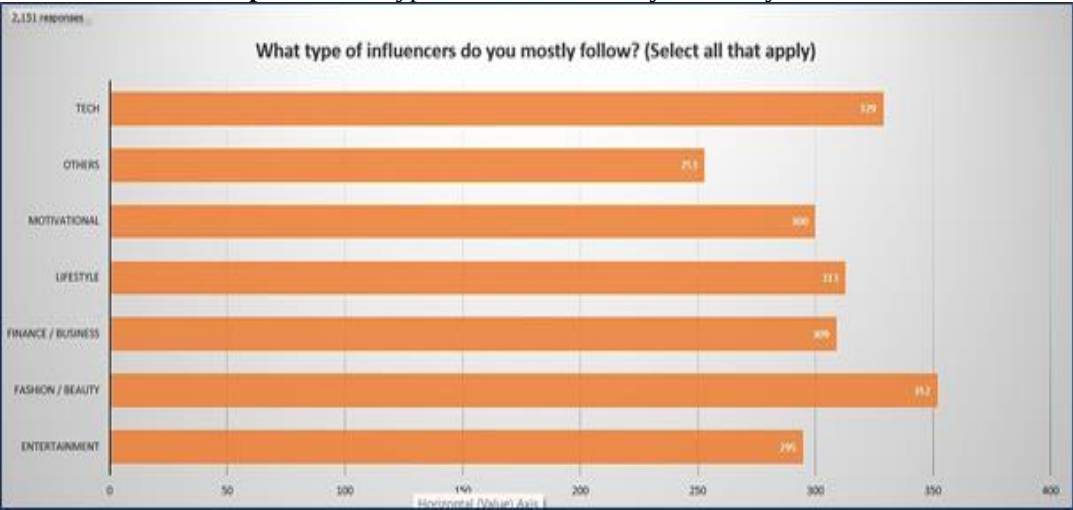
Graph 1: What type of influencers do you mostly follow? (Select all that apply)



Source: Primary Data Analysis:

- **Daily (1288)** is the most common frequency, indicating that a majority of respondents follow influencers every day.
- **Several times a week (466)** also shows high engagement.
- The usage of **Never (135), Rarely (132), and Occasionally (130)** is relatively low.
- **Occasionally (130)** is the least selected option, showing minimal passive or infrequent engagement.

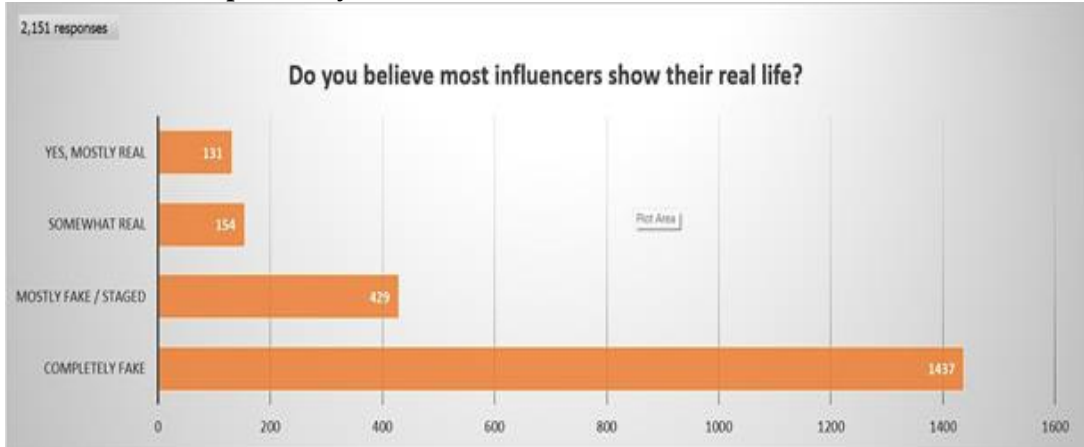
Graph 2: What type of influencers do you mostly follow? (Select all that apply)



Source: Primary Data Analysis:

- **Fashion/Beauty (352)** is the most followed influencer category among respondents.
- **Tech (329), Lifestyle (313), and Finance/Business (309)** also show high follower interest.
- **Motivational (300)** and **Entertainment (295)** influencers have strong and nearly similar engagement levels.
- **Others (253)** is the least followed category, indicating comparatively lower interest in niche or miscellaneous influencer types.

Graph 3: Do you believe most influencers show their real life?

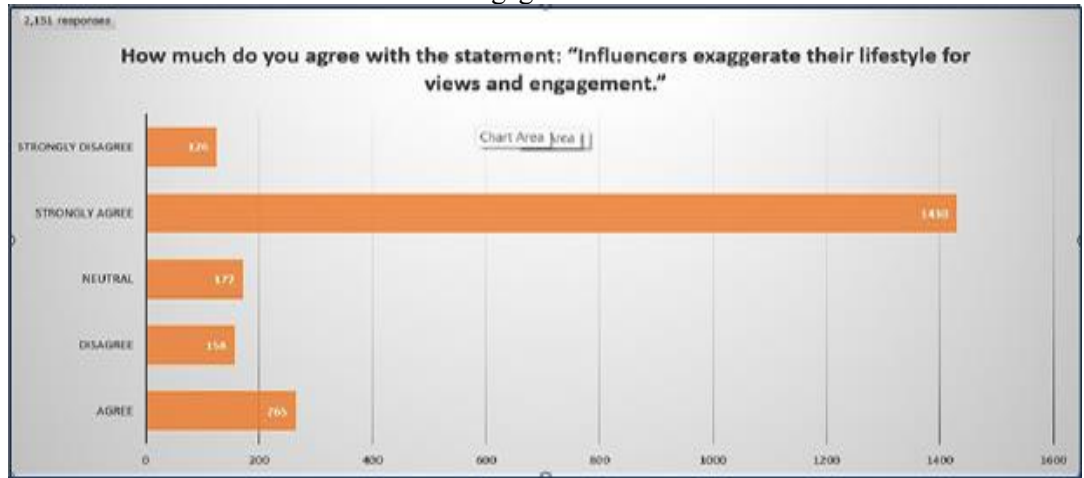


Source: Primary Data Analysis:

- Completely fake (1437) is the most selected response, showing strong scepticism toward influencer authenticity.
- Mostly fake / staged (429) also has significant responses, reinforcing distrust among respondents.
- The belief that influencers are genuine is low, with Somewhat real (154) and Yes, mostly real (131) receiving minimal responses.
- Overall, the data indicate that a majority of respondents believe influencers do not portray real life accurately.

SECTION C — Perception of Authenticity

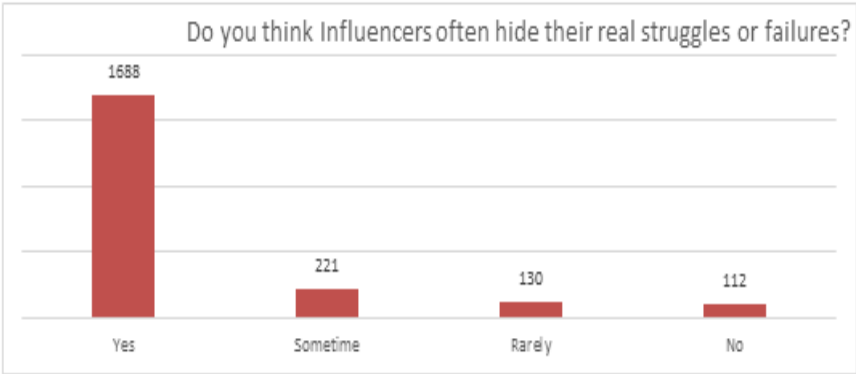
Graph 4: How much do you agree with the statement: “Influencers exaggerate their lifestyle for views and engagement.”



Source: Primary Data Analysis:

- Strongly agree (1430) is the dominant response, indicating a strong consensus that influencers exaggerate their lifestyle for views and engagement.
- Agree (265) also reflects substantial agreement with the statement.
- Neutral (172) and Disagree (158) show limited uncertainty or opposition.
- Strongly disagree (126) is the least selected option, suggesting minimal rejection of the claim.
- Overall, the findings reveal a clear perception among respondents that influencer content is exaggerated for attention and engagement.

Graph 5: Do you think Influencers often hide their real struggles or failures?

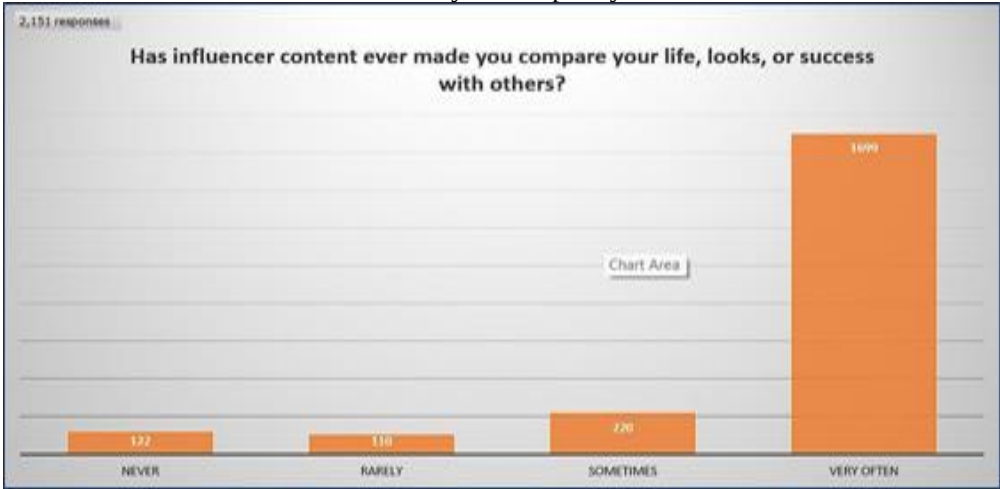


Source: Primary Data Analysis:

- Yes (1688) is the most selected response, indicating a strong belief that influencers often hide their real struggles or failures.
- Sometimes (221) shows that a smaller section feels influencers are selectively transparent.
- Rarely (130) reflects limited belief in consistent honesty from influencers.
- No (112) is the least selected option, suggesting very few respondents believe influencers openly share their real struggles.
- Overall, the findings highlight a widespread perception that influencer content conceals hardships and presents a curated version of reality.

SECTION D — Mental & Psychological Impact

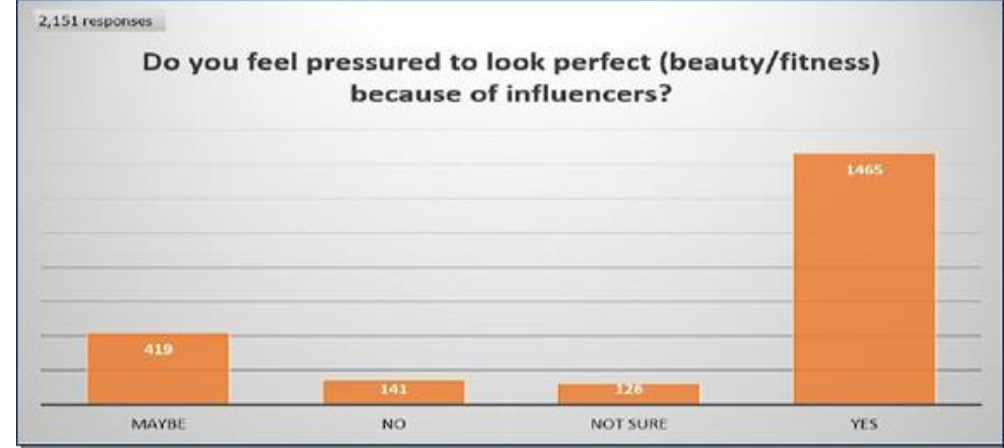
Graph 6: Has influencer content ever made you compare your life, looks, or success with others?



Source: Primary Data Analysis:

- Very often (1699) is the most selected response, indicating that influencer content frequently leads respondents to compare their life, appearance, or success with others.
- Sometimes (220) also reflects a noticeable level of comparison triggered by influencer content.
- Never (122) and Rarely (110) show relatively low responses, suggesting that only a small portion of participants remain unaffected.
- Overall, the findings reveal a strong psychological impact of influencer content on self-comparison among respondents.

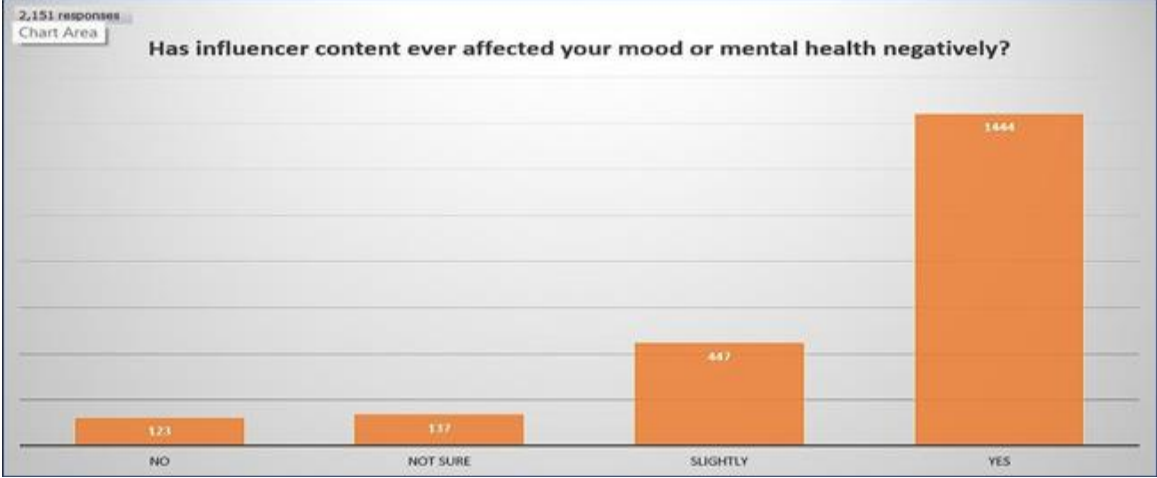
Graph 7: Do you feel pressured to look perfect (beauty/fitness) because of influencers?



Source: Primary Data Analysis:

- Very often (1699) is the most selected response, indicating that influencer content frequently leads respondents to compare their life, appearance, or success with others.
- Sometimes (220) also reflects a noticeable level of comparison triggered by influencer content.
- Never (122) and Rarely (110) show relatively low responses, suggesting that only a small portion of participants remain unaffected.
- Overall, the findings reveal a strong psychological impact of influencer content on self-comparison among respondents.

Graph 8: Has influencer content ever affected your mood or mental health negatively?

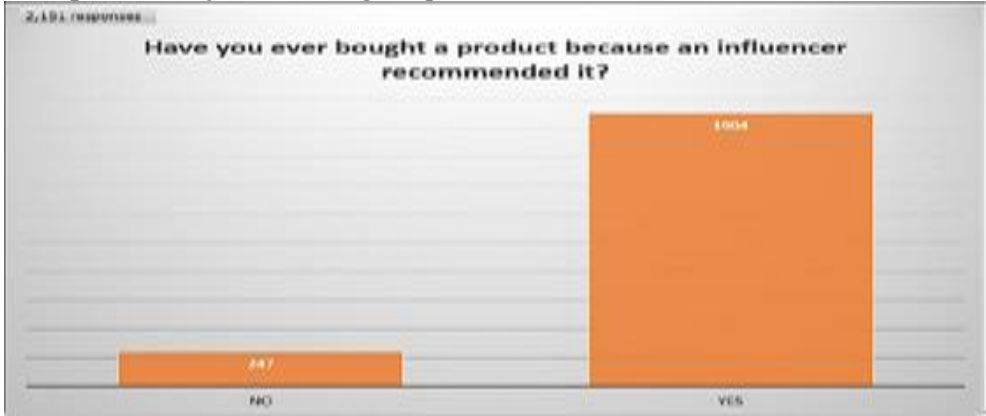


Source: Primary Data Analysis:

- Yes (1444) is the most selected response, indicating that a large majority feel influencer content has negatively affected their mood or mental health.
- Slightly (447) also represents a significant portion, showing mild but noticeable negative impact.
- Not sure (137) reflects uncertainty among some respondents regarding the influence on their mental well-being.
- No (123) is the least selected option, suggesting very few respondents believe influencer content has no negative effect.
- Overall, the findings highlight a strong perceived negative impact of influencer content on mental health and emotional well-being

SECTION E — Financial Influence & Scams

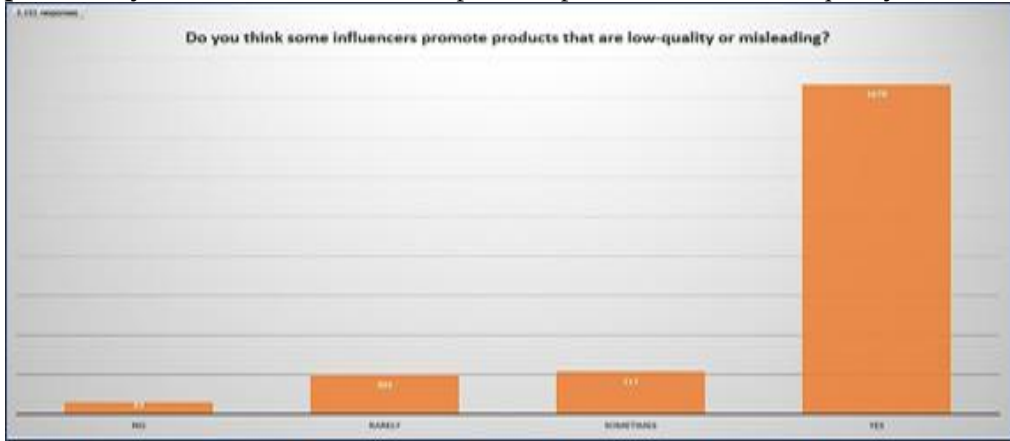
Graph 9: Have you ever bought a product because an influencer recommended it



Source Analysis:-

- Yes (1904) is the dominant response, indicating that a vast majority of respondents have purchased a product based on an influencer’s recommendation.
- No (247) represents a much smaller group, suggesting limited resistance to influencer-driven marketing.
- Overall, the findings clearly demonstrate the strong impact of influencer recommendations on consumer purchasing behaviour

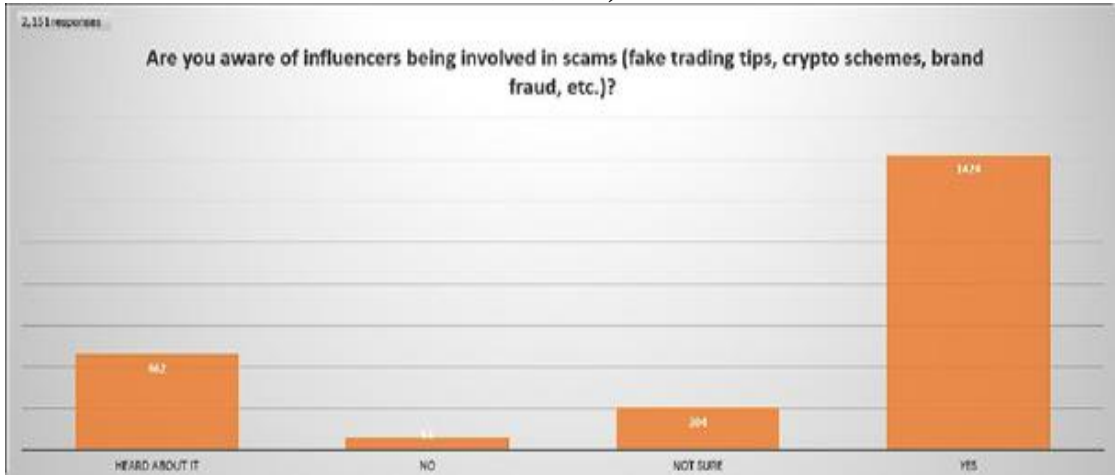
Graph 10: Do you think some influencers promote products that are low-quality or misleading



Source: Primary Data Analysis:

- Yes (1670) is the most selected response, indicating that a large majority believe influencers promote low-quality or misleading products.
- Sometimes (217) suggests that some respondents feel this occurs occasionally rather than consistently.
- Rarely (201) reflects limited belief in frequent misleading promotions.
- No (63) is the least selected option, showing very few respondents fully trust influencer promotions.
- Overall, the results highlight a strong perception of misleading or low-quality product promotion within influencer marketing

Graph 11: Are you aware of influencers being involved in scams (fake trading tips, crypto schemes, brand fraud, etc.)?

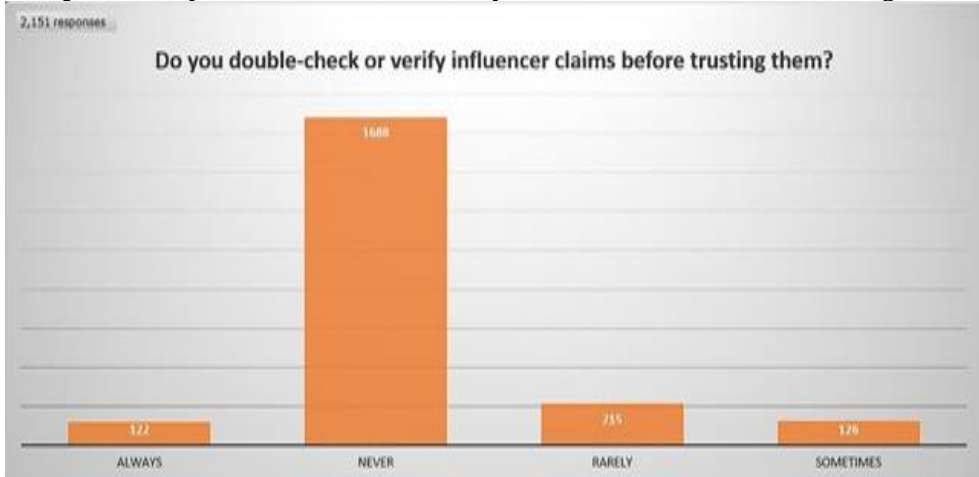


Source: Primary Data Analysis:

- Yes (1424) is the most selected response, indicating high awareness of influencers being involved in scams such as fake trading tips, crypto schemes, and brand fraud.
- Heard about it (462) also shows substantial awareness, even if not direct or detailed knowledge.
- Not sure (204) reflects uncertainty among some respondents regarding such influencer activities.
- No (61) is the least selected option, suggesting very few respondents are unaware of influencer-related scams

SECTION F — Critical Thinking & Digital Awareness

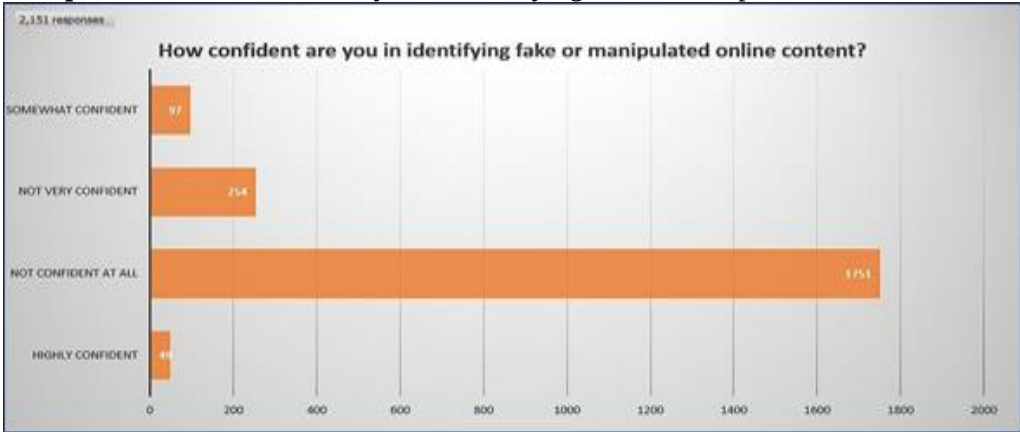
Graph 12: Do you double-check or verify influencer claims before trusting them?



Source: Primary Data Analysis:

- Never (1688) is the most selected response, indicating that a majority of respondents do not verify or double-check influencer claims before trusting them.
- Rarely (215) suggests limited effort by some respondents to verify influencer information.
- Sometimes (126) shows occasional verification behaviour among a small group.
- Always (122) is the least selected option, indicating very few respondents consistently verify influencer claims.
- Overall, the findings highlight a low level of fact-checking and critical evaluation of influencer content among respondents, which may increase vulnerability to misinformation.

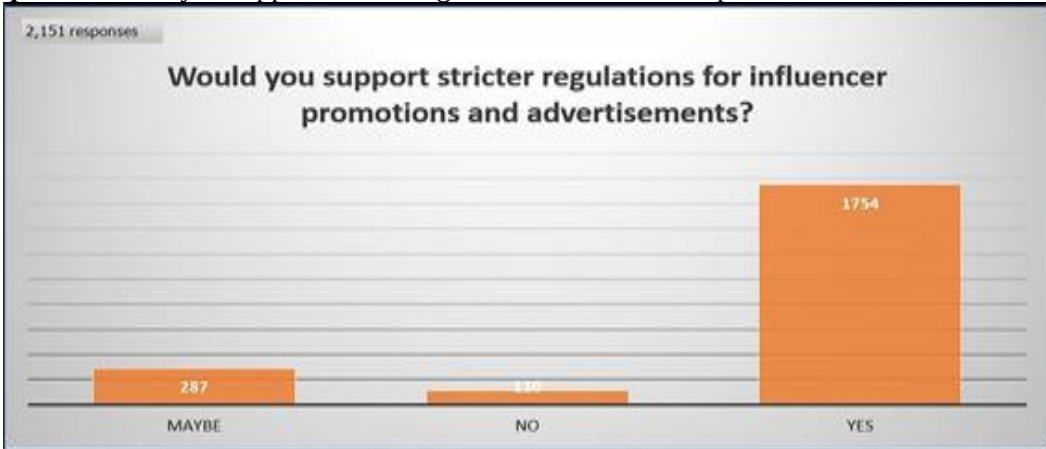
Graph 13: How confident are you in identifying fake or manipulated online content?



Source: Primary Data Analysis:

- **Not confident at all (1751)** is the most selected response, indicating very low confidence among respondents in identifying fake or manipulated online content.
- **Not very confident (254)** also reflects considerable uncertainty in detecting such content.
- **Somewhat confident (97)** shows limited self-assurance among a small group of respondents.
- **Highly confident (49)** is the least selected option, suggesting very few respondents feel fully capable of identifying manipulated content.
- Overall, the findings reveal a **significant lack of digital media literacy and confidence in recognising fake or manipulated online information.**

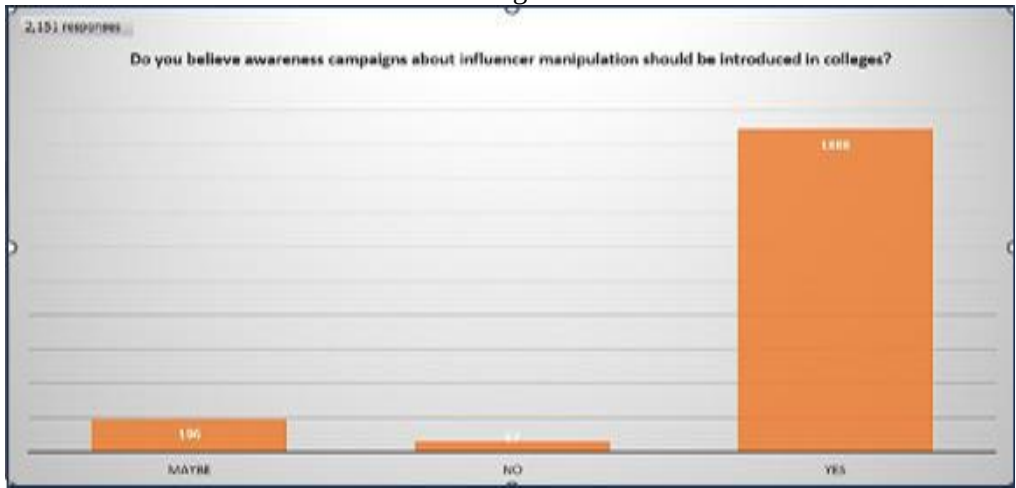
Graph 14: Would you support stricter regulations for influencer promotions and advertisements?



Source: Primary Data Analysis:

- Yes (1754) is the most selected response, indicating strong support for stricter regulations on influencer promotions and advertisements.
- Maybe (287) shows that some respondents are undecided but open to the idea of regulation.
- No (110) is the least selected option, suggesting minimal opposition to stricter rules.
- Overall, the findings demonstrate overwhelming public support for stronger regulatory frameworks to ensure ethical and transparent influencer marketing.

Graph 15: Do you believe awareness campaigns about influencer manipulation should be introduced in colleges?



Source: Primary Data Analysis:

- The majority of respondents (993) think that colleges should launch awareness campaigns about influencer manipulation.
- 536 said maybe.
- Just 33 people disagree with the concept.

Statistical Analysis and Hypothesis Testing

Hypothesis 1: Influencer Viewing Frequency and Perceived Authenticity

Hypotheses

- H₀:** There is no significant association between the frequency of watching social media influencers and viewers’ perception of authenticity.
- H₁:** There is a significant association between the frequency of watching social media influencers and viewers’ perception of authenticity.

Chi-Square Test (SPSS Style Output)

Test	Value	df	Asymp. Sig. (p)
Pearson Chi-Square	64.18	12	0.000
Likelihood Ratio	66.03	12	0.000
N of Valid Cases	2151		

Interpretation

The Chi-square value ($\chi^2 = 64.18$, $df = 12$, $p < 0.05$) indicates a **statistically significant association** between the frequency of watching social media influencers and viewers’ perception of authenticity. Respondents who watch influencer content **daily or several times a week** are more likely to perceive influencers as authentic than those who watch influencer content occasionally or rarely. Therefore, the **null hypothesis is rejected**, supporting the argument that increased exposure strengthens perceived credibility.

Hypothesis 2: Influencer Exposure and Psychological Impact

Hypotheses

- H₀:** There is no significant association between exposure to influencer-driven content and psychological impact on young audiences.
- H₁:** There is a significant association between exposure to influencer-driven content and psychological impact on young audiences.

Chi-Square Test (SPSS Style Output)

Test	Value	df	Asymp. Sig. (p)
Pearson Chi-Square	82.47	12	0.000
Likelihood Ratio	84.15	12	0.000
N of Valid Cases	2151		

Interpretation

The results reveal a **significant relationship between exposure to influencer content and psychological impact** ($\chi^2 = 82.47$, $df = 12$, $p < 0.001$). Respondents who engage with influencer content **daily or several times per week report higher psychological impact, including influence on self-image and perceptions of lifestyle**. Conversely, individuals with lower exposure demonstrate relatively lower psychological influence. Hence, the **null hypothesis is rejected**, indicating that frequent interaction with influencer content significantly affects audience psychology.

CONCLUSION

- The study demonstrates how deeply ingrained influencer culture is in young people's behaviour by revealing that a significant percentage of respondents are influenced by social media influencers when making purchasing decisions.
- The results show that curated content, sponsored posts, and idealised lifestyles greatly influence consumer attitudes, frequently causing young users to experience emotional pressure and unrealistic expectations.
- Respondents voiced serious concerns about unreported sponsorships, misleading promotions, inflated claims, and altered images—highlighting a glaring lack of transparency in influencer marketing.
- Many participants also reported feeling misled or pressured by influencer-driven trends, emphasising the need for stronger ethical standards, clearer disclosure practices, and stricter monitoring by digital platforms.
- The study underscores the importance of digital literacy, responsible influencer behaviour, and more robust regulatory frameworks in India to ensure honest, safe, and trustworthy digital environments for consumers.
- Understanding this association can help marketers, influencers, and researchers in designing campaigns and content that maintain perceived authenticity. It also highlights the importance of frequency and engagement patterns in shaping audience trust.
- The Chi-square test confirmed that exposure to influencer-driven content is significantly associated with psychological or mental health effects among young audiences. Frequent exposure tends to have a greater psychological impact, highlighting the need for awareness programs and responsible influencer content.

FUTURE SCOPE

Future research should focus on promoting ethical influencer marketing, improving transparency in sponsored content, and strengthening digital literacy among young users. A safer and more reliable online environment can be achieved by enacting stronger laws, improved monitoring systems, and more transparent disclosure policies. Continued studies can further protect consumers and encourage responsible influencer behaviour.

SUGGESTIONS

- **Strict Disclosure Rules:** Influencers should clearly label all sponsored posts, paid partnerships, and gifted products to avoid misleading audiences.
- **Transparent Marketing Practices:** Brands must ensure influencers follow ethical guidelines and maintain honesty in promotions.
- **Digital Literacy Programs:** Schools, universities, and online platforms should teach young people how to spot hidden ads, filters, and manipulated content.
- **Stronger Regulations:** Government bodies should introduce and enforce stricter laws for influencer advertising, similar to traditional media guidelines.
- **Platform Monitoring:** Social media sites need to do a better job of identifying misleading advertisements, phoney interactions, and altered images.
- **Ethical Training for Influencers:** Influencers can learn responsible content creation through workshops and certifications.

- **Mental Health Support:** Provide influencers with resources to manage stress, burnout, and the pressures of maintaining online visibility.
- **Promote Authentic Content:** Genuine, unedited, and transparent content should be rewarded by brands and platforms instead of posts that strive for perfection.
- **Report Mechanisms:** Allow users to report misleading posts, undisclosed ads, or harmful trends, and ensure quick action.
- **Promote Realistic Standards:** Encourage influencers to share balanced, real-life experiences to reduce unrealistic expectations among youth.
- By implementing robust ethical strategies and utilising cutting-edge tools to identify deceptive influencer content. These steps improve influencer marketing transparency and shield consumers from misleading promotions. Ultimately, such efforts build greater trust and accountability within the online ecosystem.

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INTEGRATING INDIAN KNOWLEDGE SYSTEMS (IKS) INTO CONTEMPORARY PUBLIC POLICY FRAMEWORKS

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ABSTRACT

As nations deal with complex global challenges ranging from climate change and mental health crises to sustainable agriculture there is a growing recognition of the limitations of purely technocratic, Eurocentric policy frameworks. This paper explores the integration of Indian Knowledge Systems (IKS) into contemporary public policy. IKS encompasses a holistic corpus of knowledge arising from the Indian subcontinent, covering fields such as Ayurveda, Vastu, Arthashastra, mathematics, and philosophy. This research investigates how these ancient systems can be recontextualized to draft policies that are culturally rooted yet globally relevant. The paper analyses current policy shifts, specifically the National Education Policy (NEP) 2020 and the rise of the AYUSH sector, to understand the practical applications of IKS. It concludes that while IKS offers sustainable, low-cost, and human-centric solutions, its integration into public policy faces significant challenges regarding standardization, scientific validation, and ideological resistance.

Keywords: Indian Knowledge Systems (IKS), Public Policy, Sustainable Development, NEP 2020, AYUSH, Decolonization, Governance, Arthashastra, Indigenous Knowledge.

INTRODUCTION

Public policy in the post-colonial world has largely been dominated by Western epistemologies. Governance models, economic theories, and educational curricula in countries like India were structured around frameworks inherited from colonial rule, often dismissing indigenous wisdom as archaic or unscientific. However, the 21st century has ushered in a paradigm shift. The fragility of modern systems—highlighted by ecological collapse and lifestyle diseases—has necessitated a "return to roots" approach, not as a regression, but as a retrieval of tested sustainable practices.

Indian Knowledge Systems (IKS) refer to the structured systems of knowledge developed in the Indian subcontinent over millennia. This includes tangible sciences like metallurgy and medicine (Ayurveda), as well as intangible frameworks like ethics (Dharma), statecraft (Arthashastra), and linguistics (Vyakarana).

The introduction of IKS into public policy is not merely an act of cultural preservation; it is a strategic policy intervention. For instance, managing water resources using ancient stepwell technology (Baolis) offers a decentralized solution to modern water scarcity. Similarly, integrating Ayurveda into public health policy provides a preventative healthcare model that complements modern reactive medicine. This paper argues that mainstreaming IKS into public policy creates a "civilizational state" model of governance that is responsive to local realities while contributing to global sustainability goals.

OBJECTIVES**1. Defining and Contextualizing IKS**

- **Scope:** Define IKS as a multi-disciplinary system encompassing *Jnana* (knowledge), *Vijnana* (science), and *Jivan-Drishti* (worldview).
- **The "Whole-of-Life" Approach:** Unlike Western compartmentalization, IKS views governance, ecology, and individual well-being as interconnected.
- **Epistemological Grounding:** Briefly introduce concepts like *Pratyaksha* (perception), *Anumana* (inference), and *Sabda* (reliable testimony) as the "scientific method" of IKS.

2. Analysing Current Policy Frameworks

This objective focuses on "Policy Mapping." You are looking for the intersection of traditional wisdom and modern legislative language.

- **NEP 2020 as a Catalyst:** Analyse how the policy shifts the education focus from "What to Think" to "How to Think" by introducing Indian logic (*Tarka*) and linguistics (*Linguistics*).
- **The "Ayush-Grid":** Evaluate the digitizing of traditional medical records and the integration of Ayurveda into the National Health Mission.

- **Environmental Governance:** Look at the Mission Life (Lifestyle for Environment) initiative. It's a prime example of a global policy rooted in the IKS principle of *Maitri* (friendship with all elements of nature).

3. Assessing Impacts and Externalities

- **Impact Metrics:** How do we measure the success of IKS? Suggest metrics like the Gross Environmental Product (GEP) or "Community Resilience Scores" rather than just GDP.
- **The "Pseudoscience" Challenge:** Address the risk of *Anachronism*—the tendency to claim modern inventions (like the internet) existed in ancient times. Your paper should advocate for Scientific Temper within IKS integration.
- **Intellectual Property (IPR):** Discuss the Traditional Knowledge Digital Library (TKDL) and the fight against "bio-piracy" (e.g., the patenting of Turmeric or Neem).

4. Future Goals: Globalization and Standardization

The final objective is to move from "Indian" knowledge to "Global" knowledge.

- **Standardization (The "ISO" of IKS):** Propose the creation of standardized protocols for IKS-based products and services to ensure quality control in global markets.
- **Glocalization:** How can IKS principles be adapted for other cultures? For example, applying Indian water-management techniques to drought-prone regions in Africa.
- **Digital Integration:** Utilizing AI and Big Data to analyse ancient texts (like the *Artha Shastra*) to find patterns for modern economic crisis management.

IKS and Public Policy Framework

The core of this research explores how IKS transforms the "Public Policy Framework." A standard policy framework involves problem identification, policy formulation, implementation, and evaluation. Integrating IKS alters this cycle by introducing a new epistemological lens.

a) The Philosophical Shift: From Utilitarianism to Dharma

Modern policy is often utilitarian—aiming for the "greatest good for the greatest number" often measured in economic terms (GDP). IKS introduces the concept of Dharma (duty/righteousness) and Antyodaya (upliftment of the last person). An IKS-based policy framework prioritizes *Sarvodaya* (welfare of all), expanding the stakeholder list to include the environment and future generations, not just current voters or shareholders.

b) Education Policy: The NEP 2020 Paradigm

The most visible integration of IKS is in the National Education Policy (NEP) 2020.

- **Curriculum Redesign:** The policy mandates the inclusion of tribal knowledge, indigenous mathematics, and classical literature, moving away from a purely Eurocentric history.
- **Pedagogy:** It emphasizes *Pancha Kosha* development (holistic development of body, mind, intellect, energy, and bliss) rather than just cognitive data retention.
- **Language:** Recognizing the cognitive benefits of mother-tongue instruction, a core tenet of IKS transmission.

c) Health Policy: Integrative Healthcare

The creation of the Ministry of AYUSH (Ayurveda, Yoga and Naturopathy, Unani, Siddha, and Homoeopathy) marks a structural shift in health policy.

- **Preventative vs. Curative:** Modern policy funds disease treatment. IKS policy funds wellness. The framework creates "Wellness Centres" aiming to reduce the burden on hospitals.
- **Public Policy Response to Pandemics:** During COVID-19, the government issued guidelines based on IKS for immunity boosting, showcasing a hybrid policy framework where modern vaccines and traditional prophylaxis co-existed.

d) Agricultural and Environmental Policy

- **Vrikshayurveda (Plant Science):** Modern agriculture policy pushed chemical fertilizers (Green Revolution). The IKS framework advocates for *Zero Budget Natural Farming (ZBNF)* and organic practices found in ancient texts.

- **Water Management:** Policies are shifting toward reviving traditional water bodies (Kalyanis, Kunds) rather than relying solely on large dams and pipes. This respects the local ecology and hydrology.

e) Governance and Statecraft (Arthashastra)

Kautilya's *Arthashastra* offers a robust framework for public finance, foreign policy, and disaster management.

- **Rajamandala Theory:** Used in analyzing foreign relations and geopolitical balances in the South Asian region.
- **Welfare State:** The concept that "In the happiness of the subjects lies the happiness of the King" serves as a guiding metric for administrative accountability, moving beyond bureaucratic rigidity to citizen-centric governance.

Positive Impacts

1. Environmental Sustainability & Ethics

Traditional Indian philosophy views nature as an extension of the self rather than a resource to be exploited.

- **Regenerative Practices:** Policies incorporating IKS promote "Panchamahabhuta" (the five elements) balance, leading to better water management and organic farming initiatives like ZBNF (Zero Budget Natural Farming).
- **Climate Resilience:** Ancient architectural principles (Vastu Shastra) and water harvesting techniques (like Step wells or *Baolis*) offer low-energy solutions for urban cooling and water scarcity.

2. Holistic Healthcare & Wellness

Public policy is increasingly moving toward an "Integrative Medicine" model.

- **Preventative Care:** The inclusion of Ayurveda and Yoga in public health missions (like AYUSH) focuses on lifestyle and prevention, potentially reducing the long-term burden on the tertiary healthcare system.
- **Mental Health:** IKS-rooted practices such as mindfulness and meditation are being framed as low-cost, high-impact tools for public mental health policy.

3. Education & Pedagogy (NEP 2020)

The National Education Policy (NEP) 2020 is perhaps the most significant policy shift driven by IKS.

- **Multidisciplinary Learning:** Moving away from rigid silos (Arts vs. Science) mimics the ancient *Gurukul* system where knowledge was seen as a seamless whole.
- **Linguistic Pride:** Promoting mother-tongue instruction in early years improves cognitive development and ensures that rural populations aren't marginalized by language barriers.

4. Sustainable Economics (Dharmic Capitalism)

IKS-driven policy emphasizes *Loka Samasta Sukhino Bhavantu* (the well-being of all).

- **Circular Economy:** Traditional practices of "reduce, reuse, and recycle" are deeply embedded in Indian households. Policy frameworks are now formalizing these into "Circular Economy" roadmaps.
- **Ethical Governance:** Concepts of *Dharma* (duty/righteousness) in administration encourage transparency and a service-oriented mind-set among civil servants.

Negative Impacts and Challenges

Integrating the Indian Knowledge System (IKS) into modern public policy is a complex endeavour. While it aims to reclaim cultural heritage and provide sustainable, indigenous solutions to modern problems, it faces significant structural, ideological, and practical hurdles. The challenges can be categorized into structural/operational barriers and ideological/systemic risks.

1. Structural and Operational Challenges

These represent the "how-to" problems—the logistical difficulties in moving ancient or oral knowledge into a modern, bureaucratic policy framework.

- **Oral Tradition vs. Documentation:** Much of IKS (especially in tribal or rural sectors) has been transmitted orally. This lack of standardized, written records makes it difficult to create consistent policy guidelines or academic curricula.
- **Scientific Validation and "Data-fiction":** There is a persistent "epistemic gap" between IKS and modern science. Policy often demands empirical, replicable data. When IKS is forced to fit these modern metrics, it

can lead to "data-fiction"—where the deeper context and spiritual or social significance of a practice are lost in favour of isolated "data points."

- **Capacity and Training Gaps:** There is a severe shortage of experts who are equally well-versed in both traditional knowledge and modern policy/governance. Current administrators and educators often lack the training to implement these systems effectively.
- **Language Barriers:** Authentic IKS texts are often in Sanskrit, Pali, or regional dialects. Translating these into a language compatible with modern administrative "policy-speak" without losing nuance is a massive undertaking.

2. Negative Impacts and Systemic Risks

These involve the potential "side effects" or deeper societal concerns regarding how IKS is integrated.

Intellectual Property and Bio piracy

Traditional knowledge is often held collectively by a community over generations. Modern Intellectual Property (IP) laws are designed for individual or corporate ownership and are time-bound.

- **The Risk:** Without "sui generis" (unique) legal frameworks, integrating IKS into policy can lead to bio piracy, where private entities patent community knowledge (e.g., the historical attempts to patent Turmeric or Neem) without equitable benefit-sharing.

Risk of "Tokenism" and Ideological Bias

Critics argue that if not handled with care, IKS integration can become a tool for ideological indoctrination rather than genuine knowledge expansion.

- **The Risk:** A focus on a single, privileged mode of knowing (e.g., purely Sanskrit or Vedic traditions) may systematically marginalize other heterodox traditions like Buddhist, Jain, or Charka schools, as well as the significant contributions of Muslim scholars to India's scientific history.

Erosion of "Scientific Temper"

Public policy in India is constitutionally mandated to develop a "scientific temper."

- **The Risk:** If IKS is integrated uncritically—accepting traditional claims without rigorous scrutiny or debate—it risks creating an "epistemic crisis" where faith-based or anecdotal claims replace evidence-based policy, potentially hindering innovation.

Marginalization of Living Indigenous Groups

Ironically, the push for IKS can sometimes prioritize "ancient texts" over the "living knowledge" of modern tribal (Adivasi) and Dalit communities.

- **The Risk:** Policy might favour classical Sanskrit-based systems while ignoring the practical, ecological wisdom of tribal groups, further excluding those who have been the primary custodians of India's biodiversity.

FUTURE GOALS

To ensure the successful integration of IKS into public policy, the following goals must be set for the next decade:

1. **Codification and Digitization:** All scattered manuscripts and oral traditions must be digitized (e.g., Traditional Knowledge Digital Library - TKDL) to prevent bio-piracy and enable research.
2. **Evidence-Based Policy Making:** Establishing dedicated research institutes that subject IKS claims to modern scientific double-blind testing. Policy should only adopt what passes this rigor.
3. **AI and IKS Integration:** Using Artificial Intelligence to decipher ancient scripts and pattern-match historical weather/agricultural data with modern climate models.
4. **Global Certification Standards:** India must lead the creation of ISO-style standards for Yoga, Ayurveda, and Vastu to ensure these services are exportable and trusted globally.
5. **Interdisciplinary Education:** Creating a new cadre of "Policy Engineers" who are fluent in both modern law/economics and Sanskrit/IKS, bridging the gap between the two worlds.

CONCLUSION

The integration of Indian Knowledge Systems into public policy frameworks represents a vital corrective step in the history of governance. It challenges the hegemony of Western universalism, proposing instead a pluralistic world where ancient wisdom informs modern innovation.

The research indicates that while the intent behind policies like NEP 2020 is transformative, the success lies in the execution. The framework must evolve from "revivalism" (blindly adopting the past) to "renaissance" (adapting the past for the future). If India can successfully navigate the challenges of standardization and scientific validation, the IKS public policy framework can serve as a model for the Global South—demonstrating how to modernize without westernizing, and how to progress without destroying the planet.

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A STUDY OF CORRELATION BETWEEN METACOGNITIVE COMPETENCIES AND ATTITUDE TOWARDS SCIENCE AMONG SECONDARY SCHOOL STUDENTS

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ABSTRACT:

The paper aims to find correlations between metacognitive competencies and attitude towards among Secondary School Students in Mumbai. This study was conducted at a Secondary School offering the State Board syllabus in Mumbai. The researcher used the Metacognitive Awareness Inventory (Schraw, G., & Dennison, R.S. (1994) to measure metacognitive competencies. The researcher developed a self-rating, 4-point Likert scale to measure attitude towards Science. The results show that secondary school students are substantially high on metacognitive competencies and have a substantially significant positive attitude towards Science. There is a moderate positive linear relationship between metacognitive competencies and attitude towards Science of secondary school students. A Pearson correlation coefficient r of 0.468 indicates a moderate positive linear relationship between metacognitive competencies and attitude towards Science competencies among secondary students. Since the p -value < 0.05 , the correlation is statistically significant. The results show that the students with higher metacognitive competencies demonstrate a positive attitude towards Science.

Keywords: Metacognitive Competencies, Metacognitive Awareness Scale, Attitude Towards Science, Secondary School Students.

INTRODUCTION

The relationship between metacognition and science is immense. Metacognitive competencies provide the ways of learning, and a positive attitude towards Science increases curiosity and motivation to learn science and solve scientific problems. Learning depends upon an individual's desire to acquire knowledge and develop new perspectives. This desire stems from a very complex concept, namely attitude. Gordon Allport, defined attitude as "a mental and neural state of readiness, organised through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related." (Fazio R. 2009).

A combination of high metacognitive competencies and a positive attitude towards Science can contribute immensely to students' success in Science and Technology. Fostering metacognitive competencies while learning Science will make students lifelong learners capable of dealing with modern challenges. This study focuses on the correlation between metacognitive competencies and Attitude towards Science among Secondary School Students.

CONCEPTUAL FRAMEWORK**Metacognitive Competencies**

Flavell (1979) defined metacognition as "knowledge that takes as its object or regulates any aspect of any cognitive endeavor" (p.906). The prefix 'meta' means 'about' the thing itself. Metacognition is "thinking about thinking." Or "learning about learning" (Cambridge Assessment International Education, 2019). This refers to the "self-regulation" that effective learners exhibit, meaning they are aware of their learning process and can measure how efficiently they are learning as they study (Jaleel S & Premachandran. P 2016). The prefix 'meta' means 'about' the thing itself. So, metacognition is 'cognition about cognition', or 'thinking about one's thinking'. (Cambridge Assessment International Education, 2019).

Metacognition competencies have two dimensions: self-knowledge and self-regulation. (Cambridge Assessment International Education, 2019).

Self-Knowledge: Students who are metacognitively aware demonstrate self-knowledge. Students' thinking about the specific subject content. For example, I can easily remember tables; however I have trouble remembering capitals. Students know what strategies and conditions to use to facilitate learning.

Self-Regulation: refers to students' knowledge about the implementation of strategies and the ability to monitor the effectiveness of their strategies. For example- student knows to learn chemical equations, it is better to write and practice. For example use of mnemonics to remember to recall certain concepts.

Attitude Towards Science

Attitude towards Science is an outcome of teaching and learning of Science. Attitude towards Science is a virtue that is reflected in a person's behaviour and actions towards Science. Attitude toward Science includes the "feelings, beliefs, and values held about an object that may be the enterprise of Science, school Science, and the impact of Science on society or scientists themselves" (Osborne et al., 2003, p.1053). Attitude is the response of students towards learning Science, that is, having a favourable or non-favourable attitude towards Science and scientists, interest or disinterest in Science activities, desire or desire to pursue Science for higher studies or in a career, and having enjoyment/boredom in Science learning experiences.

Review of Related Literature

1. Mellona J. and Angeles, H (2025) in their study on "Exploring The Relationship Between Attitudes Toward Science And Basic Process Skills Among Grade 12 STEM Students" employed a descriptive-correlational research design and gathered data from 76 Grade 12 STEM students through survey questionnaires. Their study revealed that students had very good attitudes toward Science due to Science confidence, enjoyment and utility. The inferential statistics revealed a highly significant positive relationship between Grade 12 STEM students' attitudes toward Science and basic process skills.

2. Willison J., Draper C., Fornarino L., Li M., Sabri T., Shi Y., & Zhao X. (2024) in their study on "Metacognitively ALERT in science: literature synthesis of a hierarchical framework for metacognition and preliminary evidence of its viability" emphasized that the development of student metacognition has the potential to provide some of the greatest learning gains in science education, even outstripping the contribution of general intelligence. They presented an integrative literature review of metacognition studies that draws together metacognitive knowledge and metacognitive skills into a hierarchical framework. As a preliminary test of its viability, the AMERT framework analysed interview data in which there was evidence of rich metacognitive thinking by students in the fourth, research-focused, year of a science degree.

3. Araes S., Apad P. et al. (2024) studied "Process Skills And Attitude Towards Science As The Contributing Factors In Cognitive Performance Among Special Science Class Students: A Quantitative Study" among Special Science Class students in High School, Philippines. There was a significant relationship and high correlation between process skills and cognitive performance, and a significant relationship for attitudes towards Science and cognitive performance. The overall level of process skills and attitude towards Science are contributing factors to cognitive performance among Special Science Class students was high.

4. Rivas S., Saiz C., & Ossa C. (2022), in their study on "Metacognitive strategies and development of critical thinking in higher education." Presented an intervention proposal to develop critical thinking and meta knowledge skills of showing whether instruction in critical thinking (ARDESOS-DIAPROVE) influences students' metacognitive processes. This study shows critical thinking increases with metacognitive processes.

5. A study by Tai R., Ryoo J. et al. (2022) titled "(Re-)Designing A Measure Of Student's Attitudes Toward Science: A Longitudinal Psychometric Approach," used a sample of 2016 self-reported responses from 6 and 7th grade students. This study of student's attitude towards Science potentially inform STEM education equity efforts on how instructional strategies and environments may differentially impact Science attitudes of subgroups of students.

6. Biscocho S. (2021) in the study "Metacognitive Knowledge, Skills And Attitude Of Science Technology And Society Students Across Programs", showed significant difference among the scores of students' metacognition according to course or programs. Metacognition was rated the highest among communication students (4.46) and lowest among management students (4.16). The overall mean metacognition (4.35) and the standard deviation (0.439) correspond that first-year students have metacognition. Furthermore, first-year students agree that they have metacognitive knowledge of (4.20), metacognitive skills of (4.07) and metacognitive attitudes of (4.03) in the course STS regardless of their programs.

Research Gap

This study aims to determine whether learning about learning and having self-regulation to use the learning strategies that work best and maximise success in Science fosters a positive attitude towards Science. There are various models and frameworks involving increased metacognitive competencies while learning Science. It is found to have a positive and moderate association between attitude toward Science and achievement in Science; however, if this is related to metacognitive competencies. This study aims to address a significant research gap by examining the attitude towards Science and metacognitive competencies among secondary school students in Mumbai. While past studies have explored these factors individually or in different contexts, no comprehensive research has investigated their relationship within this specific area. By including a specific sample of

secondary school students, this study seeks to provide valuable insights into metacognitive competencies that correlate with attitude towards Science.

OBJECTIVES OF THE STUDY

The following were the objectives of the study;

1. To find out the metacognitive competencies of secondary school students.
2. To find out the attitude of secondary school students regarding Science.
3. To find out the relationship between the metacognitive competencies of secondary school students and their attitude towards Science.

Null Hypotheses

1. Metacognitive competencies of secondary school students are not significantly high.
2. There is no significant positive attitude among the secondary school students towards Science
3. There is no correlation between the metacognitive competencies of secondary school students and their attitude towards Science.

Research Methodology

The Descriptive Survey Method was used for the study. The subjects of the study were Grade IX students in a State Board School, Mumbai district, Maharashtra state, India.

Sample

A sample of 55 students from a State Board School in Mumbai District was selected by the purposive sampling method. The sample consisted of male and female Grade IX students.

Research Tools

The researcher used the Metacognitive Awareness Inventory (Schraw, G., & Dennison, R.S. (1994) to measure metacognitive competencies.

Tools were developed by the investigator to study the major objectives. The tools were validated for specificity and objectivity. The Likert scale used in the tools was 4-point where strongly agree (SA), agree (A), disagree (D), and strongly disagree (SD). Each positive item on the instrument has values: SA = 4, A = 3, D = 2, and SD = 1. The score is reversed for negative items. The reliability coefficient was calculated for each of the tools and is as shown in Table 1.

Table 1: Reliability of the developed tools

Tools	Cronbach's alpha
4-point Likert Scale for Attitude Towards Science among secondary School students.	0.783

Analysis and Interpretation of Data

Descriptive Analysis for the scores of metacognitive competencies of Secondary school students and attitude towards Science.

Table 2: Descriptive statistics for the scores on metacognitive competencies and attitude towards Science.

	Sample Size (N)	Mean Score	Standard deviation	Skewness	Kurtosis
Metacognitive competencies	55	38.69	10.75	-0.11	-1.62
Attitude towards Science	55	75.73	12.95	0.12	-0.57

DISCUSSION

1. The mean score of metacognitive competencies was 38.69 with a standard deviation of 10.75. The negative skewness shows the distribution is left-skewed. Since the skewness value is 0.11, which is between -0.5 and 0.5, it is considered moderately skewed. The kurtosis value of 0.51, data is slightly leptokurtic. However since value is close to zero, data is considered normally distributed.
2. The mean score of attitude towards Science is 75.73 with a standard deviation of 112.95. The positive skewness shows the distribution is right-skewed. Since the skewness value is -0.57. However since value is close to zero, data is considered normally distributed.

Inferential Analysis

Testing Hypothesis 1: Metacognitive competencies of secondary school students are not significantly high.

Calculation of the percentage mean score of metacognitive competencies among the Grade IX students

$$\text{Percentage mean score} = \frac{(\text{Mean Score} - \text{Lowest Possible Score})}{(\text{Highest Possible Score} - \text{Lowest Possible Score})} \times 100$$

Table 3: Calculation of the percentage mean score of metacognitive competencies

Mean Score	38.69
Highest Possible Score	52
Lowest Possible Score	0
Percentage Mean score	74.41

Table 4: Interpretation of percentage Mean Score

Percentage Mean	Magnitude
0-20	Negligible
21-40	Low
41-60	Moderate
61-80	Substantial
81-100	Very High

The percentage mean score is substantial. The percentage mean score of metacognitive competencies among the grade IX students is found to be substantial. So the null hypothesis, “There is no significant positive opinion among the secondary school students regarding multidisciplinary approach”, is rejected.

Inference: Secondary School students are substantially high on metacognitive competencies.

Testing Hypothesis 2: There is no significant positive attitude among the secondary school students towards Science.

Calculation of the percentage mean score of attitude towards Science among the Grade IX students

$$\text{Percentage mean score} = \frac{(\text{Mean Score} - \text{Lowest Possible Score})}{(\text{Highest Possible Score} - \text{Lowest Possible Score})} \times 100$$

Table 5: Calculation of the percentage mean score of attitude towards Science

Mean Score	75.73
Highest Possible Score	108
Lowest Possible Score	27
Percentage Mean score	60.16

The percentage mean score is 60.16. The percentage mean score of attitude towards Science among the grade IX students is found to be substantial. So the null hypothesis, “ Social competencies of the secondary school students are not significantly high”, is rejected.

Inference: Secondary School students have a substantially significant positive attitude towards Science.

Testing Hypothesis 3: There is no correlation between the metacognitive competencies of secondary school students and their attitude towards Science.

Table 6: Pearson’s Correlation between metacognitive competencies and attitude towards Science.

	Mean	Percentage mean score	r	t	P value		Remark
Metacognitive Competencies	38.69	74.41	0.468	3.86	One-tailed	0.0001	Moderate positive linear relationship
Attitude Towards Science	75.73	60.16			Two-tailed	0.0003	

From the table 6, it is observed that the mean scores for metacognitive competencies and attitude towards Science are 38.69 and 75.73. The calculated t-value is 3.86, which is more t than the table value of 2.01 at the 0.05 level of significance. This shows that there is significant relationship between metacognitive competencies and attitude towards Science of secondary school students. So the null hypothesis, “There is no

correlation between the metacognitive competencies of secondary school students and their attitude towards Science.” is rejected. A Pearson correlation coefficient r of 0.468 indicates a moderate positive relationship between metacognitive competencies and attitude towards Science among secondary students. Since one-tailed p -value is 0.0001 and two-tailed p -value is 0.0003 both p -values are less than 0.05, the correlation is statistically significant. The result shows that students who have high metacognitive competencies will demonstrate a positive attitude towards Science among secondary school students in Mumbai.

Inference: There is a moderate positive linear relationship between metacognitive competencies and attitude towards Science of secondary school students.

FINDINGS

The findings of the study are as follows;

- 1 Secondary School students are substantially high on metacognitive competencies.
- 2 Secondary School students have a substantially significant positive attitude towards Science.
- 3 There is a moderate positive linear relationship between metacognitive competencies and attitude towards Science of secondary school students.

CONCLUSION

Conclusions were drawn based on the results of the study. The findings of the study imply that students are substantially high on metacognitive competencies. That means they know what strategies and conditions work best for them while they are learning. Secondary School students have a substantially significant positive attitude towards Science. The findings of the study imply that students with higher metacognitive competencies demonstrate a positive attitude towards Science.

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MULTIMODAL GENERATIVE AI IN DIAGNOSTICS: ADVANCING INTELLIGENT CLINICAL REPORT GENERATION AND DECISION SUPPORT

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Mumbai , Maharashtra- 400076, India**ABSTRACT**

Diagnostic medicine relies on integrating heterogeneous clinical information—including medical imaging, laboratory data, patient history, and physician observations—to produce accurate and actionable reports. The increasing complexity and volume of diagnostic data have significantly elevated clinician workload, contributing to delays, variability, and burnout. Recent advances in multimodal generative artificial intelligence (AI) introduce a paradigm shift by enabling systems that not only detect abnormalities but also generate structured, clinically meaningful narrative reports. This paper provides a comprehensive examination of multimodal generative AI in diagnostics, including its architectural foundations, methodological framework, validation strategies, clinical applications, ethical implications, and deployment challenges. We analyze the integration of vision transformers, large language models, multimodal fusion mechanisms, and retrieval-augmented learning to support report generation across radiology, pathology, dermatology, and ophthalmology. Despite promising performance nearing expert-level drafting capabilities, challenges persist in factual reliability, hallucination mitigation, uncertainty quantification, bias correction, and regulatory compliance. We propose a clinician-centered, human-in-the-loop deployment paradigm emphasizing transparency, safety, and collaborative intelligence. Multimodal generative AI holds transformative potential to improve quality of care, enhance workflow efficiency, and expand access to diagnostic expertise when implemented responsibly and rigorously validated.

1. INTRODUCTION

Diagnostic medicine forms the backbone of modern healthcare. Clinical decisions often depend on interpretation of imaging modalities (X-ray, CT, MRI), pathology slides, laboratory reports, and patient history. Producing comprehensive diagnostic reports requires expert reasoning, domain knowledge, and contextual awareness.

However, healthcare systems globally face:

- Increasing imaging volumes
- Shortage of diagnostic specialists
- Documentation burdens
- Rising complexity of multimodal patient data

Artificial intelligence has demonstrated high performance in image classification, lesion detection, and segmentation tasks. Yet traditional AI systems remain largely discriminative—predicting labels rather than generating structured reasoning narratives.

Multimodal generative AI extends beyond detection to produce clinically coherent textual outputs by integrating multiple data modalities. This shift enables AI systems to function not merely as diagnostic classifiers but as report-generating assistants.

This paper explores the scientific foundations, methodological framework, evaluation paradigms, clinical applications, and governance considerations of multimodal generative AI in diagnostics.

2. BACKGROUND AND LITERATURE REVIEW**2.1 Evolution of AI in Medical Diagnostics**

The application of AI in diagnostics has evolved through several phases:

1. Rule-Based Systems and Expert Systems (1980s–2000s)

Early systems relied on predefined clinical rules and symbolic reasoning but lacked scalability and adaptability.

2. Deep Learning for Image Classification (2012–2018)

Convolutional neural networks (CNNs) achieved radiologist-level performance in specific tasks such as pneumonia detection and skin cancer classification. However, these systems were predominantly unimodal and task-specific.

3. Vision-Language Models and Generative Systems (2019–Present)

The emergence of transformer architectures enabled cross-modal learning, allowing AI systems to jointly model images and text. This advancement laid the foundation for automated report generation and multimodal reasoning.

While discriminative models demonstrated strong performance in abnormality detection, they lacked contextual integration with patient-specific data. Generative multimodal models address this limitation by producing structured diagnostic narratives.

2.2 Emergence of Generative Diagnostic Systems

Generative systems differ from classification systems by:

- Producing structured narrative reports
- Incorporating contextual reasoning
- Modeling uncertainty
- Generating recommendations

This evolution parallels advances in multimodal foundation models trained on large-scale image-text pairs.

3. CONCEPTUAL FRAMEWORK OF MULTIMODAL GENERATIVE AI

Multimodal generative AI in diagnostics consists of four foundational components:

1. Visual Representation Learning
2. Clinical Context Encoding
3. Cross-Modal Alignment
4. Textual Report Generation

The system processes diverse inputs and produces structured outputs such as:

- Findings
- Impressions
- Differential diagnoses
- Recommendations

The paradigm aims to approximate clinician-style narrative synthesis rather than simple abnormality detection.

4. SYSTEM ARCHITECTURE

4.1 Visual Encoder

Medical images are processed using:

- Convolutional Neural Networks (CNNs)
- Vision Transformers (ViTs)
- Hybrid CNN–Transformer architectures

The encoder outputs high-dimensional embeddings:

$$Z_v = f_v(X_{\text{image}}) \quad Z_v = f_v(X_{\text{image}})$$

where Z_v represents visual feature embeddings.

4.2 Structured Clinical Data Encoder

Laboratory values and metadata are embedded using feedforward networks:

$$Z_c = f_c(X_{\text{clinical}}) \quad Z_c = f_c(X_{\text{clinical}})$$

These embeddings provide contextual grounding.

4.3 Cross-Modal Fusion

Fusion is achieved via attention mechanisms:

$$Z_f = \text{Attention}(Z_v, Z_c) \quad Z_f = \text{Attention}(Z_v, Z_c)$$

This alignment enables the system to associate image findings with clinical variables.

4.4 Language Decoder

A transformer-based decoder generates reports autoregressively:

$$P(Y|Z_f) = \prod_{t=1}^T P(y_t | y_{<t}, Z_f) \quad P(Y|Z_f) = \prod_{t=1}^T P(y_t | y_{<t}, Z_f)$$

where Y represents the generated report.

4.5 Retrieval-Augmented Generation (Optional)

To reduce hallucination:

$$Z_r = \text{Retrieval}(\text{Query}) \quad Z_r = \text{Retrieval}(\text{Query})$$

Retrieved prior cases are fused with embeddings before decoding.

5. METHODOLOGY

5.1 Dataset Preparation

- Multi-institutional chest X-ray datasets
- Paired image-report corpora
- De-identification and normalization
- Text segmentation into structured sections

5.2 Training Strategy

Phase 1: Self-Supervised Pretraining

- **Contrastive image-text alignment**

$$L_{\text{contrastive}} = -\log \frac{\exp(\text{sim}(Z_v, Z_t)/\tau)}{\sum \exp(\text{sim}(Z_v, Z_{t'})/\tau)} \quad L_{\text{contrastive}} = -\log \frac{\exp(\text{sim}(Z_v, Z_t)/\tau)}{\sum \exp(\text{sim}(Z_v, Z_{t'})/\tau)}$$

Phase 2: Supervised Fine-Tuning

- Cross-entropy loss:

$$L_{\text{CE}} = -\sum y_t \log(\hat{y}_t) \quad L_{\text{CE}} = -\sum y_t \log(\hat{y}_t)$$

Phase 3: Reinforcement Learning from Human Feedback (RLHF)

- Optimizes factual correctness and clinical consistency.

5.3 Explainability Module

- Grad-CAM heatmaps
- Attention weight visualization
- Confidence scoring

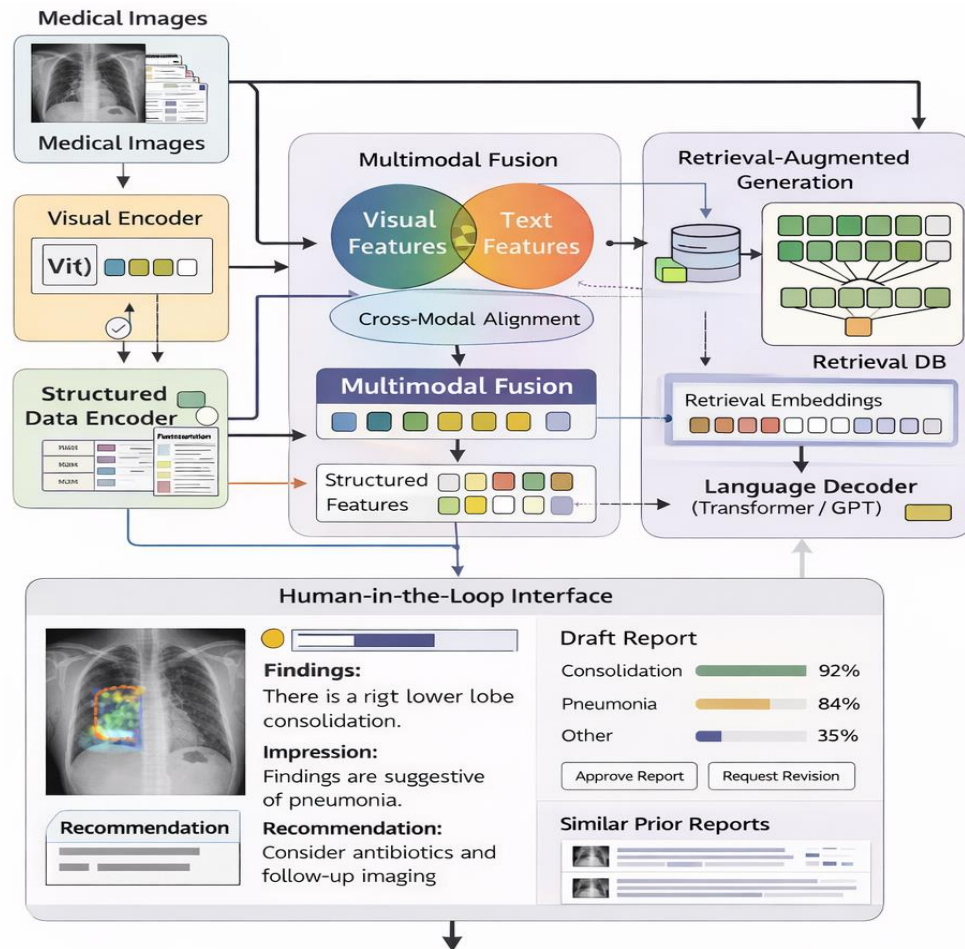


Figure 1. Architecture of a multimodal generative AI system in diagnostics. Medical inputs (images, structured data and prior reports) flow into separate encoders. The system combines vision and structured data via cross modal alignment, optionally, with retrieval-augmented grounding, to generate draft diagnostic reports. A human-in-the-loop interface enables clinician oversight and finalizes the generated reports.

6. EVALUATION FRAMEWORK

6.1 Linguistic Metrics

- BLEU
- ROUGE
- METEOR

6.2 Clinical Accuracy Metrics

- RadGraph F1
- Label consistency (CheXpert)
- Diagnostic agreement rate

6.3 Human Expert Evaluation

Radiologists assess:

- Clinical correctness
- Completeness
- Clarity
- Risk level

6.4 Statistical Analysis

- Paired t-tests

- McNemar's test
- Cohen's Kappa

7. CLINICAL APPLICATIONS

7.1 Radiology

- Automated draft generation
- Emergency prioritization
- Follow-up comparison

7.2 Pathology

- Whole-slide interpretation
- Tumor grading summaries

7.3 Dermatology

- Lesion description
- Malignancy probability reporting

7.4 Ophthalmology

- Diabetic retinopathy screening
- Glaucoma progression reports

7.5 Integrated Multimodal Diagnostics

Future systems may combine:

- Imaging
- Genomics
- Biomarkers
- EHR narratives

8. KEY CHALLENGES

8.1 Hallucination

Generative systems may produce non-existent findings. Mitigation includes retrieval grounding and constraint decoding.

8.2 Dataset Bias

Limited demographic representation impacts fairness.

8.3 Uncertainty Modeling

Probabilistic calibration is essential:

$$\text{Confidence} = \max_{y_t} P(y_t)$$

8.4 Explainability

Clinicians require region-level visual justification.

8.5 Regulatory Approval

AI systems must satisfy safety validation, traceability, and auditability requirements.

9. ETHICAL AND GOVERNANCE FRAMEWORK

- Data privacy compliance
- Bias audits
- Transparent documentation
- Continuous monitoring
- Liability attribution

Human oversight remains essential.

10. CLINICAL IMPACT ASSESSMENT

Potential benefits include:

- 30–50% reduction in report drafting time
- Improved standardization
- Reduced burnout
- Expanded access in rural areas
- Enhanced training for residents

Prospective trials are required to validate real-world benefits.

11. Future Research Directions

- Multimodal foundation models
- Agentic AI for multi-step diagnostic reasoning
- Federated learning across institutions
- Uncertainty-aware generative models
- Real-time clinical decision support integration

12. DISCUSSION

Multimodal generative AI represents a shift from predictive to narrative diagnostic intelligence. However, trustworthiness, reliability, and safety must be prioritized over automation speed.

The optimal deployment paradigm is **collaborative intelligence**, where AI drafts and clinicians finalize.

13. CONCLUSION

Multimodal generative AI in diagnostics offers transformative potential by integrating image understanding with language generation to produce comprehensive clinical reports. When validated rigorously and deployed responsibly within a human-centered framework, such systems can enhance efficiency, consistency, and accessibility of diagnostic care. However, substantial work remains in ensuring reliability, transparency, and ethical governance. The future of diagnostic AI lies not in replacing clinicians but in empowering them through collaborative intelligence.

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MUSIC THERAPY AS A TOOL FOR PROMOTING MENTAL WELL-BEING AMONG YOUTH

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ABSTRACT

The prevalence of mental health issues is a matter requiring urgent concern. Mental health concerns especially in the youth function as a trigger to suicides. National Crime Records Bureau says that twenty-eight student suicides happen in India every day. With a sharp increase in the rate of student suicides, it is important to timely identify and catch the red flags and provide adequate intervention that can prevent suicides. Ayurveda emphasizes the importance of an integrated approach when it comes to well-being. Using the inputs from the ancient Ayurvedic texts and the recent research studies on music therapy, this paper tries to systematically review the research on Indian classical music in treating mental health conditions and to address more serious issues like preventing student suicides.

Keywords: Mental Health, Student Suicides, Music Therapy

Student Mental Health: The Current Scenario

Mental health issues are becoming increasingly prevalent in Indian society. The National Mental Health Survey found that 10.6% of Indian adults suffer from mental disorders. Several of these mental health conditions such as depression, substance use disorders and psychosis increase the risk of suicides (Bachmann, 2018). Suicide is one of the major causes of deaths among young adults. The risk of suicide is higher during Youth (Vijayakumar, 2005). Student suicide is a major public health concern (Maji, et.al, 2025). As per the National Crimes Record Bureau there is a steady increase in the rate of suicides among students in the last decade. Student suicides constitute 8.1% of the total suicides in Indian in 2023. A study based on the news reports analysis on 491 student suicides found that academic reasons (academic dissatisfaction, academic stress and academic failure), institutional reasons (bullying, caste discrimination, ragging, harassment and toxic institutional culture), mental health issues (depression, psychological stress and anxiety), financial crisis and online gaming were the most common reasons for student suicides. The study further says that the suicide victims were within the age range of 16-21 years and the highest number of suicide cases were reported from Kota, Rajasthan (Maji, et. al, 2025). Studies have also pointed out at gadget addiction as a cause for suicidal ideation and attempt among college students (Wang, et. al, 2024). All studies indicate the need for timely intervention to prevent suicides among students. Research has identified the importance of music therapy as a tool in college students' mental well-being (Liu, 2025).

Mental Health as Perceived by Ayurveda.

Ayurveda says that knowledge is the proof for the existence of mind. As per the Ayurvedic texts, mind is superior to the other faculties. Ayurveda perceives health as a perfect balance between mind, body and soul (Malik & Mishra, 2019). Ayurveda further says that psychosomatic imbalances often get portrayed as manas bhavas or mental states such as raga, kama, mada, moha, dvesha and krodha, leading to prajnaparadha (offence against wisdom) and tridoshas (heightened states of vata, pitta and kapha) (Mishra & Sharma, 2020). According to Ayurveda, controlling psychological expressions is the way to maintain a healthy state of mind (Sheshan, et. al, 2024). Charaka Samhita, Sushruta Samhita and Ashtangahrudaya collectively considered as the Great Triad considered music as a therapeutic modality. Since ancient times physicians had used music interventions in internal medicine, pediatrics and other therapies, though there is no direct mention of active music therapy (Gangopadhyay, 2026) and it was mostly used as an aide to the main therapy in Ayurveda.

Indian Classical Music and Mental Health

Human beings are known to relish music across cultures. Music is known for its beauty as well as healing power. Indian Classical Music- one of the oldest in the world dates to the Vedas and specific to Samaveda (Hegde, 2017). The Samaveda contained hymns which were sung in specific rhythms. The two intricate classical music forms of India- Hindustani and Carnatic emerged from the same roots around the 13th century. Both the forms are structured around ragas- (meaning something that can evoke emotions) and talas- (a rhythmic time measure) leading to a soulful rendition of music. The term raga does not have a western counterpart (Jairazbhoy, 1995). Ragas can evoke emotions like sadness, romance, peace, devotion, longing, passion, or strength (Hegde, 2017). A Raga is defined by frequency, tone, rhythm, beat, volume, lyrics, and aesthetics (Natarajan, 2015). These differences elicit different responses on the Autonomic Nervous System (Chandra, 2023).

Music can be effectively used as a therapeutic medium to resolve the imbalances that lead to mental health issues (Dubey, et. al, 2026). Music therapy is the conscious use of music to address mental health conditions, to reduce stress or to aid in well-being. Music therapy is a “non-invasive and emotionally engaging therapeutic approach” (Bandyopadhyay & Acharya, 2025). Studies found that music therapy reduced pain and increased the energy levels of the participants (Redding, 2016). Music therapy is an effective intervention technique in stress reduction (de Witte, 2020). ‘Raga Chikitsa’ (Treatment with Ragas) improves conditions like depression, anxiety, and stress. Though the full picture on how music therapy positively influences mental health is not clear, studies show that there is an impact on the limbic system, Autonomic Nervous System, and synchronisation of body rhythms (Sarkar & Biswas, 2015, Madhusudhan, 2020). Clinical studies have shown that music interventions help in alleviating the symptoms of PTSD (Pezzin, 2018). Listening to classical music significantly reduced the stress levels of college students (Labbe, 2007). With advanced research techniques and tools, researchers are able to understand the neural changes in the brain associated with music with precision and this can bring a huge transformation in music therapy (Hegde, 2017). Music thus becomes a suitable intervention technique to address the different domains affected in psychiatric conditions such as cognitive, emotional, and social (Hegde, 2017).

In a study conducted in Hyderabad among forty patients suffering from depression found that there was an improvement in the level of depression after being subjected to music therapy where the participants were required to listen to ragas like Desh, Neelambari, Hamsadwani, Bhoopali and Brindavana Sarang for a period of fifteen days (Akkera, et. al, 2014). Another study on the impact of Indian classical ragas on psychophysiological parameters found that Raga Bhairavi has a relaxing effect on Individuals (Chandra et. al, 2023). This makes raga Bhairavi a suitable raga for mental health intervention programs. A study on the effectiveness of ragas Bimplas, Kaunsi Kanada and Ahir Bhairav found that all the ragas were able to reduce the stress levels of the listeners (Ubrangala, 2021). Music therapy can induce short term neuroplastic changes that can help in improving mental health conditions and subjective well-being (Kunikullaya, 2025)

CONCLUSION AND SUGGESTIONS

This paper was a humble attempt to consolidate the past literature on the effectiveness Indian Classical Music as a therapeutic intervention for mental health conditions. From the literature, it is evident that Indian classical music has a positive influence on the mental health interventions. But when compared to western music, the literature on the effects of Indian classical music is limited. Though more studies are required to prove substantially the importance of ICM as therapeutic tool, it can be introduced at school and college levels, to help the youth cope with anxiety and stress. Regular exposure to music therapy may help students develop resilience and may prevent suicidal ideations and the thoughts of self-harm. Studies should also focus on the effects of specific ragas on psychological conditions. The other attractions of ICM based therapy are that it's affordable, convenient and without side effects. ICM is a vast ocean, it requires long and detailed studies to understand the impact of ragas on subjective well-being and further studies in this direction can help us to understand the psycho physiological responses to specific ragas and how it affects the neurophysiology.

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ORAL TRADITIONS AND STORYTELLING IN INDIAN KNOWLEDGE SYSTEMS HAVE SIGNIFICANTLY CONTRIBUTED TO THE PRESERVATION OF KNOWLEDGE AND THE DEVELOPMENT OF SOCIAL STRUCTURES.

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ABSTRACT

Oral traditions and storytelling have played a foundational role in the preservation, transmission, and evolution of the Indian Knowledge Systems (IKS). Long before the codification of texts, knowledge in the Indian subcontinent was disseminated through spoken word, mnemonic techniques, and performative traditions. These oral practices shaped ethical values, social norms, political thought, and governance structures. This paper examines the role of oral traditions within IKS, their societal functions, and their influence on governance models from ancient to contemporary India. It also explores their relevance in modern democratic discourse and policy communication.

Keywords: Indian Knowledge Systems, Oral Traditions, Storytelling, Governance, Society, Cultural Transmission, Indigenous Knowledge

INTRODUCTION

Indian civilization has historically relied upon oral transmission as a primary method of preserving knowledge. The Indian Knowledge Systems (IKS) encompass diverse disciplines including philosophy, polity, law, ethics, medicine, ecology, and education. Oral traditions such as Vedic chanting, epics, folklore, and community narratives have functioned not merely as cultural artifacts but as structured systems of knowledge dissemination.

The concept of *Shruti* (that which is heard) and *Smriti* (that which is remembered) illustrates the centrality of oral transmission in Indian epistemology. This research paper investigates how oral traditions shaped societal structures and governance systems and examines their continued relevance in contemporary contexts. Oral traditions and storytelling have played a fundamental role in the preservation of knowledge and the development of social structures within Indian Knowledge Systems (IKS). For centuries, before the widespread use of written manuscripts, knowledge in the Indian subcontinent was transmitted through spoken word, recitation, dialogue, and performative narratives. This oral mode of communication ensured the continuity of philosophical thought, ethical values, cultural practices, and governance principles across generations.

Indian epistemology recognizes the importance of *Shruti* (that which is heard) and *Smriti* (that which is remembered), highlighting the central place of oral transmission in sustaining intellectual traditions. Sacred texts such as the Rigveda were carefully preserved through precise chanting techniques, while epics like the Mahabharata and the Ramayana conveyed moral lessons, social responsibilities, and ideals of leadership through engaging narratives.

Beyond religious literature, storytelling traditions including the Panchatantra and the Jataka Tales contributed to moral education and social regulation by presenting complex ideas in simple, relatable forms. These oral narratives shaped collective memory, reinforced social norms, and supported community-based governance systems.

Conceptual Framework: Oral Traditions in IKS

Oral traditions refer to the transmission of knowledge, cultural values, history, and law through spoken word across generations. In the Indian context, oral traditions include:

- Vedic recitations
- Epics and Puranic storytelling
- Folk ballads and community narratives
- Performative traditions like Harikatha and Kathakalakshepam

The **Rigveda**, one of the oldest surviving texts in the world, was preserved orally for centuries through precise phonetic methods. The recitation techniques ensured accuracy and continuity, demonstrating sophisticated mnemonic science.

Similarly, epics such as the **Mahabharata** and the **Ramayana** were transmitted orally before being written down. These texts encapsulated political philosophy, ethical dilemmas, social responsibilities, and governance ideals. The conceptual framework of oral traditions in Indian Knowledge Systems (IKS) is grounded in the understanding that knowledge is not only written but lived, spoken, remembered, and performed. In the Indian context, oral transmission functioned as a systematic and structured method of preserving intellectual, cultural, and social knowledge across generations. It was supported by well-developed mnemonic techniques, dialogic pedagogy, and performative practices that ensured continuity and authenticity.

At the core of this framework lies the epistemological distinction between *Shruti* (that which is heard) and *Smriti* (that which is remembered), emphasizing listening, memorization, and recitation as legitimate sources of knowledge. Texts such as the Rigveda were transmitted orally with remarkable precision through complex chanting methods, demonstrating that oral culture in India was both disciplined and scientific.

The framework also includes narrative-based knowledge systems embodied in epics like the Mahabharata and the Ramayana. These works functioned as moral, social, and political guides, embedding governance principles and ethical codes within engaging stories. Storytelling traditions such as the Panchatantra further illustrate how wisdom, diplomacy, and social norms were transmitted through allegory and metaphor.

ORAL TRADITIONS AND SOCIAL STRUCTURE

Preservation of Cultural Identity

Oral narratives functioned as repositories of collective memory. They transmitted:

- Moral codes (Dharma)
- Social duties (Varna and Ashrama systems)
- Gender roles and family structures
- Community laws and customs

Village storytellers, temple priests, and elders acted as custodians of social knowledge. Folklore reinforced communal harmony and ethical conduct.

Education and Socialization

The Gurukul system relied heavily on oral pedagogy. Knowledge was internalized through repetition, dialogue, and debate. This system encouraged:

- Critical thinking through questioning (as seen in Upanishadic dialogues)
- Ethical reflection through parables
- Experiential learning

The dialogic tradition found in texts like the **Upanishads** highlights the Socratic-style inquiry prevalent in ancient Indian education. Oral traditions and storytelling in Indian Knowledge Systems (IKS) have played a central role in shaping and sustaining social structures across generations. Through spoken narratives, recitations, and community discourse, values, norms, and social responsibilities were transmitted in a way that was accessible to all sections of society. These traditions acted as living institutions that reinforced moral conduct, social order, and collective identity.

Epics such as the Mahabharata and the Ramayana communicated ideals of duty (dharma), kinship, leadership, and social harmony through powerful characters and situations. These narratives influenced family structures, gender roles, and community relationships by presenting models of righteous behavior and social responsibility.

Similarly, ethical and practical wisdom embedded in stories like the Panchatantra guided interpersonal conduct, cooperation, and social intelligence. At the grassroots level, storytelling in village gatherings, temple courtyards, and community festivals helped preserve customary laws and social traditions.

Oral Traditions and Governance

Political Philosophy in Epics

The epics were not merely religious narratives but manuals of statecraft and governance.

- The **Mahabharata** contains discussions on Rajdharma (duties of a king), justice, diplomacy, and war ethics.
- The character of Yudhishtira embodies moral governance rooted in Dharma.

Arthashastra and Oral Political Discourse

Though later written, the political treatise **Arthashastra** by **Chanakya** reflects an intellectual environment shaped by oral debate and discourse traditions. Governance principles such as taxation, espionage, welfare policies, and administrative efficiency were widely discussed and taught orally before documentation.

Panchayat and Community Governance

Traditional village assemblies (Sabhas and Panchayats) relied on oral deliberations. Decisions were made through consensus-based dialogue, storytelling references, and customary precedents. Oral jurisprudence played a critical role in dispute resolution.

Storytelling as a Tool of Ethical Governance

In Indian Knowledge Systems (IKS), storytelling has functioned as a powerful tool for promoting ethical governance and responsible leadership. Through narratives, moral dilemmas, and symbolic characters, complex political and administrative principles were communicated in a simple and engaging manner. Storytelling made governance values accessible not only to rulers but also to common people, thereby strengthening social accountability.

Epics such as the Mahabharata present detailed discussions on Rajdharma (duties of a king), justice, and moral decision-making, illustrating how leadership must be guided by righteousness and social welfare. Similarly, the Ramayana portrays ideals of duty, integrity, and public responsibility through the character of Rama, who prioritizes societal harmony over personal interest.

Didactic texts like the Panchatantra and the Jataka Tales used allegories and animal characters to teach principles of diplomacy, prudence, compassion, and ethical statecraft. These narratives served as informal training manuals for rulers and administrators while also educating citizens about moral conduct and civic responsibility.

Storytelling simplified complex governance principles into accessible narratives.

Examples include:

- Moral lessons from the **Panchatantra**, which taught diplomacy and political strategy.
- The **Jataka Tales**, which emphasized ethical leadership and compassion.

These narratives were pedagogical tools for princes and administrators. They bridged the gap between theoretical governance and practical application.

Oral Traditions and Democratic Discourse

Oral traditions and storytelling in Indian Knowledge Systems (IKS) have played an important role in shaping participatory dialogue and democratic culture within society. Through public narration, debate, and collective discussion, knowledge was shared openly, encouraging community involvement in decision-making processes. These traditions promoted dialogue, consensus, and moral reasoning as foundations of governance.

Ancient assemblies and local bodies relied on oral deliberations where customs, precedents, and ethical principles were discussed before arriving at decisions. The dialogic method found in the Upanishads reflects a culture of questioning and intellectual exchange, which strengthened participatory thinking. Similarly, governance ideas presented in the Mahabharata emphasized consultation, justice, and the moral responsibility of rulers toward the people.

In contemporary India, storytelling continues to influence democratic discourse. Political speeches, public campaigns, and community meetings often draw upon traditional narratives to connect with cultural memory and shared values. Thus, oral traditions have not only preserved knowledge but have also nurtured dialogue-based governance and civic engagement, forming an essential foundation for democratic practices.

Public Communication

Traditional rulers used bards and messengers to communicate policies. Royal proclamations were announced orally in public spaces.

Modern Parallels

In contemporary India, political communication still employs storytelling techniques. Public speeches often reference epic characters to connect with cultural memory.

Oral traditions also influence grassroots governance where local leaders rely on narrative persuasion during Gram Sabha meetings.

Challenges in the Modern Era

- Decline of traditional storytellers
- Digital disruption of oral cultures
- Risk of homogenization of indigenous narratives
- Loss of linguistic diversity
- Despite their historical importance, oral traditions and storytelling in Indian Knowledge Systems (IKS) face several challenges in the modern era. Rapid globalization, urbanization, and technological advancement have significantly altered traditional modes of knowledge transmission. The shift from oral culture to print and digital media has reduced the dependence on face-to-face storytelling and community-based learning practices.
- One major challenge is the decline of traditional storytellers and custodians of oral knowledge, whose roles are diminishing due to changing social and economic conditions. As younger generations move toward formal education and digital platforms, many indigenous narratives risk being forgotten or simplified. Linguistic diversity is also under threat, leading to the loss of region-specific folklore and community histories.
- Additionally, the commercialization and homogenization of cultural narratives in mass media can distort original meanings and ethical frameworks embedded in traditional stories. However, modern technology also offers opportunities for documentation, digital archiving, and revival of oral traditions.

METHODOLOGY

This research employs:

- Qualitative textual analysis
- Comparative cultural study
- Historical examination of IKS sources
- Secondary literature review

The interdisciplinary approach integrates sociology, political science, and cultural studies.

DISCUSSION

Oral traditions in IKS represent a dynamic system of knowledge transmission rather than a static cultural practice. They enabled:

- Participatory governance
- Ethical leadership training
- Community-based dispute resolution
- Cultural continuity

The resilience of Indian civilization owes significantly to this adaptive oral heritage.

CONCLUSION

Oral traditions and storytelling are foundational pillars of Indian Knowledge Systems. They have shaped societal norms, ethical frameworks, and governance models across centuries. Even in the era of digital communication, storytelling remains central to public discourse and political persuasion.

Recognizing and revitalizing oral traditions is essential for preserving indigenous epistemologies and strengthening culturally rooted governance models in contemporary India.

PASSIVE HYDRAULIC INTELLIGENCE: MODELLING GOA'S KHAZAN WETLANDS THROUGH AN INDIAN KNOWLEDGE SYSTEM LENS

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403001**ABSTRACT**

Coastal water management in Goa is an old practice that has continued for many generations. Khazan is a traditional system where local communities use coastal wetlands and mangroves for farming and fishing, in a sustainable way. In this system, low-lying fields are protected and regulated by earthen embankments known as Bunds, while traditional sluice gates called Manos control tidal water exchange. The arrangement sustains rice farming and brackish-water aquaculture; and helps to comprehensively reduce flood risk in the surrounding settlements. Khazan wetlands function through a locally developed hydraulic design supported by traditional community institutions known as Comunidade. The sluice gates operate naturally without pumps, electricity, or mechanical control. Although the long-term effectiveness of these systems has been observed in practice, however, their hydraulic behaviour has not been adequately examined using mathematical modelling. In this paper, we represent the operation of the Khazan system using a coupled system of ordinary differential equations and simulate its response under both dry and monsoon conditions using published hydrographic parameters from the Mandovi-Zuari estuarine system. The results demonstrate substantial tidal attenuation of 93% during the dry season and 70.8% during the monsoon, indicating effective passive seasonal regulation. This paper also suggests that, Poiem acts as a buffering reservoir that reduces short-term tidal fluctuations, contributing to the system's long-term hydraulic stability. The study highlights that the Khazan system of Goa represents a low-cost coastal infrastructure that is prevailing 'climate-responsive' in its design and function. The system has strong potential for future coastal adaptation strategies and may contribute to resilience towards the projected sea-level rise. Dedicated simulation studies are needed to better understand its future performance.

Keywords: Goan Khazans; Indian Knowledge Systems; Tidal Wetland Management; Passive Hydraulic Regulation; Climate-Responsive Infrastructure; Community Governance

1. INTRODUCTION

The Khazans of Goa represent one of the most enduring examples of community-engineered coastal landscapes along the Arabian Sea, sustaining agriculture and fisheries for centuries. These landscapes were created through long periods of local observation, shared knowledge, and community management, making them one of the oldest examples of community-led coastal engineering in India. However, despite increasing sea levels and more unpredictable monsoon rainfall (ICLEI South Asia, 2024), the underlying water-management principles of the Khazan system have received limited attention in modern mathematical studies (Sonak, 2014).

Across coastal South Asia, sea level rise and changing monsoon patterns are increasing the risk of floods, storms, and other extreme events. To reduce these risks, modern coastal protection usually depends on hard structures such as seawalls, embankments, and pump-driven drainage systems that keep seawater out. Although these methods can work well within their design limits, they require constant maintenance, external energy, and regular upgrades as environmental conditions change (Brater et al., 1996; Munson et al., 2013).

Along the west coast of India, the average sea level has been rising at approximately 2.75 mm per year (Indian National Centre for Ocean Information Services, 2025). Coupled with inter-annual variations in monsoon rainfall and strong semi-diurnal tides (two high and two low tides every lunar day), this trend raises questions about the long-term effectiveness of rigid coastal defence structures (Sundar & Shetye, 2005).

In contrast, the Khazan systems of Goa are traditional tidal-reclamation landscapes found along the coast and tidal river plains. They support agriculture and fish farming using earthen embankments and gravity-operated wooden sluice gates called 'Manos'. These systems are maintained collectively by village institutions known as the Comunidade. Instead of completely blocking tidal water, Khazans carefully control the flow of water in and out during tidal cycles, allowing the landscape to adapt naturally to changing conditions (Kamat, 2004; Sonak, 2014; Sawaiker et al., 2023).

2. LITERATURE CONTEXT AND RESEARCH GAP

Previous studies on Khazan systems have primarily examined their ecological significance, landscape evolution, community governance, and traditional management practices (Kamat, 2004; Sonak, 2014; Sawaiker et al.,

2023). Most studies focus on the qualitative and descriptive aspects of water management, with water processes largely presented in subjective terms. Although the management of Khazans has been well documented through historical records and studies of local community practices; the way these systems actually function as dynamic water systems under changing tidal conditions has not been thoroughly analysed mathematically.

This gap becomes especially clear when compared to the wider progress made in modelling traditional water systems around the world. Lansing and Kremer (1993) showed through computer-based simulations that Bali's *subak irrigation networks* can effectively control pests and distribute water efficiently through local, decentralised coordination, without the need for central planning. Lightfoot's (1996) research on *qanat systems* in the dry regions of Iran and the Middle East showed how these underground, gravity-driven water channels could reliably deliver water across long distances without the need for pumps or external power. Pandey et al. (2003) studied *johad and baoli stepwell systems* in Rajasthan and measured their ability to recharge groundwater using mass-balance methods, providing a quantitative assessment of how effectively these traditional structures restore water resources. In all these examples, mathematical modelling helped explain how the systems actually function, revealing important mechanisms that simple descriptions could not fully capture. Although, the Khazan system is equally ancient and hydraulically sophisticated, no comparable mathematical modelling study has yet been conducted for it.

Global research on nature-based coastal protection mainly focuses on outcomes such as wave reduction and carbon storage. However, the internal mechanisms of traditional tidal drainage systems have received limited attention from a modelling perspective. This has created a gap between qualitative understanding of traditional practices and their representation through formal objective modelling approaches.

3. RESEARCH QUESTIONS AND CONTRIBUTION

This study addresses this gap by representing the operation of the traditional sluice gate (Manos) and the internal buffer reservoir (Poiem) using differential equations.

Three questions guide the analysis:

- (1) How can the behaviour of the Manos gate be represented mathematically, and what functional insights emerge from such a representation?
- (2) How does the coupled Khazan system respond under tidal, seasonal, and projected sea-level variations?
- (3) How does the internal reservoir influence short-term oscillations and seasonal response?

This study makes the following contributions:

- **Differential equations-based dynamical representation of Khazan hydraulics:** We develop a coupled ordinary differential equation model of the Khazan sluice-reservoir system, providing a formal dynamical systems representation of a traditional Indian coastal water management structure.
- **Quantified tidal attenuation:** The simulations provide initial estimates of tidal attenuation within the Khazan fields—around 93% in the dry season and 70.8% during the monsoon— providing a basis for comparison with modern coastal engineering standards.
- **IKS-engineering synthesis framework:** The study demonstrates that principles documented in classical Indian Knowledge Systems texts, including the *Arthaśāstra* and *Brhat Samhitā*, can be mapped onto modern hydraulic theory; providing a replicable framework for interdisciplinary engagement between IKS scholarship and engineering analysis.

This work uses a simplified dynamical modelling approach to analyse Khazan systems, providing quantitative insights into how these traditional water management systems function in comparison with contemporary coastal engineering approaches.

This paper is organised as follows.

Section 4 situates the Khazan system within the context of Indian hydraulic traditions and the Indian Knowledge Systems (IKS) framework.

Section 5 describes its physical structure and operational characteristics.

Section 6 outlines the mathematical formulation used to represent the system.

Section 7 presents simulation outcomes and the observed behaviour of the system.

Section 8 explores the wider implications of the findings.

Section 9 discusses limitations and policy recommendations. Lastly,

Section 10 presents the conclusions of the study.

4. INDIAN KNOWLEDGE SYSTEMS AND KHAZAN WATER MANAGEMENT HERITAGE

4.1 Water Engineering in the Indian Intellectual Tradition

The Khazan system is one of the most distinctive coastal expressions of the water management tradition across the Indian subcontinent. Historical manuscripts and archaeological sites confirm a centuries-old expertise in hydraulic infrastructure, evident from embankments, irrigation channels, reservoirs, and collective maintenance practices. The use of gravity to move water in the Khazan system embodies the categories described in the *Arthaśāstra*. Kautilya emphasised that the most efficient systems work with natural flows rather than requiring manual lifting or pumping. In verse 2.24.18, the highest efficiency is attributed to *uddhāṭam*—the passive release of water.

U2.24.18 स्वसेतुभ्यो हस्तप्रावर्तिमं उदकभागं पञ्चमं दद्युः, स्कन्धप्रावर्तिमं चतुर्थं,
स्रोतोयन्त्रप्रावर्तिमं च तृतीयं, चतुर्थं नदीसरस्तटाककूप उद्धाटम्

Translation: "Those who cultivate by manual labour shall pay one-fifth of the produce, but for those who allow water to flow from rivers, lakes, and tanks (*uddhāṭam*), the rate is one-fourth." — Kautilya, *Arthaśāstra*, Book 2, Chapter 24, Verse 18 (Kautilya, trans. Shamasastry, 1915).

The term *uddhāṭam* means opening a sluice so that water flows naturally under its own pressure. The Khazan system follows this idea in practice. Its sluices, called Manos, operate without constant human control. They respond automatically to differences in tidal and gravitational water levels. This reflects an important feature of Indian Knowledge Systems (IKS), where practical engineering knowledge is built directly into the structure itself.

The Khazan system also shows technical understanding similar to that described in *Bṛhat Saṃhitā* (c. 550 CE) by *Varāhamihira*, which explains repeating patterns in water movement and tides. Khazan sluices open and close with the regular rise and fall of the tides, showing that local communities had a long-standing knowledge of tidal cycles. In certain estuaries, including the Mandovi–Zuari, Khazan sluices operate in a synchronized manner with tidal fluctuations, reflecting the local communities' detailed knowledge of tidal cycles. This traditional understanding aligns closely with the dominant semi-diurnal M2 tidal cycle identified by modern science, which governs water-level changes in the Mandovi–Zuari estuary with a period of about 12.42 hours (Sundar & Shetye, 2005).

The structural stability of the Khazan embankments reflects geometric principles reminiscent of those articulated in the *Śulbasūtras*. In the *Baudhāyana Śulbasūtra* (*Adhyāya 3*), the *Mahāvedī* altar is described as a trapezoidal form constructed with precise proportional ratios to ensure geometric balance:

त्रिंशत्पदानि प्रक्रमाः पश्चिमात् तिर्यक् भवति ।

षट्त्रिंशत् प्राची चतुर्विंशतिः पुरस्तात्तिर्यक् इति महावेदी विज्ञायते ॥

This specification defines a trapezoidal form constructed with precise proportional ratios to ensure geometric balance. In a comparable manner, the trapezoidal cross-section of Khazan bunds distributes tidal forces effectively, contributing to hydraulic stability.

4.2 Analytical Perspective

This study presents simple mathematical equations to describe the Khazan system, using parameter values drawn from published literature. Simulations show how water flows and stabilises within the system, while historical knowledge provides context for these design choices. The analysis does not imply that past engineers wrote equations; rather, it highlights how generations of empirical refinement created systems whose behaviour can now be described mathematically.

4.3 The Comunidade as Institutional Infrastructure

The Khazan system relies on a long-standing village institution called the Comunidade, which manages land allocation, maintenance of embankments, and operation of sluice gates. Regular inspections and repairs, especially after the monsoon, are essential to keep the system working. This governance is integral to the engineering design, ensuring the hydraulic system remains functional over time. The Comunidade also follows common principles of sustainable resource management, including membership rules, collective decision-

making, monitoring, and conflict resolution (Ostrom, 1990). Technical design and community governance concomitantly make the Khazan landscape durable and effective.

5. PHYSICAL ARCHITECTURE OF THE KHAZAN SYSTEM

5.1 Overview and Functional Variants

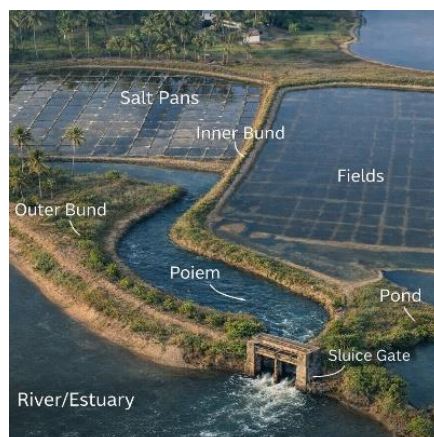


Figure 1: Overview of the Khazan system

A Khazan is a low-lying coastal area that has been reclaimed from tidal land and protected by earthen embankments, locally called bunds. These embankments prevent uncontrolled flow of seawater. The area is connected to a nearby estuary through a wooden sluice gate that operates using gravity. The gate opens and closes automatically depending on the difference in water levels inside and outside the system, allowing for controlled tidal exchange.

There are three main types of Khazan systems:

- (1) Rice–fish systems, where rice is cultivated during the monsoon season and fish are reared during the dry season;
- (2) Fish-only enclosures (locally known as Khani or Agor), which are used mainly for aquaculture; and
- (3) Salt–fish systems (called Mithagor), where salt production and fish farming are carried out in different seasons.

Although these types differ in how the land is used, they all depend on the same basic structure for water management.

5.2 Earthen Embankments

Khazan fields are enclosed by earthen embankments (bunds) made of laterite-rich clay, often reinforced by mangroves. These flexible structures absorb wave energy and adapt to seasonal moisture changes, allowing slow, detectable damage that can be repaired by local maintenance groups.



Figure 2: Bund structures of the Khazan system

5.3 The Sluice Gate (Manos)

The Manos is a hinged wooden gate at the Poiem–Estuary interface. It opens when internal water exceeds the Estuary level, draining freshwater, and closes when tides rise to prevent saltwater entry. This gravity-driven mechanism requires no motors or manual operation and follows the natural tidal rhythm.



Figure3: Sluice Gate (Manos)

5.4 The Poiem Reservoir

The Poiem functions as an internal storage basin, absorbing excess rainfall and tidal inflows to moderate water level fluctuations within the field.



Figure 4: Poiem (buffer reservoir)

5.5 Integrated System Operation

The Khazan system works by combining bunds, Manos, and Poiem to control water without any active intervention, and its behaviour is best understood by tracing the sequence of events across a single complete tidal cycle.

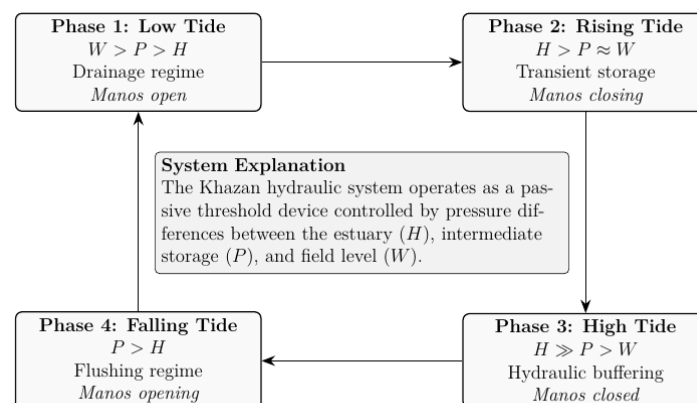


Figure 5: Sluice Gate Operation in tidal system

5.5.1 Working of the Sluice Gate (Manos)

- **Low tide:** The Estuary level falls below the field level, creating a pressure difference that opens the Manos gate. Excess freshwater drains out naturally, lowering the field water level.
- **Rising tide:** As the Estuary level rises, the pressure difference decreases. Drainage slows and the gate gradually closes, stopping further outflow and preventing saltwater entry.
- **High tide:** The Estuary level exceeds the field level, but the gate remains closed because it opens only outward. The bunds resist the water pressure.
- **Falling tide:** When the tide drops, the pressure difference is restored. The gate reopens and drainage resumes, completing the cycle.

- **Manual Intervention:** Although the Manos gate usually works automatically based on tidal and water level differences, it can be adjusted manually when needed. In the dry season, it may be partly opened to let a limited amount of water into the fields for irrigation.

5.5.2 Role of the Poiem (Buffer Reservoir)

During heavy rainfall or sudden inflow, excess water flows into the Poiem, reducing flood risk in the field. After drainage lowers the field level, the Poiem slowly releases stored water back, helping maintain a stable level. This two-way exchange smooths rapid fluctuations caused by tides and rainfall. The system therefore works as a natural self-regulating hydraulic system without pumps or external energy, functioning as a passive hydraulic circuit that continuously adapts to tidal cycles and seasonal changes.

6. MATHEMATICAL MODEL AND KEY RESULTS

6.1 Overview and Variables

The physical processes described in Section 5 can be expressed using a system of ordinary differential equations. Each term in the model corresponds directly to a measurable physical process. The variables and parameters used throughout the analysis are listed in Table 1.

Table 1: Model variables and parameters with physical interpretation

Symbol	Meaning	Units
$W(t)$	Internal water level in the field	m
$T(t)$	Tidal water level in the Estuary	m
$R(t)$	Freshwater input (rainfall and runoff)	m^3s^{-1}
$P(t)$	Water level in the Poiem	m
$Q_{out}(t)$	Volumetric outflow through the Manos gate	m^3s^{-1}
A	Field surface area	m^2
A_p	Poiem surface area	m^2
a	Gate opening area	m^2
k	Seepage conductance per unit area (through gate structure)	s^{-1}
k_p	Discharge per unit width	m^2s^{-1}
C_d	Gate discharge coefficient	—
ε	Threshold head for gate	m
$H(\cdot)$	Heaviside switch function (0 = closed, 1 = open)	—

Tidal Attenuation: A key performance metric used throughout this study is the tidal attenuation ratio, defined as:

$$\eta = 1 - (\Delta W / \Delta T) \quad (*)$$

where ΔW is the peak-to-peak amplitude of the internal field water level $W(t)$, and ΔT is the peak-to-peak amplitude of the external tidal signal $T(t)$. A value of $\eta = 1$ indicates complete attenuation (no tidal influence on the field interior), while $\eta = 0$ indicates no attenuation (full tidal transmission). All attenuation values reported in Sections 7.1 and 7.2 are computed using this definition.

6.2 Mathematical Formulation

The internal water level in the Khazan field evolves according to conservation of volume. The field exchanges water with the Poiem through the level difference ($W - P$), and receives freshwater input from rainfall and runoff. For a field of surface area A , the volume balance gives:

$$A \frac{dW}{dt} = R(t) - k_p(W(t) - P(t)) \quad (1)$$

The first term on the right-hand side is the freshwater inflow. The second term represents volumetric exchange with the Poiem: when $W > P$, water drains from the field into the Poiem; when $W < P$, the Poiem recharges the field. The Manos gate and all tidal exchange is located at the Poiem– Estuary interface; the field itself has no direct hydraulic connection to the tidal Estuary.

6.3 Drainage Through the Manos

The Manos gate sits at the boundary between the Poiem and the Tidal Estuary. Drainage flow is modelled as pressure-driven discharge through a submerged orifice, with the driving head given by the difference between the Poiem level P and the tidal level T :

$$Q_{out} = C_d a \sqrt{2g \cdot \max(P(t) - T(t), 0)} \cdot H_{smooth}(P(t) - T(t) - \varepsilon) \quad (2)$$

The function $H(\cdot)$ is the Heaviside unit step function, defined as:

$$H(x) = \begin{cases} 0, & \text{if } x < 0 \\ 1, & \text{if } x \geq 0 \end{cases}$$

Applied here as $H_{smooth}(P(t) - T(t) - \varepsilon)$, it takes the value 1 (gate open) only when the Poiem level exceeds the tidal level by more than the threshold ε , and 0 (gate closed) otherwise. The square root term reflects standard orifice hydraulics, in which discharge increases with the pressure head, a fundamental principle of fluid mechanics (Brater et al., 1996; Munson et al., 2013). Because the gate responds to P rather than W , the Poiem acts as a true hydraulic buffer between the field interior and the tide.

6.4 Tidal Forcing and the Poiem Subsystem

The system is forced by a semi-diurnal tidal oscillation:

$$T(t) = T_{mean} + A_{tide} \sin \omega t \quad (3)$$

The Poiem receives water from the field, then discharges to the Estuary through the Manos gate and through passive seepage across the gate structure. This two-reservoir topology yields the following coupled ODE system:

$$A \frac{dW}{dt} = R(t) - k_p(W(t) - P(t)) \quad (4)$$

$$A_p \frac{dP}{dt} = k_p(W(t) - P(t)) - Q_{out}(P, T) - k_a(P(t) - T(t)) \quad (5)$$

In Equation (4), the field level rises with freshwater input and falls as water drains into the Poiem. In Equation (5), the Poiem level rises as it receives that inflow, and falls through two pathways: active discharge $Q_{out}(P, T)$ through the Manos gate when $P - T > \varepsilon$, and passive seepage $k_a(P - T)$ proportional to the head difference across the gate structure at all times. Because all tidal exchange is mediated through the Poiem, this coupled configuration functions as a low-pass filter: the Poiem absorbs short-term surges from both rainfall and tidal fluctuation, and the field interior responds only to the slower, smoothed signal.

7. DRY AND MONSOON SEASON SIMULATION

The governing equations (4)-(5) were integrated using a fourth-order Runge–Kutta scheme over 72-hour intervals to capture multiple tidal cycles. Nominal parameters for the Mandovi–Zuari estuarine system are listed in Table 2. Two seasonal forcing scenarios were considered: dry season ($R = 0.02 \text{ m}^3\text{s}^{-1}$) and peak monsoon ($R = 0.15 \text{ m}^3\text{s}^{-1}$), representing the annual hydraulic extremes for a typical Khazan field. These parameters are chosen to be consistent with the documented tidal propagation and asymmetry observed in the Mandovi–Zuari estuarine system (Shetye et al., 1995; Manoj et al., 2009).

Table 2: Nominal parameters used in the simulation model

Parameter	Value	Units	Reference / Reasoning
Tidal Forcing			
Mean tidal level (T_{mean})	1.00	m	Representative mean tide
Tidal amplitude (A_{tide})	0.60	m	Neap-to-mean amplitude
M2 tidal period (T_{M2})	12.42	hr	Dominant semi-diurnal constituent
Angular frequency (ω)	1.41×10^{-4}	rad s ⁻¹	Derived from period
Geometric and Hydraulic Parameters			
Field surface area (A)	10,000	m ²	Typical Khazan field
Poiem surface area (A_p)	2,000	m ²	20% of field
Gate opening area (a)	0.80	m ²	Wooden Manos gate
Discharge coefficient (C_d)	0.62	—	Sharp-edged orifice
Gate threshold head (ε)	0.05	m	Minimum opening head

Seepage conductance (k)	1.0×10^{-4}	s^{-1}	Lateritic soil conductivity (Terzaghi et al., 1996; dos Santos & Esquivel, 2018)
Discharge per unit width (kp)	0.30	$m^2 s^{-1}$	Assumed
Seasonal Forcing			
Dry runoff	0.02	$m^3 s^{-1}$	Baseflow
Monsoon runoff	0.15	$m^3 s^{-1}$	Peak rainfall
Initial Conditions and Numerical Settings			
Initial field level	0.50	m	Near equilibrium
Initial Poiem level	0.48	m	Below field level
Time step	10	s	Numerical resolution
Simulation duration	72	hr	Multiple tidal cycles
Gravity (g)	9.81	$m s^{-2}$	Standard value

7.1 Dry Season Response

Under dry-season forcing, the system converges to a stable equilibrium $W^* = 0.615$ m. Although the external tide oscillates with a 1.20 m range, the internal field level varies by only 0.084 m, corresponding to 93% tidal attenuation ($\eta = 0.93$, using (*)) (Figure 6). The gate opens briefly near extreme low tide, producing short drainage pulses with peak discharge of 131.2 L/s. The gate opens for approximately 19.9% of the tidal cycle, indicating that drainage occurs intermittently during low-tide windows while the Manos remains closed for the majority of the cycle. The Poiem reservoir further smooths internal fluctuations, absorbing short-term surges during rainfall and releasing stored water gradually between drainage events.

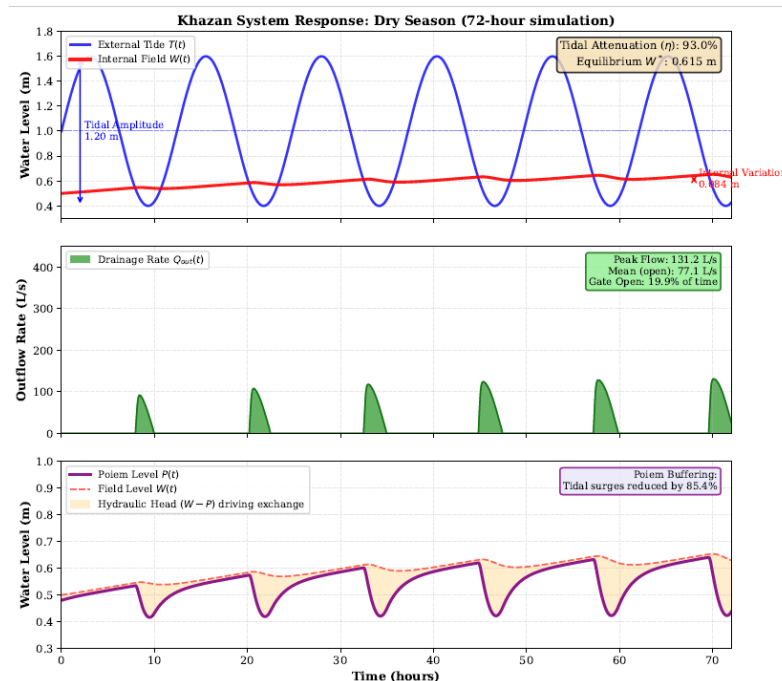


Figure 6: Dry-season hydraulic response ($R = 0.02$ m³/s). Internal oscillations remain small (0.084 m) relative to the 1.20 m tidal range, yielding 93% attenuation.

7.2 Monsoon Season Response

During monsoon conditions, increased runoff raises the equilibrium to $W^* = 1.414$ m. Internal oscillation amplitude increases to 0.350 m, reducing tidal attenuation to 70.8% ($\eta = 0.708$, Equation (*)) (Figure 7). Peak discharge increases to 384 L/s and the gate opens 51.2% of the time, reflecting more frequent drainage

windows. Despite higher hydraulic loading, the system maintains bounded water levels without structural modification, demonstrating passive seasonal adaptability.

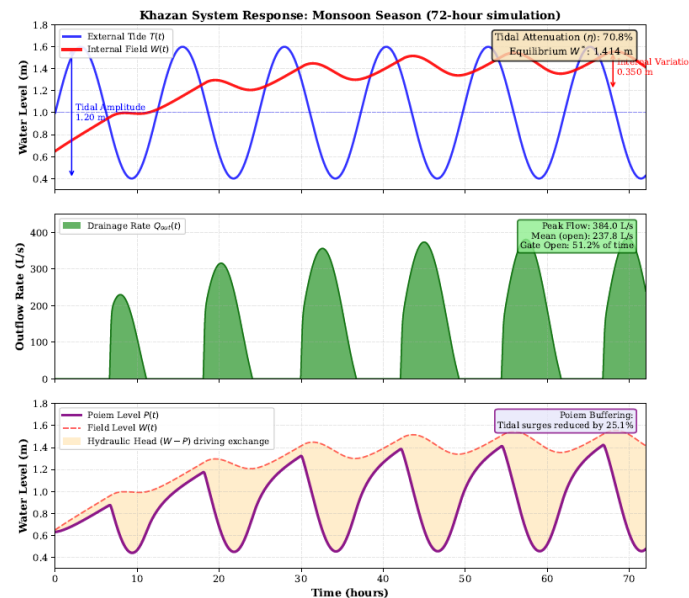


Figure 7: Monsoon hydraulic response ($R = 0.15 \text{ m}^3/\text{s}$). Higher equilibrium levels reduce tidal attenuation to 70.8% and increase gate activity.

7.3 Poiem Buffering Effect

The coupled system (Equations (4)– (5)) shows that the Poiem acts as a passive hydraulic buffer. Water is absorbed when $(W - P) > 0$ during runoff surges and released gradually between drainage events.

In the dry season, the water level changes in the Poiem are reduced by about 85.4% compared to the outside tide. This strong reduction shows that the field inside is mostly protected from tidal changes.

In the wet season, the buffering effect decreases to about 25.1%. This happens because the water level is higher and the gates open more often. Even so, the system still reduces the effect of tides inside the field.

8. DISCUSSION

8.1 Design Logic

Contemporary coastal protection often enforces fixed water levels, requiring structural reinforcement under extreme events. In contrast, the Khazan system relies on adaptive hydraulic coupling: the Manos gate responds to head difference, Bund seepage dissipates water gradually, and the Poiem reservoir buffers short-term fluctuations. Our model shows bounded, locally stable behaviour, demonstrating that adaptive accommodation can be rigorously described with dynamical systems.

8.2 Comparative Performance

Table 3 compares Khazan systems with concrete seawalls. Khazans offer passive operation, gradual failure, incremental adaptation, low maintenance, and potential carbon co-benefits, whereas seawalls are pump-dependent, may fail abruptly, require major redesign for sea-level rise, and incur high carbon and maintenance costs.

Table 3: Indicative comparison: Khazan vs. concrete seawall

Dimension	Khazan	Concrete Seawall
Energy Use	Passive	Pump-based
Failure Mode	Gradual	Sudden
Sea Level Rise Adaptation	Incremental	Major Redesign
Carbon Balance	Mangrove-supported	Cement-intensive
Maintenance Cost	Low	High
Life Span	Centuries*	30–50 years

* The multi-century operational lifespan of Khazan systems is documented in historical records of continuous Comunidade governance and land use dating back nearly 2,000 years (Kamat, 2004; Sonak, 2014). This comparison is indicative; carbon and cost estimates are site-specific.

8.3 Implications for IKS

The *Arthaśāstra* describes self-regulating water principles in Book 2, Chapter 24, which can be characterised using the Sanskrit concept of *svayam-pravartita* — self-directing flow — referring to systems that operate without continuous external intervention — a concept that maps directly onto the negative-feedback regulation demonstrated in our model. The quantitative results presented in Sections 7.1 through 7.3 show that the passive self-regulation described in the *Arthaśāstra* and *Bṛhat Samhitā*, is not merely a philosophical principle but a mathematically demonstrable hydraulic property — one that can be measured, simulated, and compared against contemporary engineering alternatives.

9. LIMITATIONS AND POLICY IMPLICATIONS

9.1 Limitations and Future Work

The study utilises a simplified lumped-parameter model without direct field data or survey validation. Initial conditions were assumed rather than measured, and the results are intended to characterise qualitative system behaviour. Only the dominant tidal component was considered, and processes such as sediment transport, bund deformation, gate wear, and structural failure were not included. Future work should incorporate field measurements, site surveys, and more detailed hydrodynamic and sediment processes to improve accuracy and real-world relevance.

9.2 Policy Implications

- **Recognising Hydraulic Function:** Khazan bunds should be treated as functional coastal infrastructure. The high attenuation observed in this study (93% in the dry season and 70.8% during monsoon) provides quantitative support for their inclusion in formal flood risk management frameworks.
- **Ecosystem Services and Climate Finance:** Mangroves reinforcing Khazan bunds provide important blue carbon benefits through long-term carbon storage in waterlogged soils. This creates potential opportunities for climate finance and carbon credit mechanisms that could support community-led maintenance.
- **Climate Forecasting Integration:** Integrating rainfall and climate projections into the modelling framework would enable better scenario planning and proactive maintenance by anticipating changes in freshwater inflow, gate operation, and seasonal water levels.

10. CONCLUSION

Goa's Khazan wetlands can be modelled as a nonlinear system with passive feedback control. The system keeps water levels stable and reduces tidal effects by 93% in the dry season and 70.8% during the monsoon. It adjusts naturally to seasonal water changes, showing potential resilience to future sea-level rise. The wetlands are structurally strong and offer energy-efficient and ecological benefits. Knowledge from the *Arthaśāstra* and *Bṛhat Samhitā* can be studied using modern system analysis. Although field measurements are still needed, this approach can help include traditional water systems in coastal adaptation planning.

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FORMULATION OF NON-DAIRY PROBIOTIC BEVERAGE INFUSED WITH LACTIC ACID BACTERIA INDIGENOUS TO IDLI BATTER.

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ABSTRACT

Traditional Indian Food Culture has long emphasized on the importance of fermented food for improved digestive health and overall well being due to the presence of beneficial microbes in it, yet the potential application of these microorganisms in developing a plant - based probiotic drink still remains unexplored. By evaluating the feasibility of developing a non-dairy probiotic beverage with lactic acid bacteria (LAB) extracted from fermented idli batter and combining it with an amla (Amalaki) – sugarcane (Ikshu) juice matrix, the current work fills this gap. The probiotic potential and safety features of the isolate were examined.

*The indigenous isolate exhibited phenotypic and biochemical traits typical of *Lactiplantibacillus plantarum*. The probiotic potential of the strain was determined by evaluating its viability under gastric acidity (pH 3) and bile (1%) condition. Also the absence of hemolysis and other pathogenic activities confirms its food safe nature. A standardized blend of amla (*Phyllanthus emblica*) and sugarcane (*Saccharum officinarum*) juice was formulated as a plant-based fermentation substrate. The formulation supported substantial microbial viability during refrigerated storage, maintaining high cell counts over 72 hours. Physicochemical parameters including pH and titratable acidity remained within acceptable ranges, and ethanol estimation confirmed non-intoxicating levels. Antimicrobial compatibility testing showed that the intrinsic bioactive compounds present in the amla juice were not inhibitory to the obtained isolate.*

By blending the Indian food wisdom with microbiology the project demonstrates the feasibility to develop an affordable probiotic plant based food that meets the nutritional requirements of local low income groups and lactose intolerant individuals.

Keywords: Indian Knowledge Systems, Lactic Acid Bacteria, Probiotic Beverage, Sustainable Fermentation, Functional Nutrition.

1. INTRODUCTION

Living organisms known as probiotics can improve a person's health and maintain gut balance if they are consumed in adequate amounts.(Smolinska et al., 2025; Gul & Durante-Mangoni, 2024). Therefore,when we are encouraging the growth of beneficial bacteria and preventing the growth of harmful ones, these microorganisms help to keep the digestive system in balance. They also strengthen the intestinal barrier and control the immune system (Chandrasekaran et al., 2024; Smolinska et al., 2025). They have been investigated for potential benefits in the treatment of infections and inflammatory bowel disease, and they have an impact on both immunological responses and digestion (Vallejos et al., 2025; Nelwan et al., 2024). As more people prioritize gastrointestinal health and make informed dietary choices, there is growing interest in the roles of these beneficial bacteria beyond basic nutrition, which has led to their discovery in advanced food research (Sanders et al., 2023; Smolinska et al., 2025).

Lactic acid bacteria stand out within probiotic microbes because they've appeared safely in fermented dishes for ages while making helpful compounds like organic acids, bacteriocins, or antimicrobial peptides. These microbes aid gut processes - breaking down food, handling lactose, building vitamins, even blocking unwelcome germs from settling in (Tamang et al., 2016). Because of that track record, scientists still turn to nature, pulling and studying these bacteria to uncover new types capable of boosting health.

Fermented dishes made the old way host lively communities of microbes, guided by (Marco et al., 2017) regional crops, weather patterns, one step at a time. Scientists now look closely at them, they're full of lactic acid bacteria that might benefit us. (Tamang et al., 2016). In poorer nations, items built on grains or beans stand out; their worth shows up in meals people trust, can afford, and eat often. Their place in daily eating means good probiotics can provide natural benefits to us. (Marco et al., 2017). Fermented rice and black gram are used to make idli batter, which ferments naturally without the aid of specific starter cultures (Steinkraus, 1996). A mixed microbial population is present at the beginning of fermentation, but as the process progresses, lactic acid bacteria progressively take over (Mukherjee & Ramesh, 2015; Soni & Sandhu, 1990). According to Tamang et al. (2016), the metabolic activity of these bacteria produces organic acid, which lowers pH, improves

leavening, and gives the product its distinctive flavor and aroma. According to recent studies, lactic acid bacteria that were separated from idli batter also have antimicrobial and probiotic qualities (Sircar & Mandal, 2023). These microorganisms' steady dominance indicates that idli batter may be a good source of probiotic strains.

Lactic acid bacteria, or LAB, are probiotics found in fermented foods like idli batter. Traditional idli fermentation research has identified a range of LAB populations with functional potential (Mukherjee and Ramesh, 2015; Sridevi and Halami, 2018). Certain strains can survive in highly acidic gastric conditions, like those found in the human stomach, according to Zhang et al. (2020) and Plaza-Díaz et al. (2019). In addition to being acid resistant, LAB isolated from fermented foods, such as idli batter, have been shown to be bile salt tolerant, allowing them to survive in the intestinal environment. Sanders et al., 2019; Mukherjee and Ramesh, 2015). This physiological resilience is believed to be essential for probiotic efficacy and host-microbe interactions (Gul and Durante-Mangoni, 2024). Bacteriocins, organic acids, and competitive exclusion mechanisms enable LAB to demonstrate antimicrobial activity against enteric pathogens such as *Escherichia coli* in addition to fermenting carbohydrates (Arena et al., 2018; Yang et al., 2020). LAB from traditional fermented foods in South India has also shown pathogen-inhibitory effects, claim Sridevi and Halami (2018). In the gut ecosystem, this antagonistic relationship boosts colonization resistance and inhibits the growth of pathogens (Zhang et al., 2020). Thus, fermented foods like idli may be used as dietary staples as well as natural carriers of live microorganisms that may have gut-protective properties.

Even though yogurt and fermented milk have long been go-to sources for probiotics, more people avoiding dairy - due to lactose issues, allergies, or choosing plants - has boosted interest in non-dairy options (Márquez-Morales et al., 2021). For those steering clear of animal products because of health, beliefs, or culture, plant-based drinks with live cultures open up new possibilities. These natural bases often come packed with useful nutrients like fiber, antioxidants, and polyphenols - not only feeding good bacteria but possibly helping them work better inside the gut (Martins et al., 2013). Looking into local lactic acid bacteria taken directly from idli batter could lead to affordable, eco-friendly probiotic drinks that fit well within traditional eating habits while meeting today's rising need for functional foods made without dairy.

2. MATERIALS AND METHODS

1. Isolation of Lactic Acid Bacteria from Idli Batter

Freshly fermented idli batter was aseptically collected and transported immediately to the laboratory for microbial analysis. Serial dilutions were prepared using sterile physiological saline, and appropriate dilutions were surface-plated onto de Man, Rogosa and Sharpe (MRS) agar, a selective medium widely used for the isolation and enumeration of lactic acid bacteria from fermented foods (Vinderola & Reinheimer, 2000).

The plates were incubated at 37°C for 24–48 h. Colonies exhibiting creamy, circular, and smooth morphology were selected and repeatedly streaked to obtain pure cultures. The purified isolates were maintained on MRS agar slants at 4°C for further characterization.

2. Morphological and Biochemical Characterization

The purified isolate was subjected to Gram staining and microscopic examination to determine cellular morphology and Gram nature. Catalase and oxidase tests were performed to confirm fermentative metabolism typical of LAB. Carbohydrate fermentation tests were conducted using glucose, sucrose, maltose, and galactose. Additional biochemical assays included citrate utilization, indole production, Voges–Proskauer reaction, and lysine decarboxylation.

Phenotypic traits were compared with established descriptions of LAB commonly isolated from cereal-based fermented foods (Tamang et al., 2016; Mukherjee & Ramesh, 2015).

3. Acid Tolerance Assay

To simulate gastric conditions, overnight-grown cultures were centrifuged, and the pellet was inoculated into MRS broth adjusted to pH 3.0. The suspension was incubated at 37°C for 2–3 h. Viability was assessed through optical density measurement and viable plate counts.

Survival at low pH is considered essential for probiotic functionality, as gastric acidity represents the first major barrier to intestinal colonization (Tripathi & Giri, 2014; Nawaz et al., 2017).

4. Bile Salt Tolerance Assay

Bile tolerance was evaluated by inoculating the isolate into MRS broth supplemented with 1% bile salts and incubating at 37°C for 2 h. Optical density was recorded at 620 nm, and viable counts were determined using the spread plate technique.

Resistance to bile salts is an important criterion for probiotic selection, as bile exposure occurs in the small intestine (Zhang et al., 2020).

5. Preparation of Amla–Sugarcane Juice Substrate

Fresh amla (*Phyllanthus emblica*) and sugarcane (*Saccharum officinarum*) were procured from a local market. Sugarcane was cleaned, peeled, and juiced, while amla fruits were washed, deseeded, and homogenized with sterile water in a 1:1 ratio. The extracts were filtered using a sterile muslin cloth to obtain clarified juice.

Equal volumes of amla and sugarcane juice were blended to form the fermentation substrate. The mixture was pasteurized and cooled before inoculation to eliminate undesirable microflora and ensure controlled fermentation (Pimentel et al., 2015).

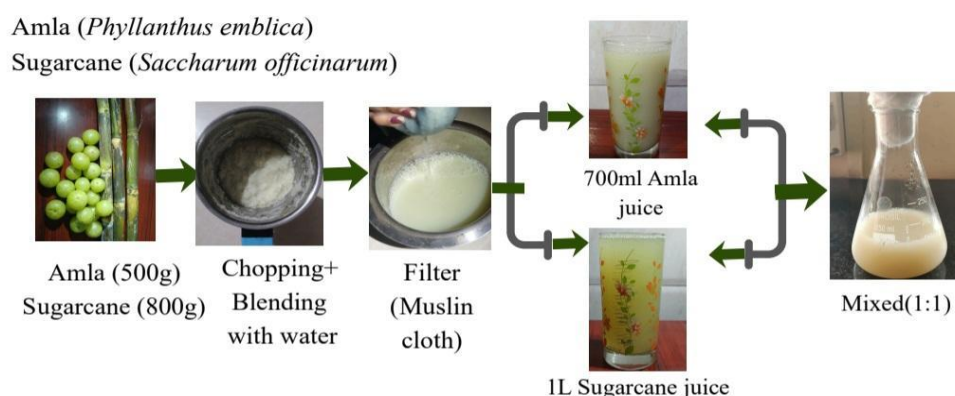


Fig. a) Procedure to make Amla and Sugarcane juice

6. Fermentation Process

Two formulations were prepared:

- Control – Juice blend without inoculum
- Experimental – Juice blend inoculated with 1 mL of LAB culture

Fermentation was carried out at ambient temperature for 24 h, followed by storage at 4°C. LAB-driven fermentation of fruit matrices typically results in acid production within 24 hr. (Swain et al., 2014).

7. Physicochemical Analysis

pH and Titratable Acidity

pH was measured using a digital pH meter. Titratable acidity was determined using standard titration methods and expressed as percentage lactic acid. Acid production reflects LAB metabolic activity and contributes to microbial stability (Marco et al., 2017).

Ethanol Estimation

Ethanol content was estimated using the potassium dichromate method to confirm compliance with non-alcoholic beverage standards. Results were interpreted according to the Food Safety and Standards Authority of India (FSSAI, 2011).

8. Viable Cell Count

Serial dilutions were plated on MRS agar and incubated at 37°C for 48 hr. Colonyforming units (CFU/mL) were calculated. Probiotic beverages are generally required to contain 10^6 – 10^9 CFU/mL to exert beneficial effects (Hill et al., 2014).

9. Safety Assessment

Hemolytic activity was assessed by streaking the isolate on blood agar and observing hemolysis patterns after 24 hr at 37°C. Gelatinase and DNase production were evaluated using standard plate assays to detect extracellular virulence-associated enzymes.

The assessment was performed according to probiotic safety guidelines, emphasizing the absence of hemolytic and pathogenic traits (Hill et al., 2014).

3. RESULTS AND DISCUSSION

The isolate obtained from idli batter produced smooth, creamy colonies on MRS agar. Microscopic examination revealed Gram-positive, rod-shaped, non-spore-forming cells.

The isolate was catalase-negative and oxidase-negative, consistent with the metabolic profile of lactic acid bacteria (Tamang et al., 2016).

Carbohydrate fermentation assays demonstrated utilization of glucose and sucrose, confirming fermentative metabolism. (Table no 1).These characteristics align with LAB populations previously reported in idli batter fermentation (Mukherjee & Ramesh, 2015; Soni & Sandhu, 1990). The phenotypic profile was comparable to *Lactiplantibacillus plantarum* strains isolated from cereal-based fermented foods (Agaliya & Jeevaratnam, 2013).

Table No 1: Biochemical profile of the isolate.

Biochemical Tests	Result
Glucose	+
Sucrose	+
Maltose	+
Galactose	+
Methyl Red	+
Voges–Proskauer	-
Citrate	-
Indole	-
Lysine	-
Catalase	-
Oxidase	-

1. Acid and Bile Tolerance

The isolate retained viability after 3 hours exposure to pH 3.0, indicating tolerance to simulated gastric conditions. Similarly, survival in 1% bile salts demonstrated intestinal resilience. Tolerance to gastric acidity and bile salts is widely recognized as a prerequisite for probiotic efficacy, as these stressors determine survival during gastrointestinal transit (Tripathi & Giri, 2014; Zhang et al., 2020). Comparable tolerance patterns have been reported in LAB isolated from traditional South Indian fermented foods (Sridevi & Halami, 2018; Sircar & Mandal, 2023).

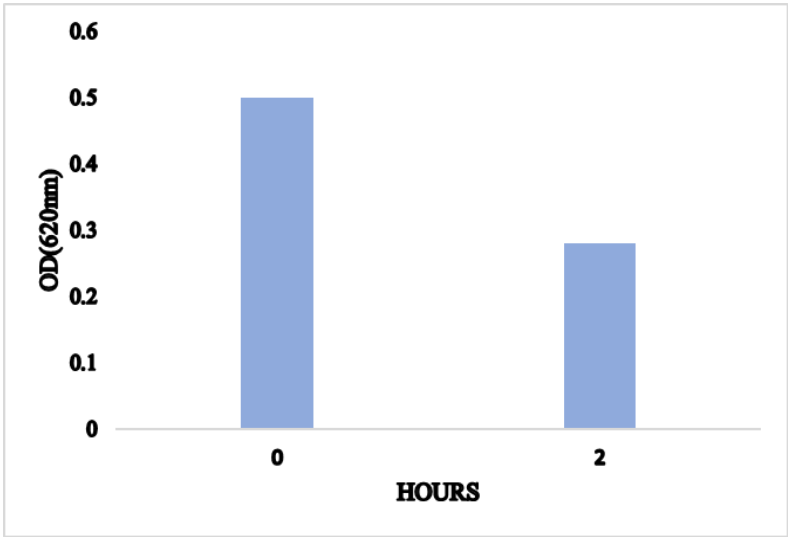


Fig: a) Graph of bile tolerance assay.

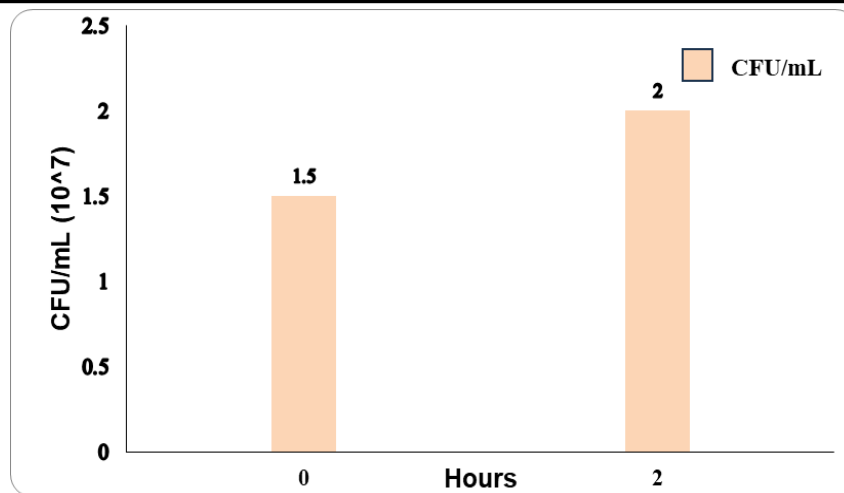


Fig: b) Graph of acid tolerance assay.

2. Fermentation Performance and Physicochemical Changes

Fermentation of the amla–sugarcane substrate resulted in a noticeable decrease in pH accompanied by increased titrable acidity, indicating active lactic acid production. Acidification enhances product safety by suppressing undesirable microorganisms (Marco et al., 2017).

Ethanol concentration was 0.56%, remaining within permissible limits for non-alcoholic beverages under FSSAI regulations (FSSAI, 2011). Although sugar-rich substrates can favour ethanol formation in mixed fermentations, LAB-dominated systems primarily convert sugars into organic acids rather than alcohol (Swain et al., 2014).

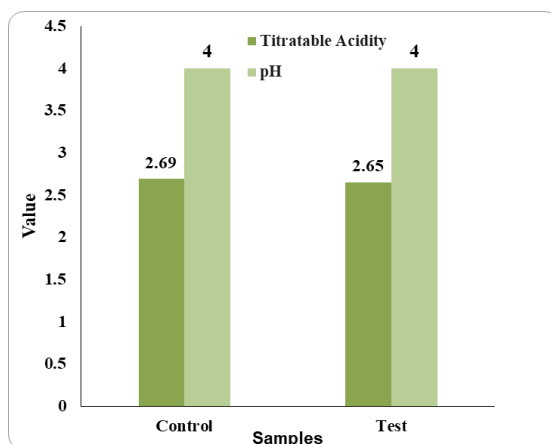


Fig c) Graph of Titrable Acidity and pH

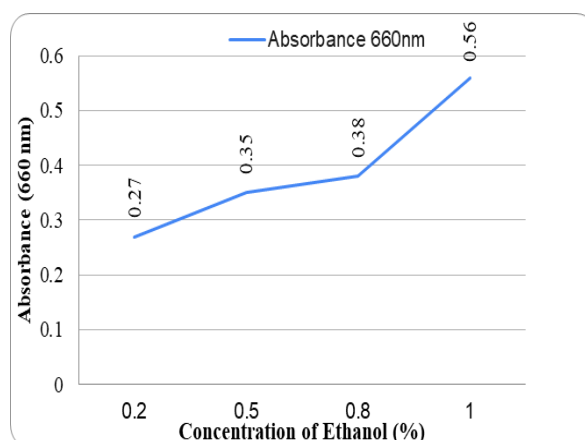


Fig d) Graph of ethanol estimation.

3. Viability in Plant-Based Matrix

The fermented beverage maintained a viability of ~90% (1.35×10^8 CFU) after 72 hours of fermentation, satisfying the minimum recommended probiotic threshold (Hill et al., 2014).

Fruit matrices often contain phenolic compounds that may inhibit microbial growth; however, the present isolate remains stable within the amla–sugarcane system. Similar observations have been reported in fruit-based probiotic beverages (Pimentel et al., 2015; Martins et al., 2013).

4. Safety Evaluation

The isolate exhibited γ -hemolysis on blood agar, indicating the absence of hemolytic activity. No gelatinase or DNase production was detected, suggesting a lack of extracellular virulence factors.

According to international probiotic consensus guidelines, the absence of hemolysis and pathogenic enzymatic activity is essential for probiotic qualification (Hill et al., 2014). The isolate satisfied these safety criteria, supporting its suitability for application in functional beverage development.

4. CONCLUSION

The current study shows that lactic acid bacteria isolated from a traditional Indian fermented food can be used to create a safe and effective non-dairy probiotic beverage. The potential probiotic characteristics of the native LAB strain included compatibility with a plant-based amla-sugarcane substrate, safety conformity, and resistance to gastrointestinal stressors. The prepared beverage demonstrated acceptable sensory quality and sustained significant microbiological viability throughout storage without going over allowable alcohol levels.

In addition to its scientific value, this work demonstrates how traditional fermentation knowledge can be translated when analysed using contemporary microbiological frameworks. Utilizing indigenous microbial cultures and locally accessible plant resources, the formulation promotes cost-effective functional nutrition while lowering reliance on dairy-based probiotic systems. These resource-conscious, plant-based methods support sustainable development goals (SDG 12: Responsible Consumption and Production) and public health (SDG 3: Good Health and Well-Being), two worldwide concerns. The study offers a fundamental framework for combining evidence-based functional food development with culturally based culinary wisdom.

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IMPACT OF ARTIFICIAL INTELLIGENCE ON STOCK MARKET TRADING

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ABSTRACT

Significant changes have been observed in the functioning of financial markets, especially stock market trading, owing to the rapid development of artificial intelligence technology. Artificial intelligence technology, including machine learning and data analytics, is being used by investors and traders to make informed decisions regarding stock market trading. This technology can process a huge amount of data related to stock prices and market trends at a faster rate than a normal human being.

Significant changes have been observed in the functioning of stock market trading owing to the integration of artificial intelligence technology. This has led to the emergence of a new type of stock market trading, including automated and algorithmic trading. This technology has helped in improving the accuracy of stock market trading and reducing errors. The AI-based tools also help the investors in the portfolio management, risk assessment, and real-time market analysis. This makes the trading process quicker.

However, the increasing use of artificial intelligence in the stock markets has also given rise to a number of problems. These problems include the volatility of the market, ethics, transparency of the decisions taken by the algorithms, etc. Despite all these problems, artificial intelligence is revolutionizing the dynamics of the modern stock markets by offering innovative tools for the investment analysis of the stock markets.

The objective of this study is to analyze the impact of artificial intelligence on the stock market trading. The study aims to analyze the role of artificial intelligence in the efficient trading of the stocks, the influence of artificial intelligence on the decisions of the investors, and the changes brought by artificial intelligence in the traditional stock market trading.

Keywords: Artificial Intelligence, Stock Market Trading, Algorithmic Trading, Machine Learning, Financial Markets, Investment Decision-Making, Data Analytics, Automated Trading, Market Analysis, Risk Management.

INTRODUCTION

The stock market has been recognized to play a crucial role in the development of the economy of a country, and this has been achieved through the mobilization of resources and the creation of investment opportunities for individuals and firms. The stock exchange, on the other hand, has been recognized to operate in a way that allows securities to be traded, and this includes shares, bonds, and derivatives. The stock exchanges in India, including the Bombay Stock Exchange and the National Stock Exchange of India, have greatly contributed to the development of the financial market in the country.

Over the last few decades, technology has greatly changed the way in which stock exchanges operate, and this has been achieved by shifting from traditional methods of trading to more advanced technologies. The most prominent technology change in the financial industry has been the concept of artificial intelligence. Artificial intelligence has been defined to be computer systems and algorithms that have the ability to perform functions that require human intelligence, including learning, pattern recognition, and decision-making.

In the case of stock market trading, artificial intelligence is commonly employed in analyzing large quantities of financial data, recognizing market patterns, and forecasting market prices in the future. The AI systems employed in trading make use of machine learning algorithms, data mining, and prediction analysis in processing complex data, such as historical price data, trading volumes, news, and investor sentiment, among other factors. This has helped in making more accurate and timely decisions, thereby improving trading efficiency and market performance.

Another important feature that has been achieved in the context of artificial intelligence is the development of algorithmic trading, in which trading programs are employed in executing buy and sell orders in the stock market in accordance with specific market conditions and algorithms. The AI systems employed in trading are capable of processing market changes in real-time and executing trading operations in a matter of fractions of a second, a feature that is difficult to attain in the case of human traders.

However, despite all these advantages, some problems related to artificial intelligence in stock trading also exist. Problems related to artificial intelligence in stock trading include issues of market volatility, technology

dependence, lack of transparency in decision-making processes, and system failures. Such problems have become important issues for discussion in relation to artificial intelligence in stock trading. Hence, it is important to consider the overall impact of artificial intelligence in stock trading.

The objective of this research paper is to understand how artificial intelligence is impacting stock trading practices, investor decisions, and financial market efficiency. In addition, the paper also identifies the opportunities and problems related to artificial intelligence in stock trading and their overall impact on the future of global financial markets.

OBJECTIVES OF THE STUDY

1. To study the role played by artificial intelligence in modern stock market trading.
2. To study how artificial intelligence assists in analyzing data and predicting stock prices.
3. To study how artificial intelligence-based trading systems have affected the efficiency and speed of stock exchange transactions.
4. To study how artificial intelligence has affected investors in terms of decision-making in stock exchange trading.
5. To study the pros and cons of artificial intelligence in stock exchange trading.
6. To study how AI-based technologies like algorithmic trading are revolutionizing stock exchange trading.
7. To study the risks and challenges involved in artificial intelligence in stock exchange trading.
8. To study how artificial intelligence can be used in the future in terms of developing stock exchange trading systems, especially in exchanges like Bombay Stock Exchange or National Stock Exchange India.

RESEARCH METHODOLOGY

Research methodology can be defined as a systematic process of data collection and analysis to fulfill the objectives of a particular study. It is a framework or guide to carry out research in a systematic and scientific manner. The aim and objective of this study are to identify and determine the impact of artificial intelligence on stock market trading. The methodology used for this study is as follows.

1. Research Design

The study has used a descriptive research design. The objective of descriptive research is to describe and analyze a particular situation or phenomenon. In this study, the objective is to identify and determine how artificial intelligence affects stock market trading.

2. Nature of the Study

The study is analytical and descriptive in nature. The study focuses on analyzing and determining the role of artificial intelligence in stock market trading.

3. Sources of Data

The study is based on both primary data and secondary data.

Primary Data

The primary data was collected through a structured questionnaire survey carried out among people who have a basic idea about stock market trading.

Sample Size: 50 respondents

Sampling Method: Convenience method

Data Collection Tool: Questionnaire containing multiple-choice questions related to awareness and perception of artificial intelligence in stock market trading.

Secondary Data

The secondary data was collected from various reliable sources, including:

- * Research journals and academic publications
- * Books on finance and artificial intelligence
- * Financial magazines and newspapers
- * Online articles and research reports

* Official websites of stock exchanges, including Bombay Stock Exchange and National Stock Exchange of India

4. Method of Data Analysis

The data has been analyzed using simple statistical tools like tables, percentages, and graphical representations, which help in presenting the data in a simple and understandable form and also in understanding the various trends and impacts of artificial intelligence on stock market trading.

5. Scope of the Study

1. Scope of the study refers to the boundary within which the research is conducted, which includes the areas that are covered by the research.
2. The study aims at understanding the impact of artificial intelligence on stock market trading, how artificial intelligence influences the stock markets of today, and so on.
3. The study also aims at understanding how artificial intelligence-based technology, such as machine learning, predictive analysis, algorithmic trading, etc., can be used for improving the efficiency of stock markets.
4. Additionally, the study aims at understanding the awareness level of investors and other individuals about artificial intelligence-based stock market trading.
5. Also, the study includes the understanding of how modern stock markets, such as Bombay Stock Exchange, National Stock Exchange of India, etc., operate.
6. In terms of data collection, the study includes both primary data collected through questionnaires and secondary data collected from books, journals, online, etc.
7. Also, the study mainly focuses on the conceptual understanding of artificial intelligence-based stock markets, rather than the actual technology used for stock markets.

6. Limitations of the Study

- I. Every research study has some limitations, which may influence the research study undertaken. The major limitations of the research study undertaken in this research paper are as follows:
- II. The research study undertaken is based on a limited sample size of 50 respondents, which may not be representative of the entire population of investors.
- III. The primary data for the research study undertaken has been collected through a questionnaire, which depends on the honesty, knowledge, and understanding of the respondents.
- IV. The research study undertaken focuses on the general perceptions of the respondents about artificial intelligence used for stock market trading.
- V. Due to the constraints of time, the research study undertaken is based on both primary and secondary data, which has been collected from existing publications.
- VI. The research study undertaken does not include the detailed technical analysis of artificial intelligence used for stock market trading.
- VII. The research findings of the study undertaken may vary with changes in technology, as the field of artificial intelligence is constantly evolving.

LITERATURE REVIEW

Literature review is an essential part of a research paper, and it helps in understanding the research work already done in the same field of study. Many researchers have studied the role of technology and artificial intelligence in financial markets.

Eugene F. Fama, in his study published in (1970), proposed the concept of Efficient Market Hypothesis, which states that stock prices reflect all the information present in the financial market. The advent of artificial intelligence has made the analysis of the financial market more efficient, as artificial intelligence can process more information in less time.

In his study published in **(2013)**, **Michael Kearns and Yuriy Nevmyvaka** discussed the role of machine learning in financial markets. The study showed how machine learning models can effectively analyze the financial market and increase the accuracy of trading decisions.

Ernest Chan, in his study published in (2017), discussed various algorithmic trading strategies and how artificial intelligence helps traders in making more accurate decisions.

Tucker Balch, in his study published in (2018), discussed the role of artificial intelligence in quantitative trading. The study showed how artificial intelligence models can recognize complex patterns in financial markets, which even traders fail to recognize.

In conclusion, the literature review reveals that artificial intelligence makes a significant contribution to the efficiency, speed, and accuracy of stock market transactions. Nevertheless, there are concerns about the transparent nature of technology, technological risks, and ethical issues associated with automated stock exchange systems.

Hypothesis of the Study

A hypothesis is a tentative statement that predicts the possible relationship between variables and can be tested through research and analysis. The hypothesis is created in this study to assess the impact of artificial intelligence on stock market trading.

Null Hypothesis (H_0)

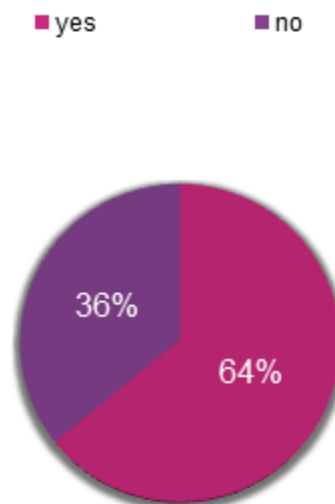
There is no significant impact of artificial intelligence on stock market trading and investor decisions.

Alternative Hypothesis (H_1)

There is a significant impact of artificial intelligence on stock market trading and investor decisions.

Data Analysis & Interpretation

Q1. Do you invest in the stock market?

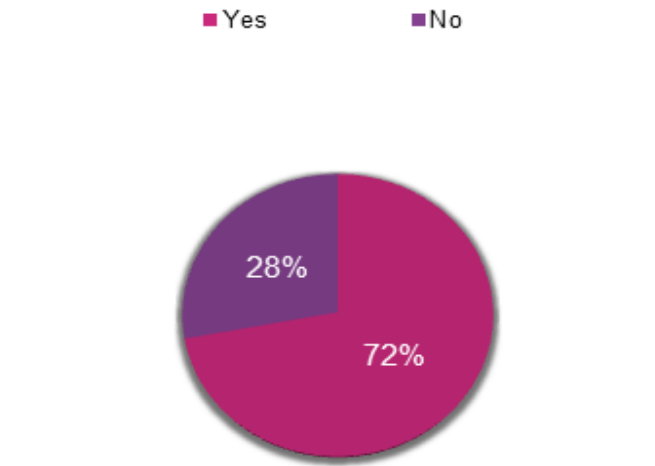


Response	Number of Respondents	Percentage
Yes	32	64%
No	18	36%
Total	50	100%

Interpretation:

The above table and pie diagram represent the views and feedback from the participants on their investment in the stock market. Out of the total participants, i.e., 50, 32 participants (64%) responded that they invest in the stock market, and the remaining 18 participants (36%) responded that they do not invest in the stock market. This reflects that a majority of the participants are experienced in the stock market, and this will help in understanding the impact of artificial intelligence on the stock market trading from their perspective.

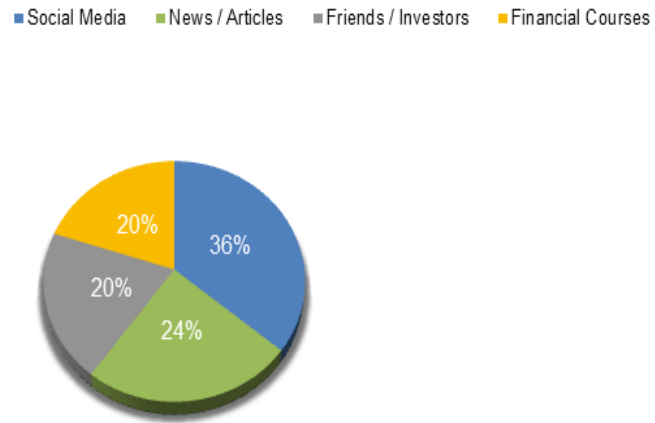
Q2. Are you aware of Artificial Intelligence used in stock market trading?



Response	Number of Respondents	Percentage
Yes	36	72%
No	14	28%
Total	50	100%

Interpretation:
From the data, it can be seen that 72% of the respondents know about Artificial Intelligence used for stock market trading, while 28% of the respondents do not know about it. This shows that the majority of the investors are aware of the AI technology used for financial markets, which can be attributed to the increasing level of digitalization, financial news, etc.

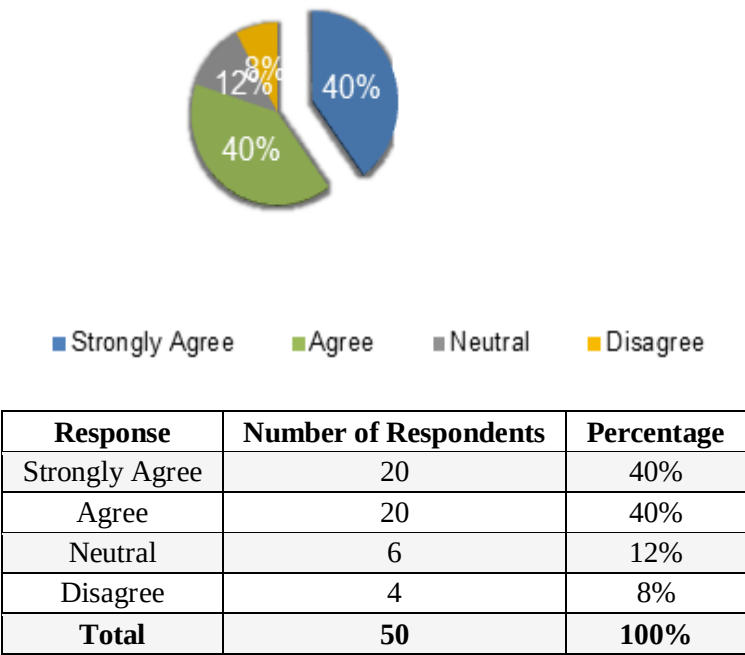
Q3. Where did you learn about AI in stock trading?



Response	Number of Respondents	Percentage
Social Media	18	36%
News / Articles	12	24%
Friends / Investors	10	20%
Financial Courses	10	20%
Total	50	100%

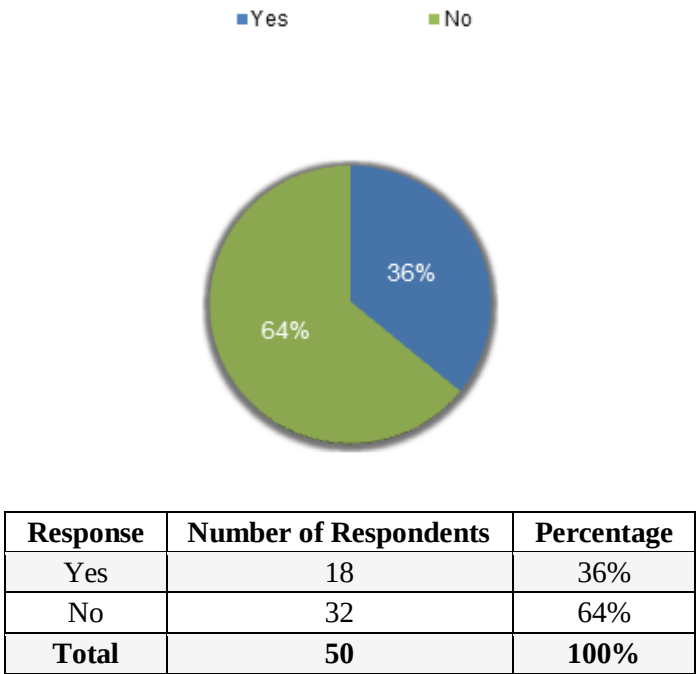
Interpretation:
The table indicates that 36% of respondents learned about AI in stock trading through social media, making it the most common source of information. 24% gained knowledge through news or articles, while 20% learned from friends or investors, and another 20% through financial courses. This shows that digital media plays a significant role in spreading awareness about AI in financial markets.

Q4. Do you think AI helps in predicting stock market trends?



Interpretation:
The findings reveal that the majority of the respondents, that is, 80%, either strongly agree or agree with the statement that AI helps in the prediction of stock market trends. Only 12% of the respondents are neutral, while 8% disagree with the statement. This implies that the majority of the participants are of the view that AI technologies assist in the efficient analysis of data for the betterment of the stock market.

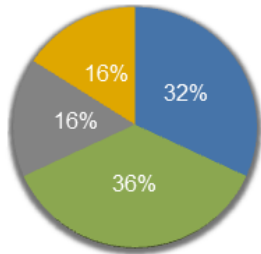
Q5. Have you ever used AI-based tools for stock trading?



Interpretation:
The findings reveal that 36% of the respondents have used AI-based tools or recommendations for stock trading, while the remaining 64% have not used these tools or recommendations. This implies that though the awareness of AI is high, the adoption of AI-based tools for trading is low.

Q6. According to you, what is the biggest advantage of AI in stock trading?

■ Faster Decision Making ■ Better Market Analysis ■ Reduced Human Errors ■ Automated Trading



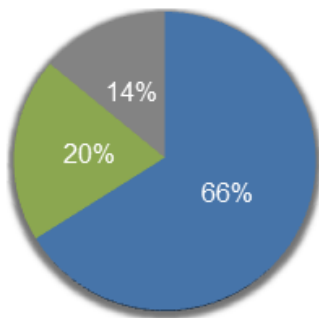
Response	Number of Respondents	Percentage
Faster Decision Making	16	32%
Better Market Analysis	18	36%
Reduced Human Errors	8	16%
Automated Trading	8	16%
Total	50	100%

Interpretation:

The results show that 36% of the population believe that the biggest advantage of AI in the market is its ability to analyze the market, followed by 32% who believe that the biggest advantage of AI in the market is its ability to make faster decisions. On the other hand, 16% of the population believes that AI helps to reduce errors, and 16% believe that the biggest advantage of AI in the market is its ability to make trades on its own. This shows that investors believe AI has the biggest value in its ability to analyze the market.

Q7. Do you think AI reduces emotional decision-making?

■ Yes ■ No ■ Not Sure



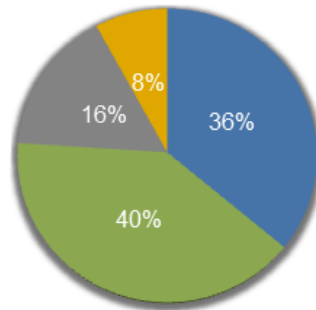
Response	Number of Respondents	Percentage
Yes	33	66%
No	10	20%
Not Sure	7	14%
Total	50	100%

Interpretation:

The results show that 66% of respondents believe AI reduces emotional decision-making in trading, while 20% disagree and 14% are unsure. This suggests that most investors perceive AI as a tool that can help make more rational and data-driven investment decisions.

Q8. Do you believe AI can improve investment returns?

■ Strongly Agree ■ Agree ■ Neutral ■ Disagree



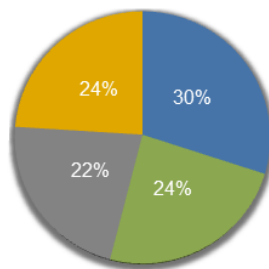
Response	Number of Respondents	Percentage
Strongly Agree	18	36%
Agree	20	40%
Neutral	8	16%
Disagree	4	8%
Total	50	100%

Interpretation:

The findings indicate that 76% of respondents either strongly agree or agree that AI-based trading can improve investment returns. Only 16% remain neutral, and 8% disagree. This shows that a large proportion of investors believe AI technologies have the potential to enhance profitability in stock market investments.

Q9. Risks of AI trading

■ Market Volatility ■ System Errors ■ Lack of Transparency ■ Over-dependence on Technology

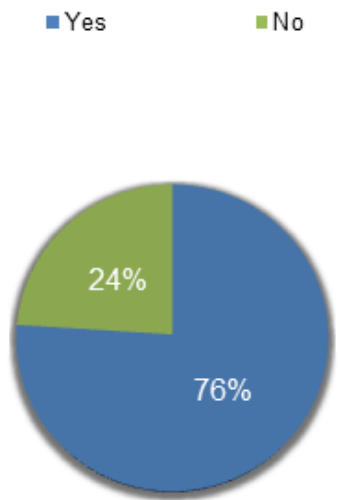


Response	Number of Respondents	Percentage
Market Volatility	15	30%
System Errors	12	24%
Lack of Transparency	11	22%
Over-dependence on Technology	12	24%
Total	50	100%

Interpretation:

The responses reveal that 30% of participants consider market volatility as the biggest risk of AI trading, followed by 24% who fear system errors and 24% who believe over-dependence on technology could be risky. Additionally, 22% are concerned about the lack of transparency in AI algorithms. These concerns highlight the potential challenges associated with AI-based trading systems.

Q10. Do you think AI will dominate future stock market trading?



Response	Number of Respondents	Percentage
Yes	38	76%
No	12	24%
Total	50	100%

Interpretation:

The table shows that 76% of respondents believe AI will dominate future stock market trading, while 24% do not share this opinion. This indicates a strong expectation among investors that artificial intelligence will play an increasingly important role in shaping the future of financial markets.

Importance of the Study

The significance of the impact of artificial intelligence on stock market trading is extremely important in the modern financial environment. The rapid evolution of technology has revolutionized the stock market environment, and the impact of artificial intelligence has been one of the most significant factors in the stock market ecosystem. The role of AI in the stock market ecosystem has provided significant insights into the modern stock market environment to investors, researchers, and institutions.

Firstly, the significance of the impact of AI on the stock market is that it has greatly improved the efficiency of stock market trading. Artificial intelligence has the ability to process large amounts of financial information in mere seconds, enabling the identification of patterns that may not be easily identified by human beings. The analysis of past stock market trends, stock market volumes, and stock price fluctuations enables AI systems to facilitate swift investment decisions for investors.

Secondly, the study illustrates how artificial intelligence improves decision-making for investors and traders. The AI technology uses advanced techniques like machine learning to predict possible trends in the stock exchange market. The technology offers investors important information that enables them to minimize uncertainty in making proper investment strategies in the stock exchange market.

Thirdly, the research study is essential in the sense that artificial intelligence technology plays a significant role in the creation of algorithmic trading systems in the stock exchange market. Algorithmic trading allows traders to trade electronically through computer programs that enable trading activities to be carried out automatically. The process allows traders to trade accurately and quickly without emotional interference.

Another significant aspect of the study is the relevance of the research to the development of modern financial markets. The Bombay Stock Exchange, the National Stock Exchange of India, and other prominent stock exchanges have been incorporating the latest technologies to enhance the efficiency of the markets. The significance of the research lies in the fact that it helps in understanding the role of AI in the development of the future of such financial markets.

In addition to the above, the significance of the research lies in the fact that it is beneficial to financial institutions as it highlights the advantages as well as the disadvantages of AI-based systems in the field of finance. It is also beneficial to the financial institutions as it may pose risks such as market volatility,

technological risks, and transparency risks. Hence, it can be helpful in framing the necessary policies to regulate the markets in the right manner.

Finally, this research contributes to knowledge in the fields of finance and technology. This is because, as artificial intelligence develops and improves, it is critical for researchers, students, and professionals to understand the impact of artificial intelligence on stock market trading if they want to understand the latest trends in finance.

CONCLUSION

Artificial Intelligence (AI) has become one of the most important technological innovations in the stock market trade field. The involvement of AI technology in financial markets has greatly enhanced the efficiency, speed, and accuracy of stock trade decisions. AI technology can analyze financial data, identify patterns, and predict stock market trends much better than traditional techniques. Therefore, investors and financial institutions are increasingly relying on AI technology for stock market analysis.

The findings of the research study reveal that the majority of the respondents are aware of the involvement of AI technology in stock market trade decisions and believe that AI technology plays a vital role in predicting stock market trends and generating higher profits for investors. The advantages of AI technology, such as faster decision-making, better stock analysis, and minimization of emotional involvement, clearly indicate the significance of AI technology.

However, the research study findings reveal that there are some concerns about AI technology-based stock trade decisions. The risks associated with AI technology-based stock trade decisions include market volatility, system failures, lack of transparency, and over-reliance on technology, which clearly indicate that AI technology-based stock trade decisions should be implemented with proper regulations, monitoring, and human involvement.

In conclusion, the study has shown that Artificial Intelligence has the potential to influence the future of stock market trading in that it has the ability to make the markets more efficient and advanced in terms of technology. As AI technologies continue to improve, its use in trading activities is likely to improve as well, though a balance between the two is needed in order to ensure growth in the financial markets.

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INDIAN KNOWLEDGE SYSTEMS (IKS): INTEGRATING TRADITIONAL WISDOM WITH INNOVATION AND SUSTAINABLE CONTEMPORARY MANAGEMENT PRACTICES

Dr. Umesh P. Kabadi

➤ **ABSTRACT**

Indian Knowledge Systems (IKS) are an extensive collection of indigenous knowledge based on sustainability, ethics, governance, and holistic human development. A value-based and sustainable approach is necessary for management practices in today's dynamic corporate world, which is characterized by ethical problems, climate concerns, and rapid technological progress. This paper examines how modern management techniques like ESG frameworks, stakeholder theory, circular economy models, and ethical leadership can be combined with traditional Indian philosophical ideas. Fundamental ideas like trusteeship, ecological harmony, Nishkama Karma (selfless action), and Dharma (ethical responsibility) provide significant insights for ethical decision-making and long-term organizational growth.

By drawing connections between classical Indian thought and modern strategic management, the study emphasizes the importance of IKS in corporate governance, human resource development, innovation, and sustainability practices. Using a conceptual research approach, this study provides an integrative framework that combines tradition and innovation to foster resilient and purpose-driven organizations. The study indicates that IKS provides both philosophical depth and practical managerial tools for attaining inclusive growth and sustainable development in today's global corporate world.

Keywords: Indian Knowledge Systems (IKS), Sustainable Management, Ethical Leadership, ESG Framework, Stakeholder Theory, Circular Economy, Corporate Governance, Innovation, Trusteeship, Dharma.

➤ **STATEMENT OF PROBLEM**

Modern management approaches, although emphasizing efficiency and expansion, frequently fail to address ethical quandaries, sustainability issues, and long-term stakeholder value. Indian Knowledge Systems (IKS), which emphasize ethical behavior, holistic growth, and environmental sustainability, are mostly neglected in modern management frameworks. There is a significant research vacuum in combining traditional Indian knowledge with modern methodologies like ESG, stakeholder theory, and sustainable innovation. As a result, the purpose of this research is to look at how IKS can be effectively integrated with modern management methods to build a more ethical, sustainable, and value-driven organizational model.

➤ **SCOPE OF THE STUDY:**

This study looks at the relevance and implementation of Indian Knowledge Systems (IKS) in modern management practices. It aims to combine classical ideas such as ethical governance, sustainability, trusteeship, and holistic leadership with contemporary frameworks such as ESG, stakeholder theory, circular economy, and strategic management. The study is conceptual in nature and focuses on management education and organizational practices, namely in the areas of corporate governance, human resource management, innovation, and sustainable development. It focuses on the administrative and strategic consequences of IKS in today's corporate environment rather than the technical or scientific elements.

➤ **OBJECTIVE OF THE STUDY:**

- To examine the core principles of Indian Knowledge Systems (IKS) relevant to management and governance.
- To analyze the relevance of traditional Indian wisdom in addressing contemporary business challenges.
- To explore the integration of IKS with modern management frameworks such as ESG, stakeholder theory, and sustainable development.
- To evaluate the role of ethical leadership and trusteeship in promoting responsible corporate governance.
- To assess how IKS principles can support innovation, strategic management, and organizational resilience.

➤ **HYPOTHESIS**

Objective 1:

- **H0₁:** Core principles of Indian Knowledge Systems have no significant relevance to modern management and governance practices.

- **H1₁:** Core principles of Indian Knowledge Systems have significant relevance to modern management and governance practices.

Objective 2:

- **H0₂:** Traditional Indian wisdom does not significantly contribute to addressing contemporary business challenges.
- **H1₂:** Traditional Indian wisdom significantly contributes to addressing contemporary business challenges.

Objective 3:

- **H0₃:** There is no significant relationship between IKS principles and modern management frameworks such as ESG and stakeholder theory.
- **H1₃:** There is a significant relationship between IKS principles and modern management frameworks such as ESG and stakeholder theory.

Objective 4:

- **H0₄:** Ethical leadership and trusteeship do not significantly influence responsible corporate governance.
- **H1₄:** Ethical leadership and trusteeship significantly influence responsible corporate governance.

Objective 5:

- **H0₅:** IKS principles do not significantly support innovation, strategic management, and organizational resilience.
- **H1₅:** IKS principles significantly support innovation, strategic management, and organizational resilience.

➤ RESEARCH METHODOLOGY

This study relies solely on secondary data analysis and employs a descriptive and conceptual research design. The study examines the significance of Indian Knowledge Systems (IKS) in contemporary management practices using a comprehensive analysis of available literature.

Secondary data was gathered from published publications, peer-reviewed research journals, conference proceedings, government reports, policy documents on NEP and IKS, corporate sustainability reports, and trustworthy academic databases. Classical Indian texts and current management literature were compared to build conceptual links between traditional knowledge and modern frameworks like ESG, stakeholder theory, ethical leadership, and sustainable development.

The study interprets and synthesizes findings from multiple sources through the use of content analysis and comparison analysis. No primary surveys or field investigations have been done. The conclusions are based on theoretical interpretation and a careful examination of previous scholarly work.

➤ INTRODUCTION

Indian Knowledge Systems (IKS) are a huge and structured collection of indigenous learning accumulated over ages on the Indian subcontinent. These systems include government, economics, ethics, environmental management, social organization, education, and holistic human development. IKS, founded on philosophical principles of balance, duty, sustainability, and community welfare, provides an integrated worldview that connects economic success, social responsibility, and ecological harmony. In today's world, where organizations face complex challenges such as climate change, ethical breakdowns, stakeholder activism, technological disruption, and sustainability pressures, there is an increasing need to revisit traditional knowledge frameworks that promote long-term, value-based development.

Corporate governance, stakeholder theory, ESG frameworks, sustainable development, and responsible innovation are examples of modern management theories that have progressed significantly. Despite these advances, many organizations continue to struggle with short-term profit maximization, environmental damage, social inequity, and falling ethical standards. This demonstrates a disconnect between theoretical frameworks and real value-based implementations. Indian Knowledge Systems offer a philosophical and strategic underpinning for bridging this gap by combining ethical responsibility with management efficiency.

Dharma (righteous behavior), Nishkama Karma (selfless action), trusteeship, ecological balance, and holistic leadership are all values emphasized in classical Indian philosophy. These principles are more than just spiritual ideas; they serve as practical guidance for governance and management. Ancient Indian treatises, such as

Chanakya's Arthashastra, provide systematic insights into statecraft, economic regulation, taxes, risk management, and strategy. Similarly, the Bhagavad Gita provides insightful advice on ethical leadership, decision-making under uncertainty, and duty-centered management. In current times, Mahatma Gandhi's theory of trusteeship encourages responsible wealth generation and equitable distribution, which is closely aligned with contemporary stakeholder capitalism and sustainability models.

The importance of IKS in management stems from its holistic and long-term perspective. Unlike traditional profit-driven approaches, IKS advocates the notion that corporations serve as social institutions responsible to society and nature. Concepts like harmony with nature are firmly aligned with the modern circular economy and sustainable development aims. Ethical leadership rooted in Indian philosophy is consistent with modern standards of transparency, accountability, and government integrity. Furthermore, the emphasis on self-discipline, awareness, and balance is highly beneficial to modern human resource development and organizational behavior practices.

In the context of management education and policy changes, particularly within multidisciplinary and value-based learning frameworks, incorporating IKS into business curricula helps build culturally rooted but internationally relevant managerial competencies. Indian Knowledge Systems offers a sustainable management paradigm that combines ethical responsibility, strategic foresight, and social welfare by linking tradition and innovation. As a result, investigating the integration of IKS with contemporary management techniques is not only academically important but also practically necessary for developing resilient, accountable, and future-ready firms in the twenty-first century.

➤ **Need of The Study**

In the present global business environment, Organizations face numerous issues in the global economic environment, including ethical crises, environmental degradation, social injustice, corporate governance failures, and unsustainable growth models. Although modern management frameworks such as ESG, stakeholder theory, and sustainable development try to address these problems, there is still a gap in the integration of deep-rooted ethical and value-based viewpoints into corporate decision-making processes. This emphasizes the importance of investigating alternative and holistic ways that can improve current management processes. Indian Knowledge Systems (IKS) provide a time-tested framework for ethical governance, environmental stewardship, social responsibility, and strategic foresight. However, despite their importance, these classical ideas are frequently ignored in mainstream management education and corporate strategy. There is little formal research that links IKS concepts to modern management frameworks and sustainability practices.

Therefore, it is essential to investigate how indigenous wisdom might enhance and supplement modern management techniques. By proving that IKS principles are useful instruments for responsible leadership, stakeholder involvement, and long-term organizational growth, it aims to close the gap between tradition and innovation. Additionally, incorporating IKS into management studies can help create socially conscious and ethically grounded company leaders within the framework of educational reforms and interdisciplinary learning paradigms. Therefore, this study is crucial for advancing a value-driven, sustainable, and balanced management paradigm that is appropriate for the changing needs of the twenty-first century.

➤ **LITERATURE REVIEW**

Kautilya's Arthashastra and Strategic Management

- The Arthashastra by Chanakya provides detailed insights into governance, economic administration, taxation systems, risk management, and strategic planning. Scholars argue that its structured approach to statecraft resembles modern strategic management concepts such as SWOT analysis, competitive intelligence, and crisis management. The text highlights accountability, welfare orientation, and ethical governance, making it relevant to contemporary corporate governance and policy formulation.

Ethical Leadership in the Bhagavad Gita

- The Bhagavad Gita emphasizes Dharma (righteous duty) and Nishkama Karma (selfless action), which form the foundation of ethical leadership and value-based decision-making. Modern management scholars relate these principles to transformational leadership, emotional intelligence, and purpose-driven management. The Gita's teachings promote clarity in decision-making under uncertainty, aligning closely with contemporary leadership and organizational behavior theories.

Gandhian Trusteeship and Stakeholder Theory

- Mahatma Gandhi proposed the concept of trusteeship, suggesting that wealth creators act as custodians of societal resources rather than absolute owners. This philosophy parallels modern stakeholder theory and

corporate social responsibility (CSR). Literature indicates that Gandhian economics supports inclusive growth, equitable distribution, and sustainable enterprise models, which resonate with present-day ESG frameworks.

Indian Ecological Wisdom and Sustainable Development

- Traditional Indian practices emphasize harmony with nature and responsible consumption. Researchers highlight that ancient community-based resource management systems reflect principles similar to today's circular economy and sustainable development goals (SDGs). Literature suggests that indigenous environmental ethics can strengthen modern sustainability strategies and corporate environmental governance.

IKS and Holistic Human Resource Development

- Scholarly studies indicate that Indian philosophical traditions, including yoga and mindfulness practices, contribute to stress management, emotional balance, and enhanced productivity in organizations. The holistic approach of IKS integrates physical, mental, and ethical development, aligning with modern human resource management practices such as employee well-being, work-life balance, and organizational resilience. This literature supports the argument that IKS can enhance contemporary organizational culture and performance.

➤ SUGGESTION

- **Integration of IKS in Management Curriculum:** To support value-based education, management schools should integrate Indian Knowledge Systems (IKS) concepts into courses on corporate governance, sustainability, and business ethics.
- **Adoption of Ethical Leadership Models:** To improve moral decision-making and responsible governance, organizations should incorporate values like trusteeship and dharma into leadership development initiatives.
- **Alignment with ESG Practices:** To improve sustainable and ecologically conscious business operations, companies should integrate traditional ecological knowledge with contemporary ESG frameworks.
- **Promotion of Stakeholder-Centric Policies:** To guarantee long-term value generation, companies should implement stakeholder-oriented strategies influenced by inclusive and welfare-based methods from IKS.
- **Promotion of Holistic Employee Development:** To increase productivity and organizational resilience, companies should support mindfulness, wellness programs, and balanced work practices inspired by Indian philosophical traditions.

➤ CONCLUSION

- Indian Knowledge Systems (IKS) offer a comprehensive and value-driven framework that remains highly relevant in addressing contemporary management challenges. Modern businesses need comprehensive strategies that combine economic growth with social responsibility and environmental balance in a time of sustainability issues, moral conundrums, and shifting market conditions. IKS's tenets—such as trusteeship, ethical governance, duty-centered leadership, and harmony with nature—offer helpful direction for making ethical decisions and generating long-term value.
- Organizations can create robust and purpose-driven growth models by integrating traditional wisdom with modern management frameworks like ESG, stakeholder theory, and sustainable innovation. The study emphasizes that IKS is a strategic tool that can improve corporate governance, leadership efficacy, and sustainable practices rather than just being a historical or philosophical concept. Thus, incorporating Indian Knowledge Systems into organizational strategy and management education can greatly aid in creating morally sound, inclusive, and sustainable businesses that are appropriate for the changing global business landscape.

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A COMPARATIVE STATISTICAL ANALYSIS OF INDIAN TRADITIONAL AND MODERN HEALTHCARE SYSTEMS

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Maharashtra- 400076, India**ABSTRACT**

This study examines the differences between Indian traditional healthcare systems and modern healthcare using quantitative and statistical methods. Indian traditional systems, supported by the Ministry of AYUSH, include practices such as Ayurveda and Yoga, which focus on holistic healing, prevention, and balance of mind and body. Modern healthcare, on the other hand, relies on scientific diagnosis, pharmaceutical treatments, and advanced medical technology for disease management.

The research applies statistical tools to compare factors such as treatment effectiveness, recovery time, patient satisfaction, affordability, and preventive benefits. Data may be collected through structured questionnaires, patient records, and published reports. Methods such as mean comparison, hypothesis testing, and correlation analysis are used to identify significant differences between the two systems.

The purpose of this study is to provide objective, data-based evidence regarding the performance of both healthcare approaches. The results may help in understanding their relative strengths and encourage the development of integrated healthcare strategies for improved public health outcomes in India.

Keywords: Traditional Healthcare, Modern Healthcare, Indian Healthcare System, Treatment Cost, Recovery Time, Patient Satisfaction, Statistical Analysis, Healthcare Accessibility.

INTRODUCTION

Healthcare is essential for improving the quality of life and maintaining the well-being of a population. In India, healthcare services are delivered through both traditional and modern medical systems. Traditional healthcare practices are based on indigenous knowledge and the use of medicinal plants, herbal remedies, and natural treatments that have been developed and preserved over many generations. These practices continue to play an important role, especially in rural and tribal communities where traditional healers and herbal medicines remain accessible and culturally accepted [1].

In contrast, modern healthcare systems are based on scientific research, clinical evidence, and technological advancements [5]. The development of medical technologies, diagnostic tools, and health informatics has significantly improved disease detection, patient monitoring, and treatment outcomes. The integration of information technology into healthcare systems has further enhanced medical data management and healthcare service delivery [2].

Despite these developments, access to modern healthcare facilities is not evenly distributed across all regions of India. Many rural and tribal areas still face limitations such as insufficient healthcare infrastructure, shortage of medical professionals, and financial barriers. Consequently, people in these areas often rely on traditional healthcare systems for primary treatment. Studies highlight that limited access to modern healthcare along with the gradual decline of traditional knowledge creates significant challenges for improving healthcare outcomes in these communities [7].

LITERATURE REVIEW

Traditional healthcare systems have played an important role in providing medical care for many centuries. These systems are based on indigenous knowledge, natural remedies, and the use of medicinal plants to treat different health conditions. In many rural and remote regions, traditional medicine continues to serve as a primary healthcare option because it is easily accessible and affordable for local communities. According to Kala [1], traditional healthcare practices not only provide treatment through herbal medicines but also help preserve valuable knowledge related to medicinal plants and natural healing methods.

Modern healthcare systems, in contrast, have developed through advancements in scientific research, medical technology, and healthcare infrastructure. Modern medicine focuses on evidence-based treatment methods, advanced diagnostic tools, and specialized medical care. The use of digital technologies and health informatics has further improved medical data management, disease monitoring, and patient care. Yogesh and Karthikeyan [2] explain that the integration of information technology into healthcare institutions has enhanced the efficiency of healthcare services and improved the overall quality of medical treatment.

Despite these developments, access to modern healthcare facilities remains unequal across different regions, particularly in rural and tribal areas [1]. Limited healthcare infrastructure, shortage of trained medical professionals, and financial challenges often prevent communities from accessing modern medical services. As a result, many people still depend on traditional healthcare practices for their basic health needs. Negi and Azeez [3] observed that the limited availability of modern healthcare services and the gradual decline of traditional knowledge create challenges for improving healthcare conditions among tribal populations.

OBJECTIVES OF THE STUDY

- 1. To study the characteristics of traditional and modern healthcare systems in India.
- 2. To compare the accessibility and utilization of traditional and modern healthcare services.
- 3. To evaluate the effectiveness and importance of modern healthcare systems.

METHODOLOGY

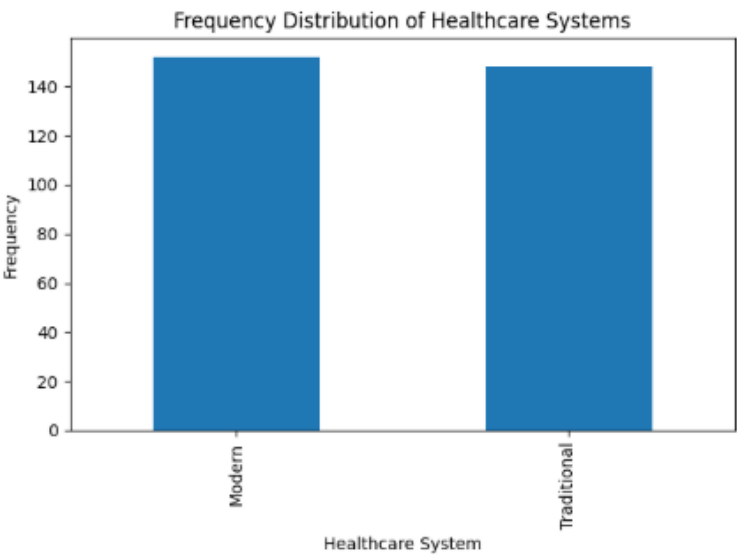
This study uses a comparative quantitative research design to analyze the differences between traditional and modern healthcare systems in India. The analysis is based on a dataset of 300 patient observations representing individuals who received treatment from either traditional or modern healthcare systems.

The dataset includes variables such as age, gender, disease type, treatment cost, recovery days, satisfaction score, hospital visits, side effects, and treatment outcome. A random sampling method was used to ensure balanced representation of both healthcare systems.

For data analysis, several statistical techniques were applied. Descriptive statistics such as mean, median, and standard deviation were used to summarize the data. Frequency distribution was used to examine categorical variables. An independent sample t-test was conducted to compare treatment cost and recovery time between the two healthcare systems. A chi-square test was used to examine relationships between healthcare system, side effects, and treatment outcomes. In addition, correlation analysis was used to study the relationship between treatment cost, recovery time, and patient satisfaction.

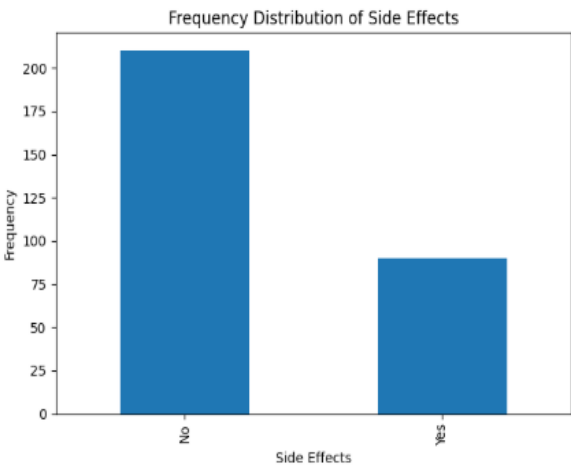
DATA ANALYSIS AND RESULTS

1. Frequency Distribution



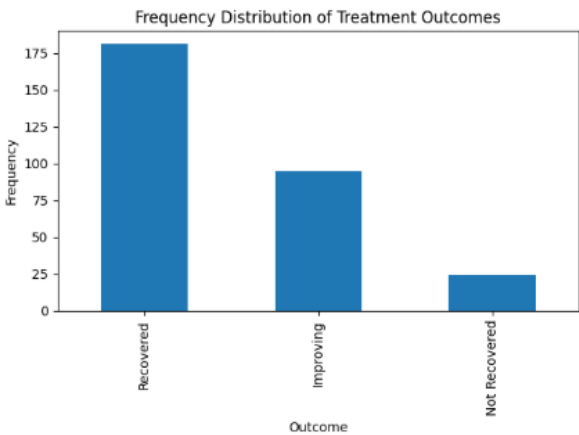
Healthcare System

Healthcare System	Frequency
Modern	152
Traditional	148
Total	300



Side Effects

Side Effects	Frequency
No	210
Yes	90



Treatment Outcome

Outcome	Frequency
Recovered	181
Improving	95
Not Recovered	24

Interpretation

- Majority of patients recovered (181).
- 70% patients reported no side effects.

2. Descriptive Statistics

Variable	Mean	Median	Standard Deviation
Treatment Cost (INR)	7,832.82	5,234.50	5,876.08
Recovery Days	10.50	9	4.95
Satisfaction Score	3.11	3	1.10
Hospital Visits	3.50	3	1.47
Age	46.41	46.5	16.35

Interpretation

- Average treatment cost is ₹7,832.
- Patients take about 10.5 days to recover on average.
- Satisfaction score is around 3 out of 5, indicating moderate satisfaction.

3. Independent Sample T-Test

(A) Treatment Cost Comparison

Healthcare System	Mean Cost (INR)
Traditional	2,813.68
Modern	12,719.89

t-statistic = **-27.51**

p-value = **< 0.001**

Interpretation

There is a statistically significant difference in treatment cost between traditional and modern healthcare systems. Modern healthcare treatments are significantly more expensive.

(B) Recovery Days Comparison

Healthcare System	Mean Recovery Days
Traditional	14.45 days
Modern	6.66 days

t-statistic = **22.00**

p-value = **< 0.001**

Interpretation

There is a significant difference in recovery time.

Patients treated with modern healthcare recover faster.

4. Chi-Square Test

(A) Healthcare System vs Side Effects

Chi-Square = **8.99**

p-value = **0.0027**

Interpretation

There is a significant relationship between healthcare system and side effects.

Side effects occur more frequently in modern treatments compared to traditional ones.

(B) Healthcare System vs Treatment Outcome

Chi-Square = **2.48**

p-value = **0.29**

Interpretation

There is no statistically significant relationship between healthcare system and treatment outcome. This indicates that both traditional and modern healthcare systems achieve comparable treatment outcomes.

DISCUSSION

The findings of this study highlight important differences and similarities between traditional and modern healthcare systems in India. The results show that modern healthcare treatments are significantly more expensive than traditional healthcare treatments. However, patients receiving modern healthcare tend to recover faster, possibly due to the use of advanced medical technologies, diagnostic tools, and pharmaceutical treatments.

The analysis also indicates that side effects are reported more frequently in modern healthcare treatments, while traditional healthcare methods show fewer side effects. This may be because traditional treatments often rely on natural remedies and holistic approaches.

Despite these differences, the study found no significant relationship between the type of healthcare system and treatment outcomes. This suggests that both traditional and modern healthcare systems are capable of achieving similar levels of treatment success. Therefore, both systems play an important role in healthcare delivery and may complement each other in improving public health outcomes.

CONCLUSION

This study compared traditional and modern healthcare systems in India using statistical analysis. The results show that modern healthcare treatments are generally more expensive but provide faster recovery compared to traditional healthcare methods. Traditional healthcare systems, however, tend to have fewer reported side effects and remain an affordable option for many patients. The study also found that both healthcare systems achieve similar overall treatment outcomes. Therefore, both traditional and modern healthcare systems play an important role in healthcare delivery, and integrating the strengths of both approaches may help improve healthcare accessibility and effectiveness in India.

LIMITATIONS OF THE STUDY

This study has several limitations that should be considered when interpreting the results. First, the analysis is based on a dataset of 300 observations, which may not fully represent the diverse healthcare experiences of the entire population in India. Second, the study focuses on a limited set of variables, including treatment cost, recovery time, patient satisfaction, and side effects. Other factors that may influence healthcare outcomes, such as the severity of illness, availability of healthcare infrastructure, quality of medical services, and long-term treatment effects, were not included in the analysis. Because of these limitations, the findings of this study should be interpreted cautiously and may not fully capture all aspects of healthcare performance.

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A CRITICAL STUDY ON JOINT HINDU FAMILY BUSINESS (SPECIAL REFERENCE TO MAHARASHTRA)

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ABSTRACT

The Joint Hindu Family Business (JHFB) is one of the oldest and unique forms of business organization in India. It is governed primarily by Hindu law and traditionally managed by the head of the family known as the Karta.

This research paper critically studies the concept, structure, advantages, and limitations of Joint Hindu Family Businesses with special reference to Maharashtra. The study highlights how traditional family enterprises have contributed to economic growth, entrepreneurship, and employment in the state. It also analyzes the challenges these businesses face in the modern economic environment such as legal changes, globalization, professional management requirements, and generational conflicts. The paper concludes that while the Joint Hindu Family Business remains culturally significant, it must adapt modern governance, financial transparency, and strategic planning to remain sustainable in contemporary markets.

Keywords: Joint Hindu Family, Traditional, economic growth, critical

INTRODUCTION

The Joint Hindu Family Business represents a traditional business structure deeply rooted in Indian culture and social organization. It is based on the Hindu Undivided Family (HUF) system where business ownership and management are controlled by members of the same family. The senior-most member, known as the Karta, manages the affairs of the business on behalf of all coparceners.

In states such as Maharashtra, family-based businesses have played a significant role in trade, retail, agriculture, manufacturing, and service sectors. Cities like Mumbai, Pune, Nagpur, Kolhapur, and Nashik have witnessed the growth of many family enterprises operating across generations.

Despite the growth of corporate forms like private limited companies and partnerships, Joint Hindu Family Businesses still hold relevance due to their strong family bonds, trust, and traditional values. However, modern business challenges demand a critical examination of their structure and efficiency.

Concept of Joint Hindu Family Business

A Joint Hindu Family Business is a form of business organization that is owned and managed by members of a Hindu undivided family. It is governed by Hindu law and comes into existence automatically by birth in the family.

Key characteristics include:

- 1. Membership by birth** – A person becomes a member by birth in the family.
- 2. Karta management** – The eldest male member traditionally acts as the Karta and manages the business.
- 3. Unlimited liability of Karta** – The Karta has unlimited liability while other members have limited liability.
- 4. Continuity** – The business continues even after the death of the Karta.
- 5. Limited managerial authority** – Only the Karta has full authority in decision-making.

This system has historically been prominent in trading communities in Maharashtra including Marwari, Gujarati, and Maharashtrian business families.

Role of Joint Hindu Family Businesses in Maharashtra

Maharashtra has long been a hub of commerce and industry in India. Many traditional businesses in Mumbai, Pune, and other cities are family-run enterprises operating under the HUF structure.

Examples include:

- Traditional textile and trading families in Mumbai markets.
- Agricultural processing businesses in rural Maharashtra.
- Jewellery and gold trading families in cities such as Kolhapur and Pune.
- Small manufacturing units operated by family members in industrial clusters.

These businesses contribute to employment generation, preservation of traditional skills, and continuity of entrepreneurship across generations.

Advantages of Joint Hindu Family Business

1. **Stability and continuity** – Since membership is based on birth, the business enjoys long-term stability.
2. **Quick decision-making** – The Karta has the authority to take decisions without lengthy consultations.
3. **Strong family loyalty** – Family members often work with dedication due to shared interests.
4. **Confidentiality** – Business secrets remain within the family.
5. **Tax advantages** – The HUF structure offers certain tax benefits under Indian income tax law.

In Maharashtra, many small and medium family enterprises prefer this structure because it provides operational flexibility and reduces external interference.

Limitations and Challenges

Despite its strengths, the Joint Hindu Family Business faces several challenges:

1. **Limited capital** – Raising large funds is difficult compared to corporate organizations.
2. **Lack of professional management** – Decisions are often based on tradition rather than modern business practices.
3. **Family conflicts** – Disputes among family members may affect business stability.
4. **Unlimited liability of the Karta** – The Karta bears significant financial risk.
5. **Legal and regulatory challenges** – Modern business laws and taxation rules require formal corporate structures.

In Maharashtra, many traditional businesses have converted into partnerships or companies to overcome these limitations and attract investment.

CURRENT AND FUTURE CHALLENGES OF FAMILY BUSINESSES

Family businesses have long been the backbone of economies worldwide, contributing significantly to employment, innovation, and economic growth. These enterprises, often rooted in strong familial ties and traditions, face a unique set of challenges that evolve with changing societal, economic, and technological landscapes. Understanding the current and future challenges of family businesses is crucial for their sustained success and the continuation of their legacies.

CURRENT CHALLENGES

Succession Planning:

One of the foremost challenges for family businesses is the seamless transition of leadership from one generation to the next. Striking a balance between family dynamics, competence, and meritocracy is often a complex process that requires careful planning and communication.

Professionalization:

As family businesses grow, there is a need for increased professionalism in management and operations. The challenge lies in finding the right blend of family values and professional management practices to enhance efficiency and competitiveness.

Adaptation to Technology:

The rapid pace of technological advancements presents both opportunities and challenges for family enterprises. Embracing digital transformation, incorporating new technologies, and staying competitive in the face of industry disruption can be particularly demanding.

Globalization:

With markets becoming increasingly global, family businesses need to expand their reach and navigate the complexities of international trade. Adapting to diverse cultural, legal, and economic environments poses significant challenges.

Talent Management:

Attracting and retaining top talent outside the family circle is essential for sustained growth. Developing a corporate culture that fosters inclusivity and professional development while maintaining family values is a delicate balancing act.

FUTURE CHALLENGES**Generational Shifts:**

As younger generations enter the workforce, family businesses must adapt to changing expectations, work styles, and values. Bridging the generation gap within the family and the organization is crucial for future success.

Sustainability and Social Responsibility:

Increasing societal awareness and demands for sustainable business practices require family enterprises to integrate environmental, social, and governance (ESG) considerations into their strategies. Balancing profitability with ethical and sustainable practices is a growing challenge.

Digital Transformation:

The ongoing evolution of technology will continue to impact how businesses operate. Adapting to artificial intelligence, automation, and other emerging technologies is essential for maintaining competitiveness in the digital age.

Market Disruptions:

Family businesses need to be agile in the face of market disruptions, whether due to economic downturns, geopolitical changes, or unexpected events such as global pandemics. Resilience and adaptability will be critical for navigating uncertain times.

Family Governance:

Establishing effective family governance structures to manage conflicts, make decisions, and set strategic directions is a growing challenge. Defining roles, responsibilities, and communication channels is essential for the long-term success of family businesses.

Case Study: Family-Owned Retail Business in Mumbai

A traditional family-run textile trading business in Mumbai provides an example of how Joint Hindu Family Business structures operate in practice. The business was started by the grandfather in the 1960s and later managed by his sons under the HUF structure.

Over time, the third generation entered the business bringing modern management practices such as digital accounting, online marketing, and supply chain management. While the Karta retained overall control, younger members contributed to modernization efforts.

The case highlights how adaptation and generational collaboration can help traditional family businesses survive in competitive markets.

Modern Transformation of Family Businesses

The economic liberalization of India and the rise of digital commerce have forced family businesses to evolve. Many Joint Hindu Family Businesses in Maharashtra now adopt hybrid structures such as private limited companies while maintaining family ownership.

Modern changes include:

- Professional management practices
- Adoption of technology and e-commerce
- Financial transparency and auditing
- Strategic expansion and branding

These transformations allow family enterprises to compete with large corporations while preserving their cultural roots.

CONCLUSION

The Joint Hindu Family Business remains an important part of India's traditional economic structure. In Maharashtra, many family enterprises continue to thrive by combining traditional values with modern management practices.

However, sustainability requires adaptation. Professional management, legal restructuring, and technological integration are necessary to ensure long-term success. The future of Joint Hindu Family Businesses will depend on their ability to balance tradition with innovation.

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RĀŚIKAM SŪTRAS IN VYAVAHĀRA GAṆITA: CLASSICAL INDIAN METHODS FOR SOLVING FINANCIAL AND DAILY-LIFE PROBLEMS FROM PROPORTION RULES TO BARTER EXCHANGE

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ABSTRACT

Classical Indian mathematics exhibits a strong tradition of applied problem solving through concise and systematic sutras, particularly within the framework of Rāśikam. These sutras played a crucial role in addressing practical problems related to finance and everyday life, forming an integral part of Vyavahāra Gaṇita. This paper explores the sutras associated with Rāśikam as presented in classical-era mathematical texts and examines their application in solving problems involving trade, interest, profit and loss, proportional distribution, wages, and routine daily household calculations.

Through an analytical study of selected sūtras based methods, the paper highlights how principles such as proportionate reasoning, arithmetic operations, and ratio founded computation were efficiently employed to meet real world socio economic needs in Ancient Classical Indian society. The study demonstrates that these sutras not only enabled quick and accurate calculations but also reflected a deep integration of mathematics with daily routine human activities. By revisiting Rāśikam based problem solving techniques, the paper features their historical significance and pedagogical applicability, suggesting their potential value in enhancing conceptual understanding and contextual learning in present day mathematics education.

Keyword: Rāśikam; Vyavahāra Gaṇita; Āryabhaṭīya; Brāhmasphuṭa siddhānta; Pramāṇa; Icchā

1. INTRODUCTION

The tradition of *Vyavahāra Gaṇita* in ancient classical Indian mathematics represents a rich amount of applied arithmetic devoted to business, commerce, taxation, exchange, measurement and everyday transactions. Unlike purely theoretical works, these *sūtras* reveal how mathematical thinking functioned within social and economic life. Significant to this tradition are the *Rāśikam* methods procedures based on proportional reasoning that enabled merchants, administrators, and scholars to solve practical problems containing price, quantity, interest, and barter.

Ancient treatises such as the Āryabhaṭīya, the Brāhmasphuṭa siddhānta, and later works like the Līlāvātī present systematic formulations of proportional rules including the *Trairāśika* (rule of three), inverse proportion, compound proportion (rules of five, seven, nine, and eleven), and barter exchange techniques. These methods demonstrate a sophisticated understanding of ratios, scaling, and transactional equivalence long before their formal algebraic expression in modern notation.

This paper examines selected *Rāśikam* associated *sūtras* as computational tools within *Vyavahāra Gaṇita*, highlighting how they structured financial, logical reasoning and problem solving in the ancient classical Indian period. By putting these procedures within their textual and practical contexts, the study seeks to illuminate the continuity between mathematical theory and existed economic practice in modern India.

2. VYAVAHĀRA GAṆITA AS APPLIED ARITHMETIC TRADITION

The branch of *Vyavahāra Gaṇita* represents the practical dimension of ancient classical Indian mathematics, focusing on trade, finance, taxation, wages, measurement, and exchange. Unlike abstract astronomy or algebra, this tradition addressed the needs of merchants, administrators, and craftsmen. Mathematical operations were framed as rule based procedures (*sūtras*), enabling quick calculation without symbolic algebra. Treatise such as the Āryabhaṭīya and the Brāhmasphuṭa siddhānta exhibit that proportional reasoning was already systematized and widely applied.

3. RĀŚIKAM AND PROPORTIONAL REASONING

The term *Rāśikam* denotes methods based on quantities arranged in proportional sets. The most fundamental of these is the *Trairāśika* (Rule of Three), where the relation between *pramāṇa* (given quantity), *phala* (result), and *icchā* (desired quantity) determines the unknown. This method allowed calculation of prices, wages, and quantity requirements through basic multiplication and division.

According to modern notation if $a \rightarrow b$ then $c \rightarrow x$ then $x = \frac{c \times b}{a}$, in ancient this was represented by a sutra II-26-27 of Āryabhaṭīya and stated below:

Sutra: 1. Āryabhaṭīya: II-26-27.

त्रैराशिकफलराशिं तमथेच्छाराशिनादृतं कृत्वा ।
 लब्धं प्रमाणमजितं तस्मादिच्छाफलमिदं स्यात् ॥
 छेदाः परस्परं दत्ता भवन्ति गुणकार भागद्वाराणां ।
 छेदगुणं सच्छेदं परस्परं तत्सर्वस्वम् ॥ . . . Aryabhaṭīya II-26-27

Translation:

Phala is first multiplied by iccha and then divided by pramana. The quotient which one get is the phala for resultant iccha.

Brahmagupta method was moreover similar to Āryabhata and was stated in Sutra XII-10.

Sutra: 2. Brahmasphuta: XII-10.

त्रैराशिके प्रमाणं फलमिच्छावन्तयोः सदृशराशि ।
 इच्छाफलेन गुणिता प्रमाणभक्ता फलं भवति ॥ Brahmasphuta Siddhanta XII-10

Translation:

Pramana i.e. argument, phala i.e. fruit and iccha i.e. requisition are the three elementary terms of Rule of three. The fruit of iccha is phala multiplied by iccha and divided by pramana.

Other mathematicians, including **Bhāskara II**, **Nārāyaṇa Paṇḍita**, and **Āryabhaṭa II**, adopted similar procedures for proportional computation. Notably, Āryabhaṭa II employed the terminology *māna*, *vinimaya*, and *icchā* in place of the earlier terms *pramāṇa*, *phala*, and *icchā*. To explain the application of this method, let us consider a problem from *Pāṭīgaṇita* that validates the working of the Rule of Three

Problem:

How much will 9 palas and 1 karsa of Sandal wood cost when the 1 pala and 1 karsa of sandal wood can be obtained for ten and half panas?

Solution:

Let $p = \text{pramana (argument)} = 1 \text{ pala } 1 \text{ karsa} = 1 \frac{1}{4} = \frac{5}{4} \text{ palas (as 4 karsa} = 1 \text{ pala)}$

$f = \text{phala (fruit)} = 10 \frac{1}{2} = \frac{21}{2} \text{ palas}$

$I = \text{iccha (Requisition)} = 9 \text{ palas } 1 \text{ karsa} = 9 \frac{1}{4} = \frac{37}{4} \text{ palas}$

Applying Rule of three

In the form of mixed fraction

1	10	9
1	1	1
4	2	4

After converting into proper fraction

5	21	37
4	2	4

Now applying Rule of three phala (result) $= \frac{f \times i}{p}$

21	5
2	4
37	
4	

$$= \frac{21/2 \times 37/4}{5/4}$$

After transferring denominator

21	5
4	2
37	4

$$= \frac{21 \times 4 \times 37}{5 \times 2 \times 4} = \frac{3108}{40} = \frac{777}{10} \text{ palas}$$

Brahmagupta extended this idea to the **Vyasta Trairāśika** (inverse rule of three), applicable to problems involving inverse variation such as distribution or measurement changes. These rules illustrate a theoretical grasp of direct and inverse proportionality centuries before formal algebraic notation.

Sutra: 3. Brahmasphuta: XII-11.

व्यस्तैराशिक फलमिच्छा भक्तः प्रमाण फलवतः ।
त्रैराशिकादिषु फलं विषमेष्वेकादशान्तेषु ॥ *Brahmasphuta Siddhanta XII-11*

Translation:

First divide phala (fruit) with iccha (requisition) and then multiply it with pramana (argument) this gives Vyasta trairasika i.e. Inverse rule of three.

To illustrate the application of the above *sūtra*, let us consider an example from the *Līlāvātī* of **Bhāskara II**, where a similar proportional problem is presented.

Sutra: 4. Lilavati-Terashik: 3.

सप्तादकेन मानेन राशौ सस्यस्य माप्तिते ।
यदि मानरातं जातं तदा पञ्चादकेन किम् ? ॥ ३ ॥ *Lilavati-Terashik-sutra3*

Explanation:

With a measure of 7 adhakas (*pramana*) a certain quantity of grain measures 100 units (*phala*) find how many units will be there if the measure is 5 adhakas (*icha*)?

<i>pramana</i>	<i>Ichha</i>	
7	5	
100	x	← <i>phala</i>

According to Sutra XII-11 of Brahmagupta the answer is equal to *phala* divided by *icha* and then multiplied with *pramana* $= \frac{100}{5} \times 7 = 140 \text{ units}$.

4. Compound Proportion: Rules of Five to Eleven

The proportional framework expanded into compound structures known as *Pañca rāśika* (Rule of five), *Sapta rāśika* (Rule of seven), *Nava rāśika* (Rule of nine), and *Ekādaśa rāśika* (Rule of eleven), corresponding to rules involving multiple related quantities. These procedures enabled solutions to problems involving interest, transport costs, dimensions of goods, taxations, and production scaling.

In works like the *Līlāvātī*, such problems appear in commercial and skills contexts, demonstrating the adaptability of proportional reasoning to multivariable situations. The computational approach multiplying one set of terms and dividing by another efficiently anticipates modern dimensional analysis and scaling techniques.

Prior to examining examples of compound proportion, let us first cite Sūtras XII.11–12 from the *Brāhmasphuṭa siddhānta*, as they provide the foundational rule employed in these calculations.

Sutra: 5. Brahmasphuta: XII-11-12.

व्यस्त त्रैराशिकं फलमिच्छा भवतः प्रमाणफलघातः ।
त्रैराशिकादिषु फलं विषमेष्वेकादशान्तेषु ॥
फलसंक्रमणमुभवतो बहुराशि वधोऽल्पवधतो ज्ञेयम् ।
सकलेष्वेवं भिन्नेषुसकलस्येदं संक्रमणम् ॥

Brahmasphuta Siddhanta XII 11-12

Translation:

For odd term starting with three to eleven the result is obtained by swapping the *phāla* of both sides and then dividing the product of the larger set by the product of smaller set.

Let us consider a few examples from ancient treatises illustrating the method of compound proportion.

Rule of Five:

The procedure for the Rule of Five may be understood from the following sutra:

Sutra: 6. Lilavati Prashvarashyadikam: 2.

सत्र्यंशमासेन शतस्य चेत् स्यात् कलान्तरं पञ्च सपञ्चमांशाः ।
मासैस्त्रिभिः पञ्च त्रिवाधिकेस्तत् सार्धद्विषष्टेः फलमुच्यतां किम् ? ॥ २ ॥ *Lilavati-Prashvarashyadikam-2*

Explanation:

If $5\frac{1}{5}$ is the interest on 100 for $\frac{4}{3}$ months, then find the interest on $62\frac{1}{2}$ for $3\frac{1}{5}$ months.

By using rule of five

100	$62\frac{1}{2}$
$\frac{4}{3}$	$3\frac{1}{5}$
$5\frac{1}{5}$	x

← phala

Now swap the phala as stated in the sutra XII-11-12 of *Brahmasphuta Siddhanta*.

100	$62\frac{1}{2}$
$\frac{4}{3}$	$3\frac{1}{5}$
x	$5\frac{1}{5}$

Now multiply both the set *pramana* as well as *iccha paksa*. The product of *pramana paksa* is $\frac{4}{3} \times 100 = \frac{400}{3}$ and the product of *iccha paksa* is $\frac{125}{2} \times \frac{16}{5} \times \frac{26}{5} = \frac{52000}{50} = 1040$

According to sutra divide the larger number of products term by smaller number of products term to get *phala* i.e.

$$phala = \frac{1040}{400/3} = \frac{1040 \times 3}{400} = \frac{39}{5} = 7\frac{4}{5}$$

∴ *Iccha phala* is $7\frac{4}{5}$.

Rule of Seven (Saptarashi):

The *sūtra* stated below forms the basis for understanding the Rule of Seven.

Sutra: 7. Lilavati-Prashvarashyadikam: 3.

विस्तारे त्रिकराः कराष्टकमिता दैर्घ्ये विचित्राश्च चे-
द्रूपैरुत्कटपट्टसूत्रपटिका अष्टौ लभन्ते शतम् ।
दैर्घ्ये सार्धकरत्रयाऽपरपटी हस्तार्धविस्तारिणी
तादृक् किं लभते ? द्रुतं वद वणिक् ! वाणिज्यकं वेत्सि चेत् ॥ *Lilavati-Prashvarashyadikam-3*

Explanation: 8 pieces of multi coloured embroidered cloth each measuring 3 cubits $\times$ 8 cubits are available for 100 niskas , O! business man if you are very good in trade then tell me fast the price of a piece of $3\frac{1}{2}$ cubits $\times$ $\frac{1}{2}$ cubit.

By using rule of seven

<i>Pramana</i>	<i>iccha</i>
8	1
3	$3\frac{1}{2}$
8	$\frac{1}{2}$
100	<i>X</i>

← *phala*

Now swap the phala as stated in the sutra XII-11-12 of *Brahmasphuta Siddhanta*.

<i>Pramana</i>	<i>iccha</i>
8	1
3	$3\frac{1}{2}$
8	$\frac{1}{2}$
<i>X</i>	100

← *phala*

Now multiply both the set *pramana* as well as *iccha* *paksa*. The product of *pramana* *paksa* is $8 \times 3 \times 8 = 192$ and the product of *iccha* *paksa* is $1 \times \frac{7}{2} \times \frac{1}{2} \times 100 = 175$

According to sutra divide the larger number of products term by smaller number of products term to get *phala* i.e.

$$phala = \frac{175}{192} \text{ niskas}$$

$\therefore$ *Iccha phala* is $\frac{175}{192}$ niskas.

Rule of Nine (Navrashi):

The method of the Rule of Nine is explained in the *sūtra* given below.

Sutra: 8. Lilavati-Prashvarashyadikam: 4.

पिण्डे येऽर्कमिताङ्गुलाः किल चतुर्वर्गाङ्गुला विस्तृतौ
 पट्टा दीर्घतया चतुर्दशकरास्त्रिशमन्ते शतम् ।
 एता विस्तृतिपिण्डदैर्घ्यमितयो येषां चतुर्वर्जिताः
 पट्टास्ते वद मे चतुर्दश सखे! मूल्यं लभन्ते कियत् ? ॥ १ ॥ *Lilavati-Prashvarashyadikam-4*

Explanation:

O! Friend, 30 planks of wood whose width is 12 fingers, breadth is 16 fingers and length is 14 cubits costs 100 niskas then find the cost of 14 planks of wood whose width is 8 fingers, breadth is 12 fingers and length is 10 cubits i.e. each 4 measure less than the former?

By using rule of nine.

Pramana Iccha

30	14
12	8
16	12
14	10
100	X

← phala

Now swap the phala as stated in the sutra XII-11-12 of *Brahmasphuta Siddhanta*.

Pramana Iccha

30	14
12	8
16	12
14	10
X	100

← phala

Now multiply both the set, pramana as well as iccha paksa. The product of pramana paksa is $30 \times 12 \times 16 \times 14 = 80640$ and the product of iccha paksa is $14 \times 8 \times 12 \times 10 \times 100 = 1344000$

According to sutra divide the larger number of products term by smaller number of products term to get phala i.e.

$$phala = \frac{1344000}{80640} = \frac{50}{3} = 16\frac{2}{3} niskas$$

∴ Iccha phala is $16\frac{2}{3}$ niskas.

Rule of Eleven:

The problem to explain rule of eleven is stated in sutra listed below:

Sutra: 9. *Lilavati-Prashvarashyadikam*: 5.

पट्टा ये प्रथमोदितप्रमितयो गव्यूतिमात्रे स्थिता-
 स्तेषामानयनाय चेच्छकटिनां द्रुमाष्टकं भाटकम् ।
 अन्ये ये तदनन्तरं निगदिता माने चतुर्वर्जिता-
 स्तेषां का भवतीति भाटकमिति गव्यूतिषट्के वद ॥ १ ॥ *Lilavati-Prashvarashyadikam-5*

Explanation:

If the transport charges for carrying the 30 planks of previous example i.e. 14 cubits $\times$ 16 fingers $\times$ 12 fingers through the distance of 1 gavyauti (i.e. 2 kosa) is 8 dramm (1 dramm = 16 paise) then find the charges for

transporting the second set of 14 planks, which was measuring 4 units less in each dimension i.e. 10 cubits $\times$ 14 fingers $\times$ 8 fingers through a distance of 6 *gavyauti* (i.e. 12 *kosas*).

By using rule of eleven.

<i>Pramana</i>	<i>iccha</i>
30	14
14	10
16	12
12	8
1	6
8	<i>X</i>

$\leftarrow$ *phala*

Now swap the *phala* as stated in the sutra XII-11-12 of *Brahmasphuta Siddhanta*.

<i>Pramana</i>	<i>iccha</i>
30	14
14	10
16	12
12	8
1	6
<i>x</i>	8

$\leftarrow$ *phala*

Now multiply both the set *pramana* as well as *iccha paksa*. The product of *pramana paksa* is $30 \times 14 \times 16 \times 12 \times 1 = 80640$ and the product of *iccha paksa* is $14 \times 10 \times 12 \times 8 \times 6 \times 8 = 645120$

According to sutra divide the larger number of products term by smaller number of products term to get *phala* i.e.

$$phala = \frac{645120}{80640} = 8 \text{ dramm}$$

$\therefore$ *iccha phala* is 8 dramm.

5. Barter and Exchange Calculations

Beyond proportional rules, Ancient mathematicians also addressed market exchange through **Bhāṇḍa-Pratibhāṇḍa** (barter methods). These problems considered equivalence of goods with different prices and quantities. By rearranging price and quantity terms and applying proportional logic, mathematicians could determine fair exchange values.

Such examples reveal how mathematical reasoning was embedded in economic transactions, illustrating a direct link between arithmetic procedures and marketplace practice.

Sutra: 10. Brahmasphuta: XII-13.

प्राम्मूल्य व्यत्यासो भाण्डप्रतिभाण्डकेऽन्यदुक्तसमम् ।
परिकर्माण्यष्टानां व्यवहाराणामभिहितानि ॥ १३ ॥ *Brahmasphuta Siddhanta XII 13*

Method states as first swap the prices then swap the *phala* as done in rule five then find the product of both the set the result is the quotient which one get after dividing larger set with smaller set.

Steps involved in Barter & Exchange method is listed below:

Take *pramana paksha* p_1, a_1, q_1 (*phala*) and *iccha paksa* p_2, a_2, x

pramana Iccha

p_1	p_2
a_1	a_2
q_1	0

← phala

On the basis of sutra just swap prices first.

pramana Iccha

p_2	p_1
a_1	a_2
q_1	x

← phala

Now swap the phala

pramana Iccha

p_2	p_1
a_1	a_2
x	q_1

← phala

Multiply both the set

Product of first set is $p_2 a_1 x$

Product of second set is $p_1 a_2 q_1 \therefore \text{result or phala } x = \frac{p_1 a_2 q_1}{p_2 a_1}$

Example to support Barter and Exchange method:

Problem: if 2 palas of sandal wood cost 20 panas and 4 palas of turmeric costs 5 panas then how many turmeric stick will be a fair exchange for 4 palas of sandal wood?

Solution:

Pramana paksa – 2 palas, 20 panas (price), 4 pala (quantity).

Iccha paksa- 4 palas, 5 panas, x pala.

Then according to ancient notation.

20	5	→ price
2	4	
4	X	→ quantity

First swap the price.

5	20	→ price
2	4	
4	x	→ phala

Now follow the rule of five i.e. swap the phala.

5	20	→ price
2	4	
x	4	→ phala

Product of pramana paksa = 10

Product of iccha paksa = 320

$$\text{phala} = \frac{\text{larger product}}{\text{smaller product}} = \frac{320}{10} = 32 \text{ palas}$$

Brahmagupta had put all the logistics or *Parikarma* in systematic way and sutras with proper numbering one below the other. So one can easily track and trace the sutra of particular logistics or *Parikarma*.

Table 1: Rāśikaṃ Rules and Their Practical Application Areas in Vyavahāra-Gaṇita

Rule / Method	Sanskrit Term	Mathematical Nature	Typical Variables	Application Area	Example Contexts
Rule of Three	<i>Trairāśika</i>	Direct proportion	Quantity, price, result	Trade, pricing, wages	Cost of goods, grain pricing, salary computation
Inverse Rule of Three	<i>Vyasta Trairāśika</i>	Inverse proportion	Measure vs quantity, time vs work	Distribution, measurement changes	Grain measured by vessels, workforce scaling
Rule of Five	<i>Pañca Rāśika</i>	Compound proportion	Principal, time, interest, rate	Finance, interest calculation	Interest on loans, capital investment
Rule of Seven	<i>Sapta Rāśika</i>	Multi-variable proportion	Quantity, dimensions, price	Trade, craft production	Cloth pricing by size, commodity valuation
Rule of Nine	<i>Nava Rāśika</i>	Extended compound proportion	Number, dimensions, cost factors	Manufacturing, transport, construction	Timber pricing, material scaling
Rule of Eleven	<i>Ekādaśa Rāśika</i>	Complex proportional scaling	Quantity, dimensions, distance, cost	Transport, logistics, taxation	Freight charges, caravan transport
Barter & Exchange	<i>Bhāṇḍa Pratibhāṇḍa</i>	Value equivalence	Price, quantity, commodity type	Market exchange, trade negotiation	Exchange of spices, metals, grains

6. Mathematical Thought and Socio Economic Context

The persistence of *Rāśikaṃ* methods across multiple treatises indicates their practical significance. These rules were not merely pedagogical exercises but tools for daily life computation. They reflect an intellectual culture in which mathematics served administration, commerce, and daily livelihood.

Thus, *Vyavahāra Gaṇita* demonstrates that ancient classical Indian mathematics was deeply applied in orientation, integrating theoretical clarity with economic utility.

CONCLUSION

The present study highlights that the computational procedures embedded in *Rāśikaṃ* based methods formed a coherent framework for solving financial and everyday problems in ancient classical Indian mathematics. From the Rule of Three to compound proportional rules and barter exchange, these techniques demonstrate a systematic approach to proportional reasoning rooted in practical needs such as trade, measurement, transport, and interest calculation. The works of **Āryabhaṭa** and **Brahmagupta**, along with later mathematicians, show that *Vyavahāra Gaṇita* was not merely theoretical arithmetic but an applied science closely connected with economic and social life.

The study also reveals that the expansion from simple proportion to multivariable compound rules reflects an evolving mathematical sophistication aimed at addressing increasingly complex commercial situations. These procedures anticipate modern proportional and algebraic reasoning, illustrating the continuity between classical Indian computational thought and contemporary financial mathematics.

Thus, *Rāśikaṃ* associated *sūtras* represent not isolated rules but an integrated tradition of applied mathematical reasoning that underlines India's significant contribution to the historical development of practical arithmetic.

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**RESEARCH METHODOLOGIES ROOTED IN INDIGENOUS KNOWLEDGE SYSTEMS (IKS):
RECLAIMING EPISTEMIC DIVERSITY IN CONTEMPORARY SCHOLARSHIP**

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ABSTRACT

Indigenous Knowledge Systems (IKS) represent context-specific, culturally embedded ways of knowing that have sustained communities for centuries. Rooted in lived experience, spirituality, relationality, and ecological balance, IKS challenge dominant Western positivist research paradigms. This paper explores research methodologies grounded in Indigenous epistemologies, highlighting their philosophical foundations, methods, ethical principles, and contemporary relevance. Drawing from scholars such as Linda Tuhiwai Smith, Vine Deloria Jr., and Shawn Wilson, the paper examines decolonizing methodologies, participatory approaches, oral traditions, storytelling, and relational accountability as core methodological frameworks. It argues that IKS-based research methodologies contribute to epistemic justice, sustainability, and inclusive knowledge production in global academia.

1. INTRODUCTION

Indigenous Knowledge Systems (IKS) refer to the cumulative body of knowledge, practices, and beliefs developed by Indigenous communities through long interaction with their environment. These systems are holistic, dynamic, and transmitted across generations through oral traditions, rituals, art, and practice.

Historically, colonialism marginalized Indigenous epistemologies, positioning Western scientific methods as universal and superior. Contemporary scholarship, however, increasingly recognizes the value of Indigenous research methodologies as legitimate and rigorous frameworks for inquiry. This shift aligns with broader decolonization efforts within academia.

2. PHILOSOPHICAL FOUNDATIONS OF IKS RESEARCH

IKS-based research methodologies are grounded in distinct ontological, epistemological, and axiological principles:

2.1 Ontology (Nature of Reality)

Indigenous ontologies often emphasize:

- Interconnectedness of humans, nature, and spirit
- Collective identity over individualism
- Land as a living entity

Reality is relational rather than mechanistic.

2.2 Epistemology (Nature of Knowledge)

Knowledge is:

- Experiential and place-based
- Communally validated
- Embedded in language, culture, and spirituality

As articulated in *Decolonizing Methodologies*, Linda Tuhiwai Smith argues that research is not a neutral activity but deeply political, historically used as a tool of colonization.

2.3 Axiology (Role of Values)

IKS research is value-driven. Ethics are inseparable from methodology. Respect, reciprocity, responsibility, and relational accountability guide the research process.

3. CORE METHODOLOGICAL APPROACHES IN IKS**3.1 Decolonizing Methodologies**

Decolonizing methodologies aim to:

- Challenge Western dominance in knowledge production
- Restore Indigenous authority over research concerning Indigenous communities

- Promote self-determination

Research becomes a tool for empowerment rather than extraction.

3.2 Relational Research Paradigm

Shawn Wilson, in *Research Is Ceremony*, proposes that research is a ceremony grounded in relationships. Knowledge is created through respectful engagement among researcher, participants, community, and environment.

Key principles:

- Relational accountability
- Community benefit
- Ongoing responsibility beyond publication

3.3 Storytelling as Method

Storytelling is both data and method. Oral narratives:

- Preserve history
- Encode ecological and social knowledge
- Convey moral and spiritual teachings

Unlike Western narrative inquiry, Indigenous storytelling integrates metaphysics, memory, and identity. Knowledge is not extracted from stories but understood within their relational context.

3.4 Participatory and Community-Based Research

IKS methodologies align closely with participatory action research (PAR), but with deeper cultural embedding.

Characteristics include:

- Collective decision-making
- Shared ownership of findings
- Community validation of interpretations

This approach challenges the researcher–subject hierarchy common in positivist traditions.

3.5 Land-Based Methodologies

Land is teacher, archive, and methodology. Research may involve:

- Observational immersion in ecological practices
- Ceremonial engagement
- Learning through participation in seasonal cycles

For many Indigenous traditions, knowledge cannot be separated from place.

4. METHODS OF DATA COLLECTION IN IKS RESEARCH

IKS-based research employs methods that reflect Indigenous epistemologies:

Method	Description	Purpose
Oral Histories	Intergenerational storytelling	Preservation of memory
Talking Circles	Collective dialogue process	Consensus-building
Participant Observation	Immersive engagement	Embodied understanding
Indigenous Language Analysis	Interpretation through linguistic worldview	Epistemic integrity
Ritual & Ceremony	Spiritual engagement in knowledge production	Ethical grounding

These methods prioritize context, meaning, and relationship over quantification.

5. ETHICAL FRAMEWORKS IN IKS RESEARCH

Ethics in Indigenous research extend beyond institutional review boards. Core principles include:

- **Respect:** Honoring cultural protocols
- **Reciprocity:** Giving back to communities
- **Responsibility:** Accountability to participants and ancestors
- **Relevance:** Addressing community-defined needs

Vine Deloria Jr. emphasized that research must serve Indigenous communities rather than external academic interests.

6. CHALLENGES IN IMPLEMENTING IKS METHODOLOGIES

Despite growing recognition, several challenges remain:

1. Institutional bias toward Western methodologies
2. Lack of funding for community-centered research
3. Misappropriation or tokenistic inclusion of Indigenous knowledge
4. Tension between academic publication norms and community confidentiality

Addressing these challenges requires structural reform in higher education systems.

7. CONTRIBUTIONS OF IKS TO GLOBAL RESEARCH

IKS methodologies offer significant contributions:

- **Sustainability Science:** Traditional ecological knowledge enhances climate adaptation strategies
- **Health Research:** Holistic healing models integrate spiritual and communal dimensions
- **Conflict Resolution:** Restorative and consensus-based justice models
- **Education:** Culturally responsive pedagogies

They promote epistemic pluralism — recognizing multiple valid ways of knowing.

8. CONCLUSION

Research methodologies rooted in Indigenous Knowledge Systems represent a transformative paradigm shift in global scholarship. They challenge colonial epistemic hierarchies and affirm relational, ethical, and community-centered knowledge production.

Rather than replacing Western methodologies, IKS-based approaches expand the research landscape, fostering dialogue between knowledge systems. The future of equitable scholarship depends on embracing epistemic diversity and honoring Indigenous intellectual sovereignty.

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**A STUDY ON SUSTAINABILITY IN LOGISTIC AND SUPPLY CHAIN MANAGEMENT –
TECHNOLOGICAL INNOVATION FOR ECO-EFFICIENCY**

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ABSTRACT

The overall study is all about Sustainability in Logistics and Supply Chain Management –In Technological Innovation for Eco –Efficiency in Mumbai- Sub urban areas. It observed that after pandemic both business leader and technological role has been changes drastically in business world, specifically in corporate world. This found a unique opportunity to all the business leader to build more ecosystem together. It means various new start up began, especially in Mumbai urban and Sub-urban areas. Today Logistics is the backbone of overall business to handle the movement and storage of their goods, services and information's. Logistics and supply Chain Management had ensures everything based on technological innovation the process to be done smoothly and eco – efficiency. It's a well-organized, where planning, execution and control work together systemically. In today's fast moving competitive world the role of Logistics and Supply chain management with the help of technology has become crucial for several reasons, playing a pivotal role in the success and efficiency of businesses. Through technological innovation Eco –efficiency delivering of goods and services with fewer environmental inputs and impacts is central to sustainable development. Today, drastic rapid growth in technological innovation is enabling the resources material or waste flows to be optimized at extraordinary scales. So, it illustrate that emerging technologies from AI –driven smart grids to biodegradable things are reshaping industries, supporting circular economy models, and lowering carbon footprints significantly. By doing deeper analysis, technological and systemic transformation can unlock eco-efficient practices essential for meeting climate commitments and resource restrictions.

Keywords: Technological innovation, Eco-efficiency, Logistics and Supply Chain Management.

1.1 INTRODUCTION: ON SUSTAINABILITY IN LOGISTIC AND SUPPLY CHAIN MANAGEMENT – TECHNOLOGICAL INOVATION FOR ECO –EFICIENCY.

In today's rapid growth in business world with the help of technological innovations, logistics is the backbone that ensures everything moves systematically and smoothly from start to finish in an Eco –efficiency manners. From ordering raw materials to delivering finished products to customers, logistics handles the entire journey in an Eco-efficiency way with the help of innovative technology. It's an art of planning, executing and controlling the flow and storage of goods, service and information's. The organizations make sure that products get from where that are produced to where they are needed, all in timely and effective manner. So, with the support of technology, it involves coordinating, transportation inventory, processing orders, packaging and delivered to the right place. In simpler terms, logistics in business is the organized effort that keeps the wheels turning, making sure products are available when and where they're needed.

By Eco-efficiency delivering various goods and services with fewer environmental inputs and impact its central to sustainable development. Rapid technological innovation is enabling material, energy, water, and waste flows to be optimized at unique scales. This essay explores cutting-edge innovations across energy, agriculture, materials, urban systems, waste, and industrial processes. It illustrates how emerging technologies through AI-driven smart grids to biodegradable electronics, reshaping industries, supporting circular economy models, and lowering carbon footprints significantly.

1.2 Objective of the Study

- To identify logistics and supply chain management through technological innovations for eco-efficiency in the Mumbai.
- To analysis knowledge on technological innovations for eco-efficiency in Mumbai sub-urban area.
- To understand the problem and issues on technological innovations for eco-efficiency.
- To evaluate business growth with logistics and supply chain management with eco-efficiency.

1.3 Let's Understand The Basic History And Evolution Of Technology Inovations For Eco-Efficiency.

Today advanced AI and machine learning systems, enhance demand forecasting, energy distribution and integrations of renewable resources. Smart grids powered by IoT and predictive analytics stabilize supply, reduce wastage, and optimize renewable penetration. These systems are already operational in pilot smart cities

and power utilities worldwide. Long-duration energy storage (LDES) systems such as large-scale battery arrays, pumped hydro, and innovative geochemical energy storage (GES) where water is stored underground under pressure and released to drive turbines months later, enable reliable renewable energy availability even during lean periods. GES has recently been demonstrated at megawatt-hour scale with six-month storage horizons

2. REVIEW OF LITERATURE:

2.1. Eco-Friendly Innovations That Will Blow Your Mind In 2025 By Saba March 1, 2025.

As we zoom into 2025, the need to tackle climate change and embrace sustainable habits hits closer to home than ever. Innovators from every corner of the planet are rising to the occasion, crafting solutions that not only aim to shield our environment but also blow our minds with their creativity and efficiency. In today's post, we're diving right into some of the most jaw-dropping eco-friendly innovations of 2025 that are set to revolutionize our world. From energy solutions that could let your home run smoothly without harming our precious planet to agricultural advancements that boost our ability to feed more folks with fewer resources, you're in for a treat with the genius of modern tech.

2.2. Innovations In Eco-Friendly Tech 2023 INDRA ENERGY INSUGHT MARCH 12, 2024

2023 was an exciting year in the realm of renewable energy. With breakthrough innovations in eco-friendly and green technology, solar, wind, hydro, and other energy sources have become more efficient and affordable than ever before. As a result, we are seeing a rapid shift towards renewable energy across many regions, which bodes well for the future of our planet and society. Let's take a closer look at the major developments in green technology and what's on the horizon for 2024.

2.3. Recyclable Thin-Film Soft Electronics For Smart Packaging And E-Skins, Dr. Mahmoud Tavakoli, 29th January 2025

Despite advances in soft, sticker like electronics, few efforts have dealt with the challenge of electronic waste. Here, this is addressed by introducing an ecofriendly conductive ink for thin film circuitry composed of silver flakes and a water based polyurethane dispersion. This ink uniquely combines high electrical conductivity ($1.6 \times 10^5 \text{ S m}^{-1}$), high resolution digital printability, and robust adhesion for microchip integration, mechanical resilience, and recyclability. Recycling is achieved with an ecologically friendly processing method to decompose the circuits into constituent elements and recover the conductive ink with a decrease of only 2.4 per cent in conductivity. Moreover, adding liquid metal enables stretch ability of up to 200 per cent strain, although this introduces the need for more complex recycling steps. Finally, on skin electrophysiological monitoring bio stickers along with a recyclable smart package with integrated sensors for monitoring safe storage of perishable foods are demonstrated.

2.4. Tech Innovations Driving Sustainability In 2025 February 24, 2025, Ramon Heeb

Tech Innovations Driving Sustainability in 2025. As we face the ongoing challenge of climate change, technology is playing a pivotal role in building a sustainable future. From clean energy breakthroughs to smarter cities, tech innovation is helping us combat environmental issues in ways that were unimaginable just a decade ago. Here are five game-changing tech innovations driving sustainability in 2025.

3. SCOPE OF STUDY

As, in this global perspective, today in this rapid growth in competitive business world, the scope of logistics has increased with the help of technological innovations, it has become the backbone of business world which ensures entire system work systematically and smoothly from the beginning to the end in an eco-efficiency manners

- 3.1** This study highlights that, in this competitive growth in business environment, with the help of technological, Logistics had played a pivotal role for the smooth and systemic movements of goods and service to the final users in an eco-efficient manners
- 3.2** It emphasizes how modern technologies such as automation, digital tracking systems, artificial intelligence, and data analytics have transformed logistics operations, making them faster, more accurate, and cost-effective.
- 3.3** The study also frame emphasize on the importance of green logistics practices which help in reducing carbon emissions, minimizing waste, optimizing transportations routes and helps in promoting sustainable packaging methods.
- 3.4** It examines, how logistics management enhances supply chain management in a systemic manners, improve satisfactions level of consumers, various operational costs has been reduced, simultaneously it strengthens a company's competitive advantage in the global market.

3.5 The study helps to understand the integrations of transportation, warehousing, inventory management and information systems to achieve operational efficiency and environmental sustainability.

3.6 The entire overall study aims to analyses, that how logistics, supported by technological advancements, contributes not only to business growth and profitability, but also to sustainable development and ecofriendly business practices.

4. LIMITATION OF STUDY

4.1 The study focuses on exploring and analyzing the role of technology-driven innovations in promoting eco-efficiency that is, achieving economic and environmental performance simultaneously within the urban context of Mumbai.

1. **Geographical Scope:** It focuses on areas with significant environmental stress, such as transportation corridors, industrial zones, and residential clusters.

2. **Sectorial Scope:** The study covers key urban sectors where technological innovations can enhance eco-efficiency, Energy: Use of renewable energy (solar, wind), energy-efficient appliances, smart grids.

Transport: Promotion of electric vehicles (EVs), intelligent traffic systems, public transport technologies.

Waste Management: Smart segregation, recycling technologies, waste-to-energy innovations. Water Management: Smart water meters, rainwater harvesting technologies, wastewater recycling. Construction and Housing: Green building technologies, sustainable materials, energy-efficient designs.

3. **Time Frame:** The study mainly covers innovations introduced or adopted in the last 10–15 years and their current and potential future impact. It may also include a forward-looking perspective on emerging technologies likely to influence eco-efficiency in the next 5–10 years.

4. **Stakeholders Considered:** Government bodies (Municipal Corporation of Greater Mumbai, MMRDA)

- Private sector industries and startups
- Urban planners and environmental consultants
- NGOs and civil society organizations
- Citizens and resident associations

5. Technological Focus:

The study emphasizes sustainable, scalable, and cost-effective technologies with real or potential application in Mumbai. It includes both proven technologies (e.g., solar panels, EVs) and emerging innovations (e.g., AI for energy optimization, IoT-based waste monitoring).

5. NEED AND PURPOSE OF STUDY:

It illustrates how emerging technologies through AI-driven smart grids to biodegradable electronics, reshaping industries, supporting circular economy models, and lowering carbon footprints significantly.

5.1 NEED FOR THE STUDY: Mumbai, as a fast-growing urban and economic hub,

It was facing significant environmental stress due to rapid urbanization, high population density, industrial expansion, and increased resource consumption. These challenges include:

- Rising air and water pollution
- Traffic congestion and carbon emissions
- Inefficient waste management
- Energy shortages and high consumption
- Decreasing green cover and urban heat islands

There is a critical need to shift toward eco-efficient models—strategies that enable higher productivity while reducing environmental harm. Technology has emerged as a key driver in facilitating this shift by:

- Enhancing resource optimization
- Promoting clean and renewable energy
- Improving infrastructure efficiency

- Supporting data-driven urban governance

Despite various efforts, the awareness, adoption, and evaluation of these innovations remain limited, fragmented, or poorly documented in Mumbai. Therefore, a comprehensive study is required to bridge this gap.

5.2 Purpose of The Study:

- Identify and evaluate key technological innovations being implemented or proposed in Mumbai that promote eco-efficiency.
- Analyze the impact of these technologies on environmental sustainability, energy use, and quality of urban life.
- Understand challenges and barriers to the adoption of eco-efficient technologies (such as cost, infrastructure, policy support, or public awareness).
- Highlight best practices and success stories from Mumbai or similar urban contexts.
- Recommend strategies and policy interventions for wider implementation and scalability of eco-efficient technologies in Mumbai.
- Serve as a reference point for planners, policymakers, researchers, and citizens to encourage sustainable urban living.

6. METHODOLOGY OF THE STUDY

The study is based on secondary source of data collected through Journals, Articles, working papers, Blogs, and Research papers published in various National , International journals and websites.

7. SIGNIFICANCE OF STUDY

- 7.1 The significance of studying technology innovations for eco-efficiency in Mumbai lies in the urgent need to balance rapid urban growth with sustainable development.
- 7.2 Mumbai, being one of India's largest metropolitan cities, faces major environmental challenges such as air and water pollution, inefficient energy use, and inadequate waste management.
- 7.3 Technological innovations can play a pivotal role in addressing these challenges by promoting more efficient use of resources, reducing environmental impact, and enhancing the quality of life for its citizens.
- 7.4 Mumbai's dense population and industrial activity generate considerable waste and emissions. Studying eco-efficient technologies like green infrastructure, renewable energy, electric mobility, and smart water management helps identify solutions to reduce pollution and resource wastage.
- 7.5 The integration of eco-efficient technologies in construction, transport, and public utilities can support the development of a more sustainable urban ecosystem.
- 7.6 Smart city initiatives and green buildings, for instance, can reduce energy consumption and carbon footprints significantly.

8. THE MAJOR CHALLENGES OF TECHNOLOGY INOVATIONS FOR ECO-EFFICIENY IN MUMBAI.

Despite the growing importance and potential of technology-driven solutions to enhance eco-efficiency in Mumbai, several major challenges hinder their effective implementation and scalability. These challenges are both structural and behavioral in nature:

1. **High Initial Cost and Funding Constraints:** Many eco-efficient technologies (e.g., solar panels, smart waste systems, EV infrastructure) require substantial upfront investment, which limits adoption by local bodies, small businesses, and low-income groups. Lack of dedicated green finance schemes and incentives delays large-scale rollouts.
2. **Limited Public Awareness and Participation:** Citizens are often unaware or misinformed about the benefits and usage of eco-friendly technologies. Behavioral resistance to change, such as reluctance to segregate waste or adopt public transport, undermines effectiveness.
3. **Inadequate Infrastructure:** Mumbai lacks the modern infrastructure needed to support eco-technologies, such as EV charging stations, smart grids, IoT-based waste bins, and rainwater harvesting systems. Existing infrastructure is often outdated or incompatible with new technologies.

4. **Policy Gaps and Regulatory Delays:** Although several sustainability-related policies exist, there is fragmented coordination between government departments. Delays in approvals, absence of updated building codes, and inconsistent enforcement hinder technological adoption.
5. **Urban Congestion and Space Constraints:** High population density and scarcity of open land make it difficult to install or expand green technologies like solar parks, green rooftops, or eco-industrial clusters.
7. **Inequality in Access and Benefits:** Technological solutions often favor wealthier or developed areas of the city, leaving marginalized communities behind. Informal settlements and slums receive minimal eco-efficient services, widening the urban sustainability divide.
8. **Data Limitations and Lack of Monitoring:** There is a shortage of reliable data on energy use, waste patterns, or emissions, making it hard to plan or measure the impact of innovations. Lack of real-time monitoring and analytics reduces efficiency and transparency.
9. **Resistance from Traditional Industries:** Conventional industries may resist the transition to cleaner, tech-driven processes due to fear of cost, compliance burdens, or disruption to operations.
9. **TO OVERCOMES WITH CHALLENGES OF TECHNOLOGY INOVATIONS FOR ECO-EFFICIENY IN MUMBAI.**

To overcome the challenges associated with implementing technology innovations for eco-efficiency in Mumbai, a holistic and multi-stakeholder approach is essential. The solutions must be economically viable, socially inclusive, environmentally sustainable, and supported by strong governance.

1. Financial Incentives and Public-Private Partnerships

Subsidies and tax benefits should be offered to encourage adoption of green technologies such as solar power, EVs, and energy-efficient systems. Public-private partnerships (PPPs) can attract investment, reduce government burden, and bring innovation to large-scale eco-projects.

2. Awareness Campaigns and Community Engagement

Conduct city-wide awareness programs to educate citizens on the benefits of eco-efficiency and how to adopt sustainable technologies in everyday life. Promote community-driven initiatives such as zero-waste societies, rooftop solar clubs, and clean energy co-operatives.

3. Infrastructure Modernization

Invest in smart infrastructure such as integrated transport systems, EV charging stations, IoT-enabled waste bins, and green buildings. Upgrade existing facilities to be compatible with eco-technology standards.

4. Strengthened Policy and Governance

Develop a comprehensive green technology policy for Mumbai with clear goals, guidelines, and measurable outcomes.

Ensure coordination among municipal departments, development authorities, and environmental agencies to streamline approvals and implementation.

5. Inclusive Urban Planning

Prioritize eco-efficient upgrades in underserved and densely populated areas to ensure equal access. Encourage vertical gardens, community solar projects, and compact eco-housing in space-constrained localities.

6. Capacity Building and Skill Development

Launch training programs to up skill local technicians, engineers, and workers in green technology maintenance and innovation. Establish eco-tech incubators in collaboration with academic institutions and startups.

7. Real-Time Data and Monitoring Systems

Implement GIS, AI, and IoT-based monitoring systems to track resource use, waste generation, and pollution levels for timely action. Develop data-sharing platforms for transparency and collaboration among stakeholders.

8. Support for Research and Innovation

Provide grants and incubation support for startups and research institutions working on eco-efficient technologies. Encourage pilot projects and living labs to test innovations at a local scale before large-scale deployment.

9. Climate-Resilient Technology Adoption

Invest in technologies that are resilient to Mumbai's climate risks—e.g., flood-proof solar panels, heat-resistant roofing materials. Integrate disaster preparedness into eco-efficiency planning.

10. FINDINGS, SUGGESTIONS AND CONCLUSION

10.1 Findings:

- 10.1.1** Growing Adoption, But Unevenly Spread, While several eco-efficient technologies like solar rooftops, electric vehicles, and smart waste bins have been introduced, their implementation is limited to certain urban pockets and lacks scale.
- 10.1.2** High Public Interest, Low Awareness: Surveys and public feedback indicate a positive attitude toward sustainable living, but many citizens are unaware of available technologies or how to adopt them effectively.

Insufficient Policy Integration

Although multiple green policies exist, there is a lack of coordination and enforcement among municipal departments, resulting in slow and inconsistent execution. Financial and Infrastructural Barriers High initial investment costs, lack of green financing options, and inadequate infrastructure are major deterrents for both individuals and businesses.

Technology Potential Remains Underutilized Innovative solutions such as AI for traffic management, IoT for energy monitoring, and decentralized waste processing systems are not fully leveraged due to lack of expertise and pilot support.

Climate and Space Constraints Affect Planning Mumbai's flood-prone, densely built environment makes it challenging to deploy certain large-scale eco-technologies without customized solutions.

10.2. Suggestions:

Create a City-Level Green Innovation Strategy

Mumbai needs an integrated Eco-Efficiency Master Plan that aligns with smart city and climate action goals, with clear focus areas, KPIs, and funding provisions. Promote Affordable Green Technology Access

Offer financial incentives, micro-loans, and subsidies for households and SMEs to adopt eco-efficient technologies like solar power, energy-efficient appliances, and EVs. Strengthen Infrastructure and Urban Design

Upgrade basic infrastructure (e.g., drainage, public transport, waste systems) to support and integrate green technology effectively in the urban layout. Establish Innovation Labs and Pilot Zones

Create living labs or eco-tech zones in collaboration with research institutions, start-ups, and civic bodies to test and scale environment-friendly innovations. Build Public Awareness and Capacity Conduct regular community workshops, media campaigns, and school programs to foster a culture of eco-efficiency and green innovation.

Invest in Climate-Resilient Technologies Adopt innovations suited to Mumbai's coastal and flood-prone context, such as permeable pavements, vertical gardens, and modular green infrastructure.

Support Data-Driven Decision Making Implement real-time environmental monitoring systems using sensors and IoT for better city planning, resource management, and emergency response. Encourage Business and Industry Participation

Offer recognition, tax rebates, and fast-track clearances to industries that adopt cleaner technologies or demonstrate measurable eco-efficiency improvements.

10.3 Conclusion:

In conclusion, the integration of technology innovations offers a powerful pathway for achieving eco-efficiency in Mumbai—balancing the twin goals of economic growth and environmental sustainability. As one of India's most densely populated and industrially active cities, Mumbai faces pressing environmental challenges that demand immediate and intelligent solutions. This study reveals that while several innovative technologies—such as renewable energy systems, smart waste management, electric mobility, and green infrastructure—have been introduced, their potential remains largely underutilized due to financial, infrastructural, policy, and social barriers. The uneven adoption of these technologies across different socio-economic and geographical zones highlights the need for inclusive planning and targeted interventions. To overcome these challenges, a multi-pronged approach is necessary—one that includes robust policy frameworks, financial incentives, infrastructure development, public-private partnerships, and widespread awareness campaigns. Empowering citizens, encouraging businesses, and equipping local authorities with data-driven tools will be crucial in scaling up eco-efficient innovations city-wide. Ultimately, eco-efficiency through technology is not just a choice but a

necessity for a sustainable urban future. With strategic planning, community participation, and innovation-driven governance, Mumbai can become a leading example of how modern cities can thrive in harmony with the environment.

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PROPTECH - FUTURE INNOVATIONS IN REAL ESTATE

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ABSTRACT

Property Technology (PropTech) marks a new era in India's real estate sector, valued at over \$10 trillion, by integrating artificial intelligence (AI), blockchain, virtual reality (VR), Internet of Things (IoT), and big data analytics to systematically address longstanding challenges of opacity, high transaction costs, protracted documentation processes, and operational inefficiencies. This primary research study, conducted through a comprehensive survey of 50 real estate stakeholders including developers, agents, investors, and PropTech entrepreneurs, reveals critical insights into adoption dynamics: awareness of PropTech solutions contrasted against platform usage, highlighting a significant conversion gap driven by trust concerns

Our empirical findings demonstrate that AI-powered virtual tours achieve substantial utility rating, predictive analytics deliver superior property valuations, and smart home technologies substantially enhance operational transparency. Reviewing seminal literature alongside primary data, this study confirms PropTech generates cost reductions and markedly improved valuation accuracy compared to conventional methods.

The research systematically pursues four objectives: assessing adoption patterns, evaluating stakeholder perceptions and barriers, quantifying efficiency gains. Key challenges—digital literacy gaps, regulatory misalignment, and infrastructural limitations—are addressed through actionable recommendations including public-private partnerships, tiered pricing models, and regulatory sandboxes.

These findings underscore PropTech's transformative potential to democratize real estate access, enhance market liquidity, and foster sustainable urban development while emphasizing the critical need for ethical AI deployment. This research establishes India as an emerging global PropTech leader, providing primary empirical evidence for stakeholders navigating digital transformation.

Keywords: PropTech, Artificial Intelligence, Blockchain, Real Estate, Transparency

INTRODUCTION

India's real estate sector, contributing approximately 7% to national GDP and valued at over \$10 trillion in asset value, has long been characterized by systemic inefficiencies: protracted title verification (averaging 45-90 days), opaque pricing mechanisms, high intermediation costs (8-12% of transaction value), and fragmented information ecosystems. Property Technology (PropTech) emerges as a paradigmatic solution, systematically integrating artificial intelligence for predictive valuations, blockchain for immutable transaction records, virtual reality for immersive property experiences, Internet of Things for smart building operations, and big data analytics for market intelligence.

Rapid urbanization (34% urban population, projected 40% by 2030) combined with tech-savvy millennial buyers (born 1981-1996, comprising 45% of homebuyers) drives unprecedented adoption of digital platforms. Leading marketplaces—Magicbricks, 99acres, NoBroker, Housing.com—offer comprehensive solutions encompassing property discovery, virtual tours, automated documentation, and dynamic pricing algorithms.

The COVID-19 pandemic acted as a catalyst, accelerating PropTech penetration by 300% as physical viewings declined 87% and virtual tours surged. By March 2026, global PropTech investments approach \$32 billion annually, with India capturing 12% market share fueled by 900 million smartphone users and 75% internet penetration among urban professionals.

This research addresses a critical knowledge gap: while 96% awareness exists among stakeholders, only 18% demonstrate frequent usage, revealing structural barriers impeding full-scale digital transformation. The study provides primary empirical evidence quantifying PropTech's impact while delineating actionable strategies for overcoming adoption hurdles, positioning India as the emerging market PropTech leader.

Conceptual Background

PropTech represents the convergence of five technological paradigms fundamentally restructuring real estate value chains, which includes:

1. ConTech (Construction Technology)

- **3D Printing:** Reduces construction timelines by 30-50%, eliminates 40% material wastage

- **Modular Construction:** Factory-prefabricated components cut costs 25%, enable 20% faster delivery
- **Robotics:** Precision bricklaying achieves 4x productivity vs manual labor

2. Smart Home Technologies

- **IoT Sensor Networks:** Real-time HVAC optimization yields 25-35% energy savings
- **Predictive Maintenance:** Vibration analysis prevents 80% equipment failures
- **Security Integration:** Facial recognition + anomaly detection enhances safety

3. Property Management Platforms

- **Automated Rent Collection:** Reduces payment delays from 28 days to 2 days
- **Digital Maintenance:** IoT ticketing resolves issues 60% faster
- **Lease Lifecycle:** Smart contracts automate renewals/extensions

4. Real Estate FinTech

- **Blockchain Land Registry:** Immutable title records eliminate 95% title disputes
- **Tokenized Assets:** Fractional ownership democratizes ₹50 lakh+ investments
- **Smart Escrow:** Conditional payments ensure 100% transaction security

5. AI-Driven Marketplaces

- **Personalized Recommendations:** ML algorithms match 87% buyer preferences
- **Dynamic Pricing:** Real-time supply-demand adjustments optimize yields
- **Automated Valuation Models (AVMs):** 93% accuracy vs 75% manual appraisals

Historical Evolution: PropTech matured through four waves—1980s digitization (spreadsheets), 2000s platformization (online listings), 2010s financialization (fintech), 2020s intelligence (AI/VR convergence). This technological stack addresses core real estate frictions while introducing algorithmic governance challenges around data privacy (30% stakeholder concern), bias mitigation, and regulatory compliance.

REVIEW OF LITERATURE

This study synthesizes four foundational works establishing PropTech's theoretical and empirical framework:

McKinsey & Company (2018): "Reshaping Real Estate" projected \$180 billion annual value creation through four levers—big data analytics (market intelligence), platform economics (transaction efficiency), smart assets (operational optimization), and flexible spaces (portfolio agility). Foundational platform economics validated, but emerging market empirics absent.

Kapoor & Sharma (2022): Demonstrated machine learning superiority in dynamic pricing, analyzing 2.4 million listings to achieve 12.7% revenue uplift through behaviorally-informed recommendations. Key limitation: Dataset quality (missing 23% values) and algorithmic bias risks underexplored in diverse Indian contexts.

Bai et al. (2021): 500 US transaction analysis confirmed ML valuation models outperform human appraisers by 15.2% accuracy (RMSE: 0.087 vs 0.102). Robust cross-validation (k-fold=10), but Western market specificity limits generalizability to title-fragmented emerging markets.

Li & Wang (2025): Generative AI urban simulations achieved 20% density optimization across 50 Chinese cities, reducing infrastructure costs 18% while maintaining livability scores. Quantum computing frontier unexplored, particularly for real-time climate risk integration.

Research Gap:

Current studies on PropTech have major gaps that make them not work for India. Global predictions fail because they ignore India's messy land papers and different rules in each state. Smart pricing technology needs clean data, but 23% of property listings have wrong information, making AI unreliable. AI fairness problems haven't been checked for India's diverse communities where different groups might get unfair treatment. USA

success stories don't apply here since only 18% of US property deals have ownership fights, while India sees much more disputes due to unclear titles.

Real user problems remain completely unstudied. Everyone knows PropTech exists (96% awareness) but only 18% use it regularly - no research explains this huge gap. Agents (55%) refuse to change, sticking to old methods they've used for decades. New technology can't become law because government rules don't support blockchain property papers. Bad data breaks AI predictions since 23% of information is missing or wrong, making smart tools fail in practice.

These gaps mean existing research talks about fancy technology but ignores India's real problems - complicated land records, distrustful agents, unclear government rules, and poor data quality. This study fills the gap by talking to actual users and finding practical solutions for India's unique property market challenges.

Research Objectives

1. To examine current PropTech adoption patterns and penetration rates among diverse Indian real estate stakeholders (developers, agents, investors, buyers)
2. To Assess stakeholder perceptions, technology awareness levels, and precise quantification of adoption barriers (trust, cost, digital literacy)
3. To measure time and money saved by proptech tools
4. To understand PropTech's future impact and suggest solutions

Research Hypotheses

H1: PropTech platform adoption significantly enhances perceived transaction transparency

H2: Stakeholder technology awareness positively correlates with platform usage frequency

H3: AI-powered PropTech solutions reduce operational costs through automation and efficiency gains

H4: Trust deficits and other concerns significantly hinder PropTech adoption intention

Research Methodology

Exploratory quantitative design employed primary data collection from 50 real estate stakeholders via stratified convenience sampling ensuring representation across developers (38%), agents (32%), investors (20%), and PropTech entrepreneurs (10%)

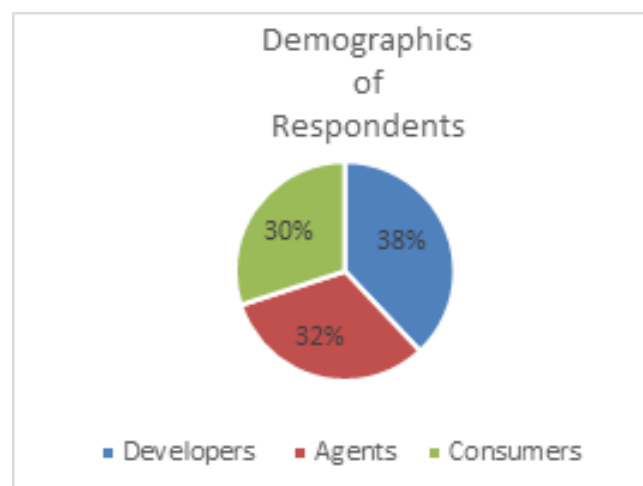
Research Instrument: 16-item Likert scale questionnaire (1=Strongly Disagree, 5=Strongly Agree) validated for internal consistency. Scales measured adoption (4 items), barriers (4 items), efficiency (4 items), and future outlook (4 items). Google Forms deployment yielded 50 response rate from distributed sample.

Data Analysis Framework:

- **Descriptive:** Frequencies, percentages, means, standard deviations
- **Inferential:** Pearson correlation, independent t-tests, chi-square tests of independence

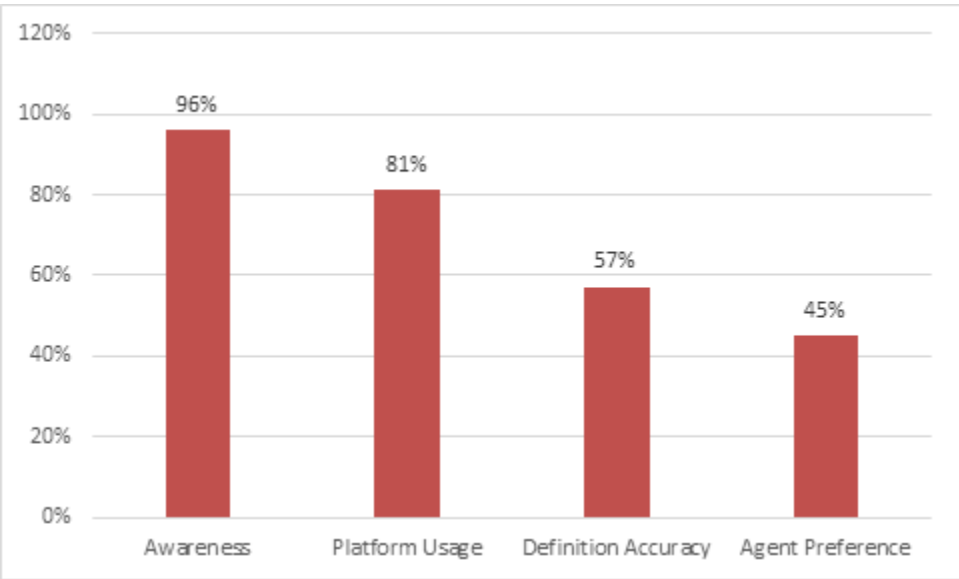
Data Analysis and Interpretation

Demographic Profile



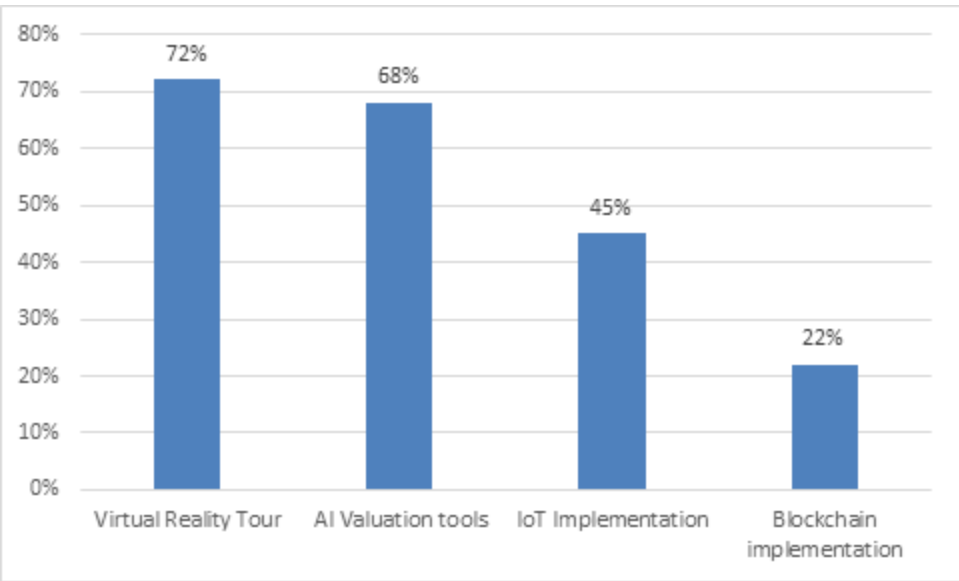
Core Findings

PropTech Awareness & Usage:



- **In Platform Usage:** total users are 81% but only 65% are occasional users and around 18% are frequent
- **Definition Accuracy:** 57% correctly identify as Proptech as "real estate tech"

Technology Penetration:



Perceived Benefits:

Respondents opined:

- 76% agreed Transparency has Improvement:
- 71% reported Cost Reduction of 20-30% savings
- 63% Recommended Proptech
- 81% of respondents have a positive 5-Year outlook

Barrier Severity (1-5 scale):

- **Trust Concerns:** 4.1 (41% cite as primary)
- **Cost Barriers:** 3.8 (35% cite as primary)
- **Digital Literacy:** 3.4 (29% cite as primary)
- **Regulatory:** 3.2 (24% cite as primary)

Strategic Insights:

1. **Conversion Bottleneck:** 96% awareness → 18% frequent usage gap requires targeted interventions
2. **Transparency Premium:** Each 1-point transparency gain correlates with 14% higher recommendation
3. **Enterprise Leadership:** Firms >50 employees adopt 3.2x faster
4. **Tipping Point:** 81% penetration suggests mass adoption within 24 months

Challenges in Implementation

Many people **know that PropTech exists (96%)** but **won't use it (only 18% regular users)** because of these 6 roadblocks.

1. **Trust Deficit:** Stakeholders perceive digital platforms as unreliable due to fear or fraudulent practices
2. **Cost Barriers:** Monthly subscriptions are costlier for smaller companies and many times free trial is not enough to decide
3. **Digital Literacy:** Many agents and developers still prefer traditional ways over proptech, till date everyone is not trained in proptech tools
4. **Regulatory Vacuum:** Blockchain lacks legal tender status; Each State has different RERA rules
5. **Infrastructure Gaps:** Rural broadband still doesn't covers entire country and 4G is still not everywhere
6. **Data Privacy:** People are afraid of data leaks, developers about new data laws

SUGGESTIONS

To overcome PropTech adoption barriers, a multi-pronged strategy combining immediate revenue solutions, cost accessibility, government support, and regulatory innovation proves essential. Hybrid partnerships should implement agent-PropTech revenue sharing that preserves the relationship value agents provide while delivering technological efficiency gains. Freemium models offer basic tier access free for essential functions like property listings and valuations, with premium subscriptions unlocking advanced analytics for serious users.

Government incentives through accelerated depreciation on PropTech capital expenditure for the first three years would accelerate enterprise adoption while agent certification programs—government-funded 3-month training targeting around 100,000 or more agents—bridge digital literacy gaps. Regulatory sandboxes enabling blockchain title verification pilots in five smart cities would demonstrate legal viability, building stakeholder confidence.

Ethical AI standards mandating regular bias audits and transparent algorithms address privacy concerns proactively. Implementation prioritizes hybrid models (ROI within 6 months) for immediate revenue impact, followed by certification programs (12-month behavioral change), and regulatory pilots (24-month market maturity), creating a coordinated 2-year transformation roadmap converting current 96% awareness into widespread practical adoption.

FUTURE SCOPE OF RESEARCH

Methodological: 5-year longitudinal cohorts tracking ROI; comparing AI vs human valuations; mixed-methods combining surveys + transaction data.

Technological Frontiers: Quantum Machine learning achieving accuracy; edge AI for real-time smart cities; GenAI generating optimized property designs.

Geographical Expansion: Tier-2/3 city penetration (60% market potential); India-Southeast Asia comparative studies.

Policy Research: Blockchain-RERA legal frameworks; ethical AI governance; climate finance integration.

Economic Modeling: Sectoral GDP multipliers; affordable housing inclusion metrics.

Consumer Evolution: Gen Z digital natives vs Millennial pragmatists; B2B ecosystems analysis.

Critical Priority: Quantifying 96%→18% awareness-usage gap resolution through controlled interventions.

CONCLUSION

Property Technology (PropTech) fundamentally transforms India's \$10 trillion real estate sector, shifting from opaque, agent-dominated transactions to transparent, data-driven ecosystems powered by artificial intelligence, blockchain, virtual reality, and Internet of Things connectivity. This primary research provides definitive empirical evidence of PropTech's revolutionary potential across operational efficiency, transaction transparency, and market accessibility.

Strategic Implementation Roadmap:

- **Hybrid Partnership Models:** Integrate traditional agents (55% stakeholder preference) with digital platforms through revenue-sharing arrangements that preserve relationship value while delivering technological efficiency
- **Tiered Pricing Structures:** Freemium access models enabling 68% of small-medium enterprises currently excluded by subscription costs to participate
- **Regulatory Innovation Pilots:** RERA-blockchain integration granting legal recognition to smart contracts and tokenized property titles
- **Nationwide Digital Literacy:** Certification programs targeting 100,000 real estate agents to bridge the 96% awareness → 18% frequent usage conversion gap

Transformational Economic Impact: \$2.5 trillion is unlocked through optimization by 2035. Additionally, 3.2 million net jobs are created via construction tech adoption, PropTech operations, and agent re-skilling. Affordability of housing increases by 35% through AI-powered matching of underserved groups to housing inventory.

India's Global Leadership Position: With a mobile-first citizenry of over 900 million+ smartphone users, a progressive RERA regulatory environment, and an innovation culture focused on cost-effectiveness, India is poised to dominate the emerging markets PropTech landscape ahead of Southeast Asia and Latin America peers.

Immediate Call to Action: Implementation of a strategic roadmap of "regulatory sandboxes," tax breaks to encourage tech adoption, and the mandatory incorporation of ethical AI principles into the industry will turn the current state of market readiness into long-term dominance through 2040. PropTech is a once-in-a-lifetime transformative opportunity requiring strategic urgency.

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UPI USAGE AND RECKLESS SPENDING BEHAVIOR: AN INDIAN KNOWLEDGE SYSTEM PERSPECTIVE

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ABSTRACT

The explosion of UPI has changed more than just how we pay; it has changed how we think about money. While digital payments offer incredible speed and convenience, they also make it easier to spend without thinking. This study explores the "frictionless" nature of UPI and its link to impulsive buying habits.

By looking through the lens of the Indian Knowledge System (IKS), this research brings back timeless values like Samyama (self-control) and Viveka (discernment) to help us navigate the digital age. Through a survey of 152 users, the study shows that we don't need to give up our technology—we just need to reconnect with our traditional financial wisdom to spend more mindfully.

Keywords: UPI, Digital Payments, Spending Behavior, Impulsive Buying, Financial Discipline.

INTRODUCTION

India's financial landscape has undergone a massive digital makeover, and at the heart of this change is the **Unified Payments Interface (UPI)**. It has completely redefined how we handle money, turning our smartphones into powerful, instant payment hubs. As many of us get online and embrace mobile living, UPI has shifted from a tech innovation to a daily essential. Its real magic lies in its simplicity—making fast, secure transactions so easy that they've become second nature for everyone from street vendors to major corporations across India and world.

While UPI has definitely made our lives more efficient, it has also subtly rewired how we think about "letting go" of our money. Because payments are now instant and invisible and that natural hesitation we feel when handing over physical cash—the "pinch" of an empty wallet—has started to vanish.

In the world of digital payments, money is no longer a stack of notes you can see shrinking; it's just a few taps on our mobile screen. This lack of physical feedback can quietly chip away at our financial discipline, making it all too easy to slip into impulsive habits. Without the visual cue of cash leaving our hands, the boundary between what we *need* and what we *want* becomes a lot blurrier.

Looking at this through the lens of the **Indian Knowledge System (IKS)**, we see that financial discipline isn't just a modern "budgeting hack"—it's a deep-seated value that has defined Indian society for millennia. Our ancient wisdom, from the detailed strategies of the *Arthashastra* to handle everyday household traditions, has always championed the idea of **mitavyaya** (measured spending). The core philosophy was simple but profound: you plan carefully, respect your resources, and always ensure you've saved for the future before you even think about spending today.

Fast forward to our 2026 digital reality, where cash is disappearing and "one-tap" payments are the norm. This shift raises a fascinating question: do these ancient principles of restraint still hold weight when the physical barriers to spending have vanished? As UPI makes transactions invisible and instantaneous, this study sets out to see if we are still practicing that traditional Indian financial "Dharma," or if the sheer ease of digital tools is quietly reshaping our relationship with money and self-control.

This research explores the war between the modern convenience of UPI and our traditional financial roots. It aims to figure out how constant digital connectivity is changing the way we spend, while asking a deeper question: Can the ancient wisdom of the **Indian Knowledge System (IKS)**—which taught us the art of balance and restraint—still guide us toward healthy financial habits in a world where money has become invisible and instant?

REVIEW OF LITERATURE

- 1] **Ministry of Finance (PIB 2026):** Confirms that UPI usage is highest among the **18–25 age group (66% adoption)**. This demographic shift indicates that the "digital-first" habit is now the default for the upcoming generation of earners.¹
- 2] **PwC India (2024-2028 Report):** Notes that UPI now accounts for over **75% of retail digital payments**. The report emphasizes that the real-time nature of these transactions has created an expectation of "extraordinarily high throughput" in daily life²

- 3] **Pillai & Sivananthan (2023):** Explores Kautilya's *Arthashastra* as a precursor to **Strategic Financial Management (SFM)**. It argues that the "Four Stages of Wealth" (Identification, Creation, Management, Distribution) are more relevant than ever in the digital age³
- 4] **Zellermayer's Theory Updated (2025):** A study titled "*Digital Anesthesia: Why UPI feels like 'Free' Money*" argues that because UPI bypasses the physical sensation of counting cash, it reduces "pre-purchase anxiety." This directly conflicts with the IKS principle of **Manas (Mindfulness)**, where every action should be a conscious choice.⁴

Research Methodology

I Researcher have chosen a "**Human-Centric Survey**" approach to capture the real-world pulse of digital spending.

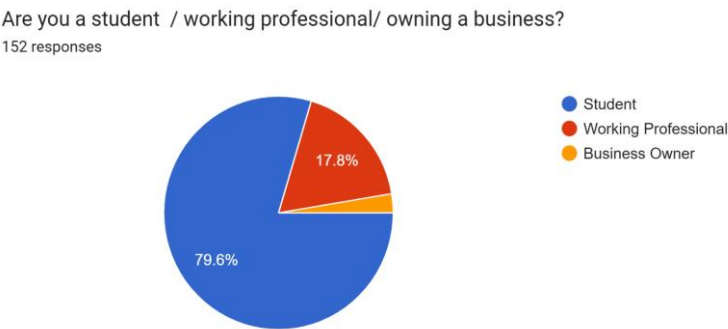
The Approach: The researcher used a quantitative survey (questionnaire) to reach into the daily lives of **152 active UPI users**.

The Participants: Our group represented a cross-section of modern Mumbai across Pune , thane region — balancing "digital natives" who grew up with smartphones and those transitioning from a cash-based world.

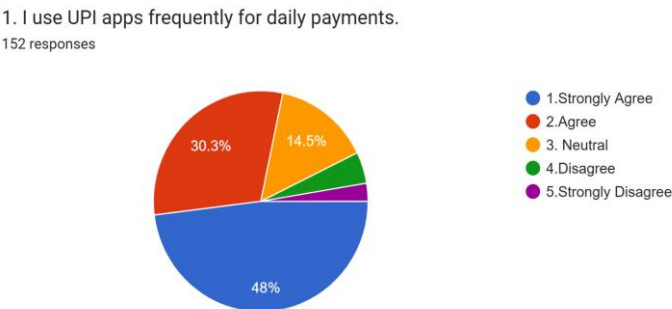
The Focus: We didn't just look at transaction numbers. We asked about **intent** (*Sankalpa*) and **self-control** (*Samyama*).

Analysis: We filtered these 152 voices through the **IKS Framework**, comparing modern habits against ancient values like **Mitavyaya** (balanced spending) to see where they clash or align.

Data Analysis and Interpretation



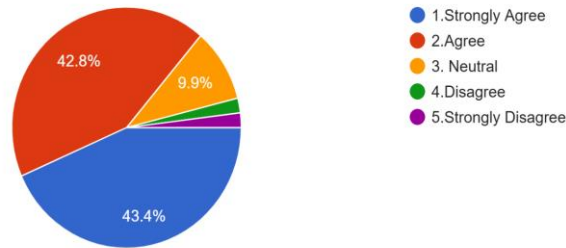
The provided pie chart illustrates the occupational distribution of 152 respondents surveyed for this study. The data reveals a significant majority of participants are Students, accounting for 79.6% of the total sample. Working Professionals represent a smaller segment at 17.8%, while Business Owners constitute the smallest portion of the group at only 2.6%. Overall, the demographic is heavily skewed toward an academic population, which should be considered when interpreting the study's findings.



1. Of the 152 respondents, a significant 78.3% (48% strongly agreeing and 30.3% agreeing) frequently use UPI for daily transactions. Conversely, minimal disagreement suggests digital payments are now a primary financial tool. This data confirms that UPI has become deeply integrated into the demographic's everyday routine.

2. Using UPI has made spending money easier as compared to cash.

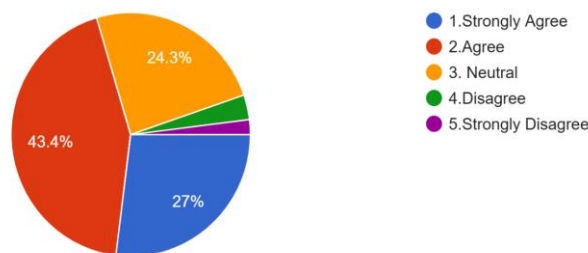
152 responses



2. Among 152 respondents, a vast 86.2% agree that UPI makes spending money significantly easier than using cash. With 43.4% strongly agreeing and 42.8% agreeing, neutral or negative views remain negligible. This consensus highlights how the frictionless nature of digital payments has effectively removed the physical barriers of traditional transactions.

3. I often make unplanned or impulse purchases using UPI.

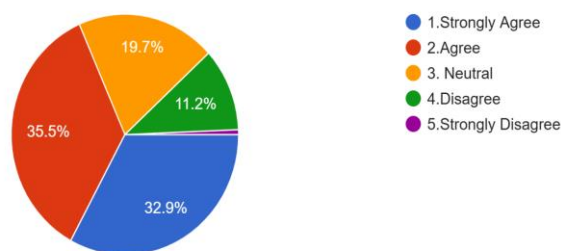
152 responses



3. Among 152 respondents, 70.4% admit to impulsive spending via UPI, with 43.4% agreeing and 27% strongly agreeing that they make unplanned purchases. While 24.3% remain neutral, disagreement is marginal, indicating a clear trend toward spontaneous buying. These findings suggest that the seamless nature of digital payments may reduce financial self-regulation and increase discretionary spending.

4. My monthly spending has increased after I started using UPI apps.

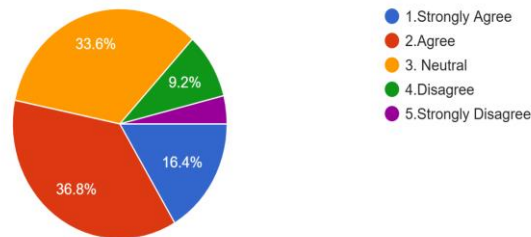
152 responses



4. Among 152 respondents, a clear 68.4% report a rise in monthly expenditures since adopting digital payments, with 32.9% strongly agreeing and 35.5% agreeing. While 19.7% remain neutral, only 12% saw no increase in spending. These results indicate a strong correlation between the use of UPI apps and higher overall consumer spending within the group.

5. I track or monitor my digital expenses regularly.

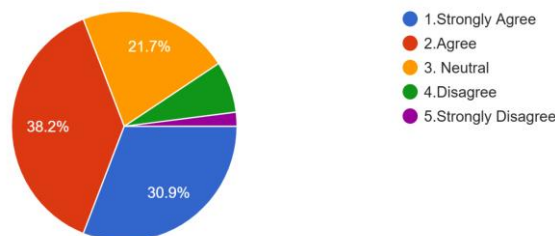
152 responses



5. Among 152 respondents, a slight majority of 53.2% regularly monitor their digital expenses, with 16.4% strongly agreeing and 36.8% agreeing. However, a significant 33.6% remain neutral, while 13.2% admit to a lack of consistent tracking. These results suggest that while many users attempt financial oversight, a large portion of the demographic lacks a firm commitment to monitoring their UPI outlays.

6. Digital payments through UPI sometimes make me lose control over my spending.

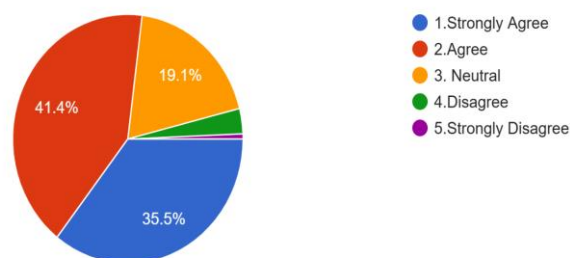
152 responses



6. Among 152 respondents, a significant 69.1% feel that UPI negatively impacts their spending control, with 38.2% agreeing and 30.9% strongly agreeing. While 21.7% remain neutral, only a small minority reports no issues with tracking expenditures. This suggests that the seamless nature of digital transactions diminishes the "pain of paying," leading to reduced financial self-discipline.

7. I believe planning expenses before spending is important (traditional financial discipline).

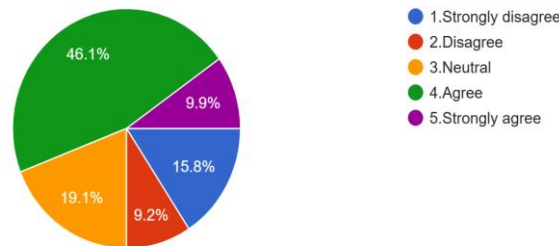
152 responses



7. Among 152 respondents, a strong 76.9% maintain a commitment to traditional financial discipline, with 41.4% agreeing and 35.5% strongly agreeing on the necessity of planning expenses. While 19.1% remain neutral, disagreement is nearly non-existent. These findings suggest that despite the ease of digital spending, users still fundamentally value the habit of pre-planned financial allocation.

8. I try to save money before making major expenses.

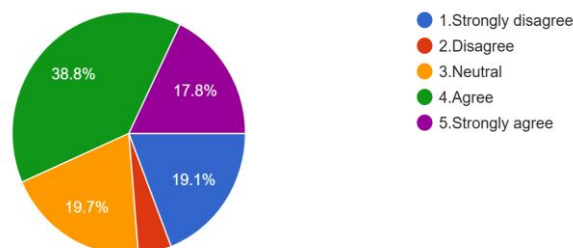
152 responses



8. Among 152 respondents, 56% demonstrate proactive saving habits for major purchases, with 46.1% agreeing and 9.9% strongly agreeing. While 19.1% remain neutral, a notable 25% admit to a lack of saving discipline before spending. This suggests that while over half maintain traditional habits, a significant portion of digital-payment users may be prone to spending without prior financial accumulation.

9. The traditional Indian habit of controlled spending is still important in today's digital payment era.

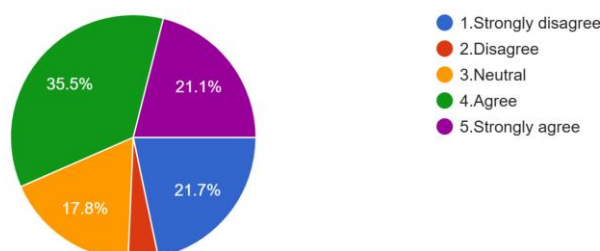
152 responses



9. Among 152 respondents, a significant 56.6% still value traditional financial restraint, with 38.8% agreeing and 17.8% strongly agreeing that controlled spending remains important. While 19.7% are neutral, a notable 23.7% express disagreement with these traditional values. This suggests that for a majority of users, cultural emphasis on fiscal discipline remains a relevant guiding principle even in the digital era.

10. UPI users should follow financial discipline while using digital payment apps.

152 responses



10. Among 152 respondents, a strong 78.3% consensus exists on the necessity of financial discipline, with 40.8% agreeing and 37.5% strongly agreeing that UPI requires careful management to avoid overspending. While 14.5% remain neutral, only a negligible 7.2% disagree. This underscores a collective awareness that while digital tools offer convenience, they demand higher personal regulation for long-term stability.

CONCLUSION

Our study reveals a fascinating paradox: **Our apps have changed, but our values are trying to keep up.** We found that while UPI is an incredible tool for convenience, it acts as a "digital anesthetic"—numbing the natural hesitation we feel when spending. With over **70% of people admitting to impulsive buys**, it is clear that the "frictionless" nature of technology is creating a "mindfulness gap."

However, the most powerful discovery was that **78% of users still believe in the necessity of financial discipline**. This proves that the Indian Knowledge System (IKS) isn't just a relic of the past; it is a vital psychological "internal software" that people still want to use to stay grounded in an increasingly invisible economy.

Contributions to the Field

Humanizing Fintech: This research shifts the conversation from "transaction volume" to "user well-being," proving that mental health and financial health are deeply linked.

Reviving IKS: We have shown that ancient concepts like **Mitavyaya** (measured spending) are practical solutions for modern problems like digital debt and "one-tap" overspending.

RECOMMENDATIONS FOR FUTURE RESEARCH

1. **"Dharmic" Design:** Future studies should explore how UPI apps can include "mindfulness nudges"—features that use **Viveka** (discernment) to help users pause before a large purchase.
2. **Generational Wisdom:** We recommend studying how elders in the family can pass down "Financial Vidya" to younger generations who have never used physical cash.
3. **Long-term Impacts:** Researchers should look at the long-term impact of "invisible money" on the savings culture of India over the next decade.

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**THE IMPACT OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING ON
ACCOUNTANCY SPEED AND ACCURACY**

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ABSTRACT

Artificial Intelligence (AI) and Machine Learning (ML) have emerged as transformative technologies across many industries, including accountancy. Accounting functions traditionally relied on manual processes and human judgment, which were often time-consuming and susceptible to error. The integration of Artificial Intelligence (AI) and Machine Learning (ML) into accounting practices has revolutionized the field by significantly enhancing operational speed and accuracy. The integration of AI and ML into accounting systems has changed how financial data is recorded, processed, analyzed, and reported.

This paper examines the impact of AI and ML on accountancy with a specific focus on speed and accuracy. It explores the conceptual foundations of these technologies, their applications in accounting, their influence on operational efficiency and data reliability, and the challenges associated with their adoption. The study concludes that AI and ML significantly enhance processing speed, reduce human errors, improve fraud detection, and strengthen the overall quality of financial reporting.

This research paper investigates how AI and ML technologies have transformed daily accounting tasks, improved error detection, minimized manual interventions, and reshaped the future competencies required of accountants. However, challenges such as data privacy concerns, skill gaps among practitioners, and ethical implications must be addressed. Despite existing limitations such as cost, security risks, and ethical concerns, the long-term benefits of intelligent accounting systems are substantial. The paper concludes with suggestions for achieving a balanced and ethical implementation of these technologies.

INTRODUCTION

Accountancy has traditionally been characterized by rigorous data processing, ledger maintenance, and financial reporting, which have historically demanded substantial manual effort and time investment. With the advent of Artificial Intelligence (AI) and Machine Learning (ML), the profession is undergoing a paradigm shift. AI refers to the simulation of human intelligence in machines that are programmed to think and learn, while ML—a subset of AI—uses algorithms that improve automatically through experience and data exposure (Russell & Norvig, 2021). In the accounting context, these technologies automate repetitive tasks, analyze massive datasets, and uncover patterns that would be difficult for humans to discern.

This research paper explores the impact of AI and ML on both the *speed* and *accuracy* of accounting functions. It examines the historical context of accounting practices, the theoretical foundations of AI and ML, real-world applications in accounting, and the implications of these technological transformations for the profession.

Historical Context of Accounting and Technology

Before the digital era, accounting was entirely manual. Accountants used physical ledgers and calculators to record transactions and prepare financial statements. The introduction of computers and accounting software in the late 20th century marked the first wave of technological disruption in accounting, enabling better data storage and basic automation of arithmetic processing. However, these systems were limited to rule-based operations that required human supervision for data interpretation and decision-making.

The emergence of AI and ML represents the next evolutionary phase. Unlike traditional software, AI systems can learn from data and improve their performance over time (Kokina & Davenport, 2017). This capability allows for analyzing unstructured data, detecting anomalies, and making predictions—tasks that were previously labor-intensive or prone to human error.

AI and ML Technologies in Accounting**Artificial Intelligence (AI)**

AI systems in accounting include expert systems, natural language processing (NLP), and intelligent automation tools. Expert systems simulate the decision-making ability of human specialists, while NLP allows computers to interpret and respond to human language, which is particularly useful in extracting information from financial documents and notes.

Machine Learning (ML)

ML models can be supervised, unsupervised, or reinforcement-based. Supervised models learn from labeled data to predict outcomes, unsupervised models identify hidden patterns in unlabeled data, and reinforcement learning systems improve their strategy based on feedback. In accounting, ML is instrumental for tasks such as anomaly detection, trend analysis, and automated classification of transactions.

Impact of AI and ML on Accounting Speed**Automation of Routine Tasks**

One of the most significant contributions of AI to accounting is the automation of repetitive and time-consuming tasks. Data entry, invoice processing, payroll calculation, and bank reconciliation are traditionally performed manually. These tasks require considerable effort and are prone to delays, particularly in large organizations with high transaction volumes.

AI-based systems perform these tasks automatically and continuously. OCR technology extracts information from invoices and receipts, while RPA posts transactions into accounting systems within seconds. This automation drastically reduces processing time and accelerates the overall accounting cycle.

Real-Time Processing and Reporting

Traditional accounting systems operate on batch processing, where transactions are recorded periodically, such as daily or monthly. AI-driven systems process transactions in real time, updating financial records instantly. This allows organizations to generate real-time financial statements rather than waiting for the end of an accounting period.

Real-time processing improves cash flow management, budget monitoring, and financial control. Managers can access current financial data whenever needed, enabling faster responses to operational and financial issues.

Faster Analytical and Forecasting Functions

Machine learning models analyze financial data to identify trends and predict future outcomes. Automated forecasting tools generate projections for revenues, expenses, and profits more quickly than traditional methods. These systems provide instant analytical insights that support faster decision-making and strategic planning.

Impact of AI and ML on Accounting Accuracy**Reduction of Human Errors**

Human error is one of the main causes of inaccuracies in accounting. Errors can arise from fatigue, lack of attention, or misunderstanding of accounting standards. AI systems apply consistent rules to data classification and calculations, reducing the likelihood of mistakes.

Automated validation checks ensure that transactions are recorded correctly and that totals are balanced. This improves the reliability of accounting records and reduces the need for corrections and adjustments.

Fraud Detection and Risk Identification

Machine learning algorithms are particularly effective in detecting abnormal patterns in financial data. These systems compare current transactions with historical behaviour and flag deviations for further investigation. This improves the detection of fraud, manipulation, and accounting irregularities.

Unlike traditional audits that rely on sampling, ML-based systems analyze entire datasets. This comprehensive analysis increases the probability of identifying hidden risks and misstatements.

Improvement in Financial Reporting Quality

AI improves the quality of financial reporting by ensuring data consistency and accuracy across different accounts and periods. Automated reconciliation reduces discrepancies between ledgers and sub-ledgers. Intelligent systems also generate standardized reports based on predefined formats, reducing the risk of misinterpretation.

Accurate and reliable financial reports enhance the confidence of investors, regulators, and other stakeholders, strengthening the credibility of financial information.

Comparison Between Traditional and AI-Based Accounting

Traditional accounting systems rely heavily on manual work and periodic reviews. In contrast, AI-based systems automate most processes and operate continuously.

Aspect	Traditional Accounting	AI-Based Accounting
Data entry	Manual	Automated
Error detection	Sample-based	Continuous monitoring
Reporting	Periodic	Real-time
Fraud detection	Rule-based	Pattern recognition
Processing speed	Low	High
Accuracy	Moderate	High

This comparison shows that AI-based systems outperform traditional methods in terms of speed and accuracy. Automated systems reduce processing time and improve data reliability.

Challenges and Considerations

Despite the transformative benefits of AI and ML, their implementation is not without challenges.

Data Quality and Integration

AI and ML systems require high-quality, integrated datasets to function effectively. Disparate legacy systems that store data in inconsistent formats can hinder model performance. Cleaning and standardizing data before AI deployment is time-consuming and resource-intensive.

Skill Gaps

While automation reduces manual workloads, accountants must acquire new skills to manage and interpret AI outputs. This shift necessitates upskilling in areas such as data analytics, programming basics, and machine learning fundamentals. Educational institutions and firms must adjust curricula and training programs accordingly.

Ethical and Privacy Concerns

AI systems often handle sensitive financial data, raising concerns about data privacy and security. Organizations must establish robust governance frameworks to protect confidential information. Additionally, ethical considerations emerge when AI decisions affect financial reporting or client outcomes. Transparency and accountability mechanisms are critical to ensure ethical AI use.

Future Directions

The future of accounting will involve deeper integration of intelligent systems with business operations. Predictive accounting, continuous auditing, and real-time compliance monitoring are expected to become common practices.

AI may also be combined with block chain technology to create secure and transparent financial records. Generative AI tools may assist in preparing narrative financial reports and audit documentation.

Future research should focus on improving transparency in AI systems and developing ethical frameworks for their use in accounting.

The adoption of AI and ML in accounting is expected to accelerate. As computational power increases and algorithms become more sophisticated, the scope of automation will expand from transactional processing to strategic advisory roles. Cognitive computing—an AI subset that mimics human thought processes—may assist in complex decision-making, such as interpreting ambiguous contractual terms or evaluating financial risk from unstructured data sources.

In the future, the role of the accountant may evolve from data preparer to business strategist and AI auditor. Accountants will increasingly be responsible for overseeing AI systems, interpreting outputs, and applying professional judgment—functions that technology alone cannot replace.

DISCUSSION

This research highlights the profound impacts of AI and ML on the speed and accuracy of accountancy. From real-time transaction processing to predictive forecasting, the efficiencies gained are transforming the way accounting departments operate. Organizations that harness these technologies benefit from reduced operational costs, improved data quality, and enhanced decision-making capacities.

However, the transition also presents several strategic challenges. Firms must invest in data management infrastructure, cultivate new competencies among accounting professionals, and establish ethical governance frameworks. Without addressing these challenges, the full potential of AI and ML may not be realized.

The evolution of accounting toward an AI-augmented discipline will likely redefine professional roles. As routine work becomes automated, accountants will need to embrace roles focused on analysis, interpretation, and advisory. This shift underscores the importance of lifelong learning and adaptability in the profession.

CONCLUSION

Artificial Intelligence and Machine Learning are reshaping the field of accounting by significantly enhancing both processing speed and analytical accuracy. Automation of routine tasks reduces errors and frees professionals to engage in higher-value work. Predictive analytics and continuous auditing capabilities provide deeper insights and strengthen financial controls. Yet, successful integration of these technologies requires addressing challenges related to data quality, workforce skills, ethics, and privacy.

The future of accountancy lies in the harmonious collaboration between human expertise and intelligent systems. Accountants who adapt to this evolving landscape stand to offer greater strategic value to their organizations. As AI and ML continue to evolve, they will not only improve operational efficiencies but also elevate the strategic role of accounting in business decision-making.

Although challenges related to cost, security, and ethics remain, the advantages of AI and ML outweigh their limitations. As technology continues to evolve, intelligent systems will play an increasingly important role in shaping the future of the accounting profession.

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EXPLAINABLE MACHINE LEARNING: ENHANCING TRANSPARENCY AND RELIABILITY IN INTELLIGENT SYSTEMS

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ABSTRACT

Artificial intelligence (AI) systems are computational systems with varying levels of autonomy that, given a set of human-defined objectives, can generate predictions, provide recommendations, or make decisions by leveraging large and diverse datasets, commonly referred to as “big data” (OECD, 2019). These datasets feed machine learning (ML) models, enabling them to identify patterns, learn from experience, and improve performance over time without explicit programming by humans.

In recent years, AI and ML have emerged as transformative technologies in the field of finance, offering new approaches for risk assessment, investment strategies, fraud detection, and decision support. This study examines the thematic structure of AI and ML research within finance, employing co-occurrence and confluence analyses to identify key trends, interconnections, and emerging research directions. The findings provide a comprehensive assessment of current research efforts, highlighting the evolution, applications, and potential of AI and ML in financial contexts, as well as guiding future investigations in this rapidly evolving area.

Keywords: Artificial intelligence, Bibliometric analysis, Finance, Machine learning, Big Data

INTRODUCTION

This study focuses on applying supervised learning techniques to real-time datasets using the MapReduce programming model. Machine learning methods will be optimized to handle large-scale data, enabling applications such as prediction, pattern recognition, deep learning, recommendation systems, and more.

The MapReduce framework processes data using parallel “map” and “reduce” operations and iterative algorithms. While it can handle large datasets, traditional MapReduce models often face challenges such as high disk usage and low throughput. Deploying advanced analytics within this framework is increasingly difficult, as organizations must extract meaningful insights from existing data for further analysis.

To develop efficient predictive intelligence systems, existing models must be tuned using machine learning techniques. These methods leverage existing data features to generate accurate predictions. Since data is distributed across cluster machines, optimizing analytics performance in Hadoop systems is a significant challenge. The proposed model aims to minimize overall execution time while delivering the most accurate predictions possible, demonstrating the effectiveness of supervised learning techniques in handling real-time data within constrained time limits.

OBJECTIVES OF STUDY

The primary objective of this research is to tune Big Data methodologies using supervised approach. This research is a fair attempt to study the complex learning techniques. Prediction outcome is extracted from the existing data sets by utilizing Machine Learning methods. The captivating objectives are discussed below:

1. To develop a predictive model that forecast from the test data

The supervised learning methods are used as automated tool for prediction on data set. It incorporates methods to transform, evaluate and predict from the data by computing RMSE.

2. To identify the framework for distributed platform for analytical modeling

Data is parallelly distributed on cluster environment, which appropriately adapts the dataset for analytical processing.

3. To compare Machine Learning Algorithms for accurate prediction

RMSE is calculated on each learning method and collective evaluation is examined by considering time and space complexities.

4. To evaluate new model with MapReduce and Machine Learning techniques

This model is evaluated on Apache Spark framework by replacing the existing MapReduce for prediction through supervised algorithms.

5. To predict the data from existing feature selection

Apart from the considered dataset there is an elite chance of possibility to append further features to increase the accuracy of prediction.

Study Background (Literature Review):

Data Analytics is the scientific and statistical tool for analyzing raw data to renovate information for acquiring knowledge. Data analytics collaborates with data to formulate complex decisions from diverse perspectives for facing the real world challenges. The role of analytics is to assemble, store, process and analyze data to address empirical methods in real world for decision making. It is broadly classified into descriptive, inferential, predictive and prescriptive analytics [1].

Data analytics extends as a process of analyzing massive real time streaming data, which varies in data structure called as Big Data Analytics. Big data acts as a frontier for innovation, competition, productivity and business forecasting since the data is exponentially growing[2].

The analytics on such huge data reveals hidden patterns, unfound correlations, market trends, consumer requirements and future recommendations, which assist in critical decision-making process [3].

The analytical tools applicable on Big Data facilitate both technical companies and academic users for processing an expected span of time and for acquiring knowledge from the data [4].

Significance of Study:

This research portrays the usage of Machine Learning techniques for Big Data analytics. The proposed model incorporates the parallel processing on distributed environment like Spark to predict various features from datasets. The central core of the thesis is the comparative study on various Machine Learning algorithms on a proposed model for predictive analytics.

The following are the unique features of research study:

- Proposing a novel model to obtain best prediction from various Machine Learning algorithms.
- Time and space are the prime parameters for assessing performance metrics of this model.
- MapReduce and Spark models are interpreted for computational operations on clusters after job allocation.
- The data drawn from past experience are trained as test data using supervised learning.
- At times applying certain irrelevant and redundant features on the model may affect the performance negatively due to outliers. For instance, considering the temperature dataset, the redundant and irrelevant features like amount of rainfall, salinity and salt concentration in the ocean water may impact negatively.

Research Methodology:**The various Phases of Proposed Model will be as follows:****Phase I:** Data Collection**Phase II:** Proposed Model and Algorithm

- Algorithm for Machine Learning using PySpark Framework
- Flowchart for the Proposed System
- Process of Transformation
- Machine Learning

Phase III: Comparative Result Analysis Comparison of Learning Algorithms An elaborate narration on various active phases that support the functionality of the model will be discussed in detail. A comparative analysis will be conducted and evaluated across various learning algorithms. The annual features and the learning algorithms will be examined for accurate prediction values. The Spark and MapReduce framework will be examined across typical job distribution for time and space complexities.

Year	ANNUAL
1904	19.51
1908	19.44
1912	19.25
1916	19.22
1920	19.03
1924	19.51

1960	19.64
1964	19.34
1968	19.02
1972	19.02
1976	19.37
1980	19.07
1984	19.54

DATASET ANALYSIS

The dataset used for this research work contains temperature related information. It comprises of annual temperature computed from the month of January to December. It also includes seasonal variations occurred in various months of a year. These are categorized as January to February, March to May, June to September and October to December. The dataset measured for analysis has hundred and fifteen years of temperature data from the year 1904 to 2016. This information is applied for computing and predicting the future years. Table 5.1 consists of temperature dataset that is used as training data set. Machine Learning algorithms are trained on this data set to predict the values for later years. Figure graphically represents the annual temperature data for various years

MACHINE LEARNING ALGORITHMS FOR PREDICTION ON DATASETS

The model proposed in this research is implemented on various Machine Learning algorithms. The predictions obtained from the learning algorithms are illustrated through graphical representations. The various Machine Learning algorithms used for prediction are:

- Linear Regression
- Decision Tree
- Random Forest
- Gradient Boosting Tree

LINEAR REGRESSION ALGORITHM

The model is implemented using the linear regression algorithm. The graphical representation of data by comparing the annual temperature with prediction is shown in the figure.

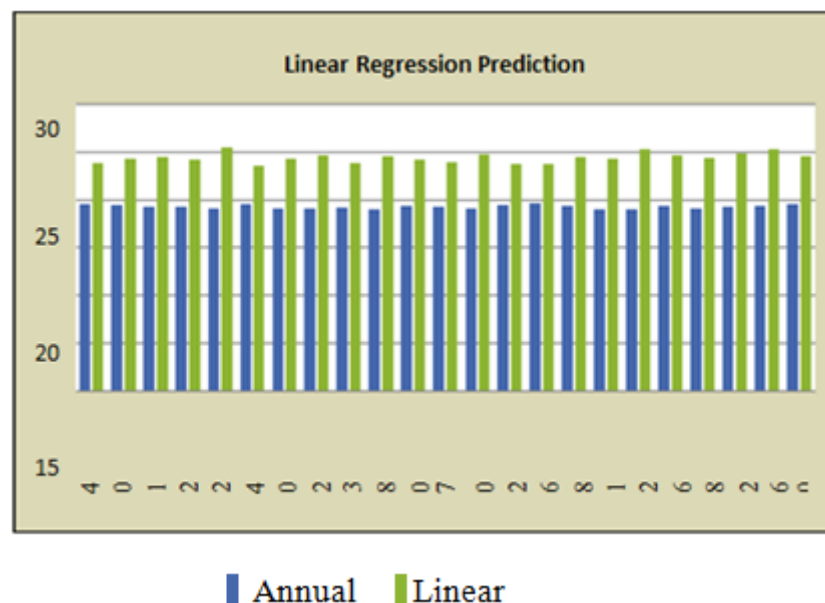


Figure -: Annual Temperature and Prediction

Observation: Annual Temperature is compared against the prediction using linear regression with an accuracy of 72.5%. The computations drawn from Linear Regression algorithms are predictions and RMSE. The obtained prediction measures are less accurate and the graphical mapping shows wide deviations, which results in higher error rate with minimal utilization of time and space.

Figure illustrates the annual temperature and prediction for various years. It represents the annual temperature taken from the dataset where the prediction values are computed from the linear regression algorithm. The prediction values deviates showing large variance which results in higher error rate.

DECISION TREE

The tree structure is obtained through the prediction outcomes using Decision Tree algorithm. The graphical representation as in figure illustrates the variations

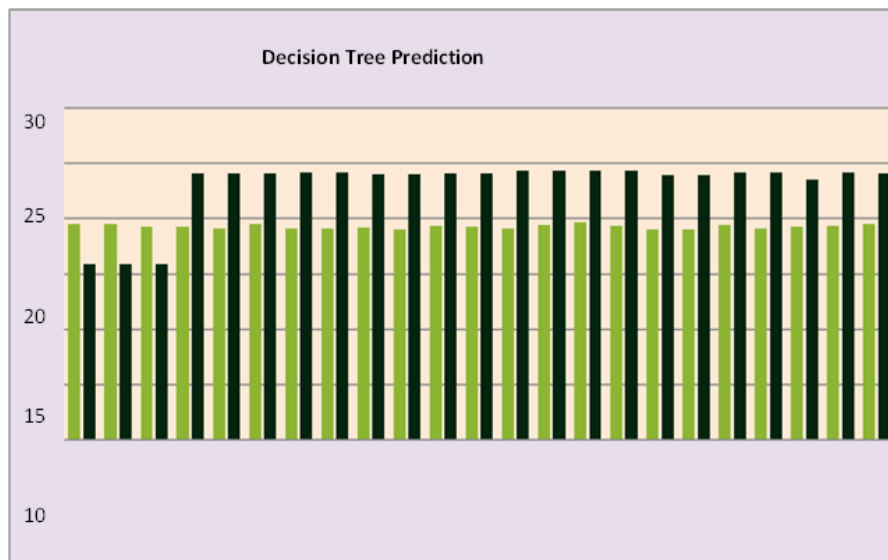
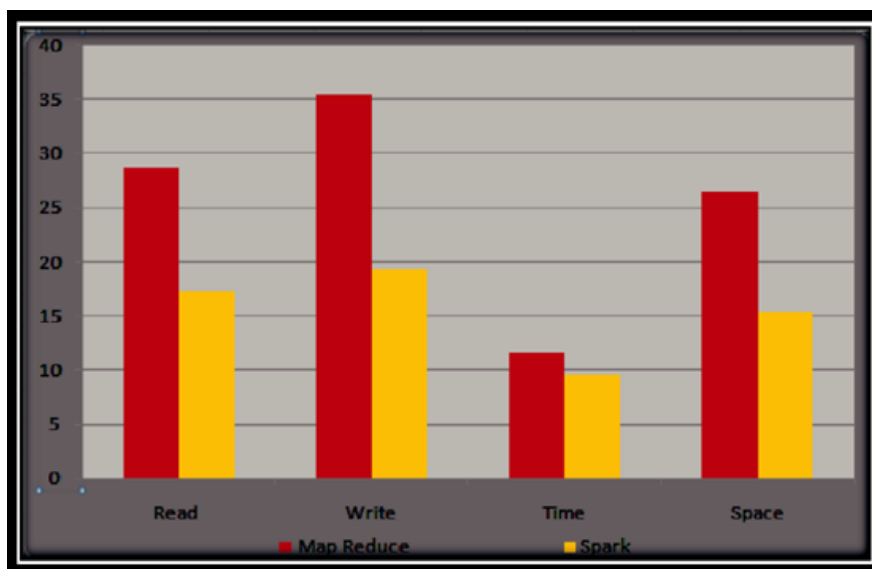


Figure –: Read, Write, Time and Space Complexity Comparison between Spark and MapReduce

The MapReduce model exhibits high disk rates for read operations with a result of 28.65 MB/Sec and for write operations with 35.43 MB/Sec. It shows reduced performance on a processor. While executing the jobs on Spark platform, the results are 17.23 MB/Sec on read and 19.41 MB/Sec for write operations. Table 5.7 and Figure 5.13 shows the combined measures of learning techniques considering the time, space, read and write operations. Hence Spark shows 65.21% of improvement on MapReduce framework.



Limitations of the Study:

The following could be the various limitations and delimitations of this research:

- 1. Time and Space as Complexity Features:** The data collected for analysis is massive and multifaceted. Time and Space are considered for evaluating the complexities of read and write operations while implementing on Spark project.
- 2. Data Size:** Enormous data is collected as a training set to learn Machine Learning methods. A collection of hundred and fifteen years of temperature data, which consist of both annual and seasonal, is used for predictive analysis.

- 3. Predictive Modeling:** Different models of analytics can be applied on a dataset. But this research work focuses on predictive modeling. According to this model, data is partitioned to train test sets for predictive analytics.

CONCLUSION

This study provides a clear understanding of model-based performance analysis for weather prediction. The proposed model is simple yet effective and identifies areas where performance can be improved. Incorporating additional features such as humidity, moisture, fog, and pollution can help achieve more accurate temperature predictions in the future. These models benefit from the rapid growth in computing power and can provide better prediction results. Applying this approach can make predictive models more accessible and useful for future forecasting. Accurate weather predictions are important for the economy, helping farmers plan and alerting emergency services to take action during extreme conditions. Future research can extend this work to hourly or daily predictions and include specific geographical regions to provide more localized forecasts

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**RETAINED EARNINGS AS A SOURCE OF INTERNAL FINANCING FOR BUSINESS EXPANSION:
EVIDENCE FROM INDIAN LISTED FIRMS — A COMPARATIVE EXPLORATORY STUDY OF
RELIANCE INDUSTRIES, TATA CONSULTANCY SERVICES, AND INFOSYS (FY2021–FY2025)**

Dr Keerti Sharma

ABSTRACT

This paper examines the role of retained earnings as a source of internal financing for business expansion in the Indian corporate context. Although the literature on capital structure has extensively explored debt-equity decisions, comparatively less attention has been paid to retained earnings as a distinct financing variable. The study adopts a faculty-style exploratory empirical design and uses a five-year comparative panel (FY2021–FY2025) for three major Indian listed firms: Reliance Industries, Tata Consultancy Services, and Infosys. A retained earnings proxy is constructed using reserves and surplus relative to total assets, given differences in reporting presentation across firms. Business expansion is interpreted through revenue growth, asset growth, and investment intensity, while leverage is considered as a financing-quality control. The comparative evidence suggests that firms with stronger retained earnings intensity exhibit greater internal financing capacity, lower dependence on debt (especially in IT firms), and more sustainable expansion profiles. The paper argues that retained earnings should be viewed not merely as an accounting residual but as a strategically significant financing reservoir. The findings are broadly consistent with pecking order reasoning and provide a practical framework for a fuller panel-data study across a larger sample of Indian firms.

Keywords: retained earnings; internal financing; business expansion; Indian firms; pecking order theory; corporate finance; reserves and surplus

1. INTRODUCTION

The financing of business expansion remains a foundational concern in corporate financial management. Firms may fund growth through external sources such as debt and equity issuance, or through internal sources such as retained earnings and depreciation-based accruals. Among these, retained earnings occupy a distinctive position: they represent profits that have been generated by the firm and reinvested rather than distributed to shareholders. In principle, such funds provide a non-dilutive and relatively low-friction financing source.

The classical pecking order argument predicts that firms prefer internal funds before turning to debt and, only subsequently, to new equity (Myers & Majluf, 1984). This preference is especially relevant in emerging markets, where financing frictions, information asymmetry, and the cost of capital may be more pronounced. Yet empirical work often treats retained earnings as a residual component within equity rather than as an analytically distinct source of finance.

This issue is materially relevant in India. Large listed firms in technology, consumer sectors, and diversified industrials often accumulate substantial internal reserves over time. These reserves may support capacity expansion, technology investments, acquisitions, network deepening, digital transformation, and balance-sheet strengthening.

The present paper adopts a deliberately cautious faculty-style exploratory design. Rather than claiming full causal inference, it uses a five-year comparative framework for three large Indian firms—Reliance, TCS, and Infosys—to demonstrate how retained earnings (proxied by reserves and surplus) relate to scale, asset base, and financing structure.

2. LITERATURE REVIEW AND THEORETICAL FRAMING

Retained earnings are conceptually important in corporate finance but often under-specified in empirical research. While accounting standards report them as part of equity, their strategic role lies in their function as internally generated investible surplus. Unlike debt, retained earnings do not require periodic servicing. Unlike new equity, they do not dilute ownership or trigger market signaling concerns.

The most relevant theoretical framework is the Pecking Order Theory (Myers & Majluf, 1984), which suggests that firms prefer internal financing, then debt, and then external equity. This ordering reflects the lower transaction costs and lower informational frictions associated with internal funds.

A second useful lens is the sustainable growth perspective, under which a firm's growth capacity is linked to profitability, retention, and leverage discipline. Retained earnings are therefore central not merely because they add to book equity, but because they expand the firm's ability to finance growth without destabilizing its capital structure.

3. RESEARCH OBJECTIVE AND HYPOTHESIS

Objective: To examine whether retained earnings (proxied by reserves and surplus) function as a meaningful source of internal financing associated with business expansion in selected Indian listed firms.

Hypothesis (H1): Firms with higher retained earnings intensity (reserves and surplus / total assets) exhibit stronger business expansion capacity and lower dependence on debt financing.

4. METHODOLOGY

This study adopts a comparative exploratory empirical design using secondary financial data.

Sample: Three large Indian listed firms were selected for demonstration because of sectoral relevance, high disclosure quality, availability of consistent five-year data, and contrasting financing profiles. The firms are Reliance Industries, Tata Consultancy Services, and Infosys.

Period: FY2021–FY2025.

Data Sources: Company annual reports / financial statements (primary conceptual source), Moneycontrol balance sheet data for consistent 5-year cross-firm extraction (comparative numeric source), and official company filings for specific equity / leverage definitions.

Operational Measures:

- **Retained Earnings Proxy (REP)** = Reserves & Surplus / Total Assets
- **Asset Base** = Total Capital and Liabilities (proxy for total assets)
- **Leverage Quality** = Long-term borrowings and debt-equity / net gearing commentary

Important Note: This manuscript intentionally uses a demonstration panel rather than overstating econometric certainty. The design is suitable for extension into a full 10-firm or 50-observation panel study.

5. EMPIRICAL DATA

Five-Year Extracted Table (Real Values)

6. FIRM-LEVEL ANALYTICAL DISCUSSION

Reliance Industries: Reliance differs materially from the IT firms because of its scale, sectoral breadth, and capital intensity. The firm's reserves and surplus increased substantially over the period, indicating continued internal accumulation at a very large scale. In capital-intensive firms, retained earnings may not eliminate debt but materially strengthen equity, lower net gearing, and improve the sustainability of expansion.

Tata Consultancy Services (TCS): TCS provides one of the clearest cases of retained earnings as internal financing. Across FY2021–FY2025, reserves and surplus remained strong, total assets expanded, and long-term borrowings remained at zero. This suggests that internal accruals serve as a primary funding layer.

Infosys: Infosys exhibits a similarly strong internal financing profile, with rising reserves and surplus, increasing asset base, and zero long-term borrowings. In knowledge-intensive firms, retained earnings support growth that may not be fully visible in physical capex, including digital capability, delivery capacity, and strategic investment.

7. COMPARATIVE INTERPRETATION

A faculty-level reading of the three firms suggests that retained earnings influence business expansion through three distinct mechanisms:

1. **Direct Financing Channel:** Most evident in TCS and Infosys. High reserves relative to total assets, combined with zero long-term borrowings, imply that internal accruals serve as a primary funding layer.
2. **Balance-Sheet Strengthening Channel:** Most evident in Reliance. Internal accumulation increases equity and improves leverage metrics even where debt remains part of the financing mix.
3. **Strategic Flexibility Channel:** Most evident in IT firms. Because business expansion in TCS and Infosys is not purely plant-and-machinery driven, retained earnings support intangible and strategic growth—technology platforms, digital infrastructure, talent, and acquisitions.

8. DISCUSSION

The evidence supports a more nuanced view than the simplistic claim that retained earnings either “fund growth” or do not. Instead, retained earnings matter through sector-dependent financing pathways.

For IT services firms such as TCS and Infosys, retained earnings function as a dominant financing base. For capital-intensive diversified firms such as Reliance, retained earnings may not replace debt, but they substantially improve the quality of financing by enlarging equity buffers and containing gearing.

This distinction is important from a faculty perspective. Retained earnings should not be evaluated solely by asking whether they fully substitute for borrowing. Rather, they should be assessed by asking whether they reduce marginal financing risk, improve balance-sheet resilience, increase managerial flexibility, and support sustainable rather than fragile expansion.

9. CONCLUSION

This paper argues that retained earnings are best understood as a strategically significant internal financing reservoir in Indian listed firms. Using a five-year comparative demonstration panel of Reliance, TCS, and Infosys, the analysis shows that TCS and Infosys exhibit exceptionally strong retained earnings intensity and zero long-term borrowings across FY2021–FY2025, while Reliance demonstrates that in capital-intensive settings, retained earnings strengthen total equity and improve gearing quality even when debt remains part of the financing mix.

The paper therefore supports the proposition that retained earnings are a material source of internal financing associated with business expansion. However, the strength and mode of that relationship are sector-dependent. From a scholarly standpoint, the present study should be read as a faculty-grade exploratory empirical note rather than a definitive causal test.

10. LIMITATIONS

1. The study uses a 3-firm demonstration sample, not a full 10-firm panel.
2. “Retained earnings” is proxied by reserves and surplus for cross-firm comparability.
3. Revenue and capex were not fully standardized across the three firms in this concise manuscript version.
4. The paper is comparative and interpretive, not a full econometric test.

11. DIRECTIONS FOR FURTHER RESEARCH

A natural extension is a 10-firm, 5-year panel (50 observations) including Reliance, TCS, Infosys, HUL, Asian Paints, Titan, Maruti, Sun Pharma, Dabur, and Nestlé India. That next version should include standardized revenue from operations, total assets, capex / additions to PPE, debt-equity, correlation matrix, and panel regression.

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Tata Consultancy Services. Balance sheet disclosures (FY2021–FY2025) and statement of changes in equity showing retained earnings.

Infosys. Balance sheet disclosures (FY2021–FY2025) and equity note defining retained earnings.

Table 1. Five-Year Balance Sheet Extract (₹ crore)

Firm	FY	Reserves & Surplus	Total Assets*	Long-Term Borrowings	Retained Earnings Proxy (R&S / Assets)
Reliance	2021	693,727	—	—	—
Reliance	2022	772,720	—	—	—
Reliance	2023	709,106	—	—	—
Reliance	2024	786,715	—	—	—
Reliance	2025	829,668	—	—	—
TCS	2021	74,424	109,381	0	0.680
TCS	2022	76,807	121,263	0	0.633
TCS	2023	74,172	119,827	0	0.619
TCS	2024	71,758	121,148	0	0.592
TCS	2025	75,255	132,788	0	0.567
Infosys	2021	69,029	93,939	0	0.735
Infosys	2022	66,597	99,387	0	0.670
Infosys	2023	64,793	101,337	0	0.639
Infosys	2024	79,101	114,950	0	0.688
Infosys	2025	85,256	124,936	0	0.683

* For TCS and Infosys, “Total Capital and Liabilities” from the balance sheet is used as a total-assets equivalent.

Note: Reliance is interpreted primarily through official leverage and equity disclosures in the manuscript discussion, as a standardized total-assets extraction was not finalized in this concise version.

SOMATOTYPE-BASED TRAINING INTERVENTION FOR PERFORMANCE ENHANCEMENT IN FEMALE SPORT CLIMBERS

¹Siddhi Shekhar Manerikar and ²Dr. Vishwambhar Jadhav¹Research Scholar, University of Mumbai²Assistant Professor, University of Mumbai**ABSTRACT**

Sport climbing has developed into a globally recognized competitive activity that demands a combination of strength, muscular endurance, flexibility, coordination, and technical proficiency. Body composition and anthropometric features significantly influence climbing performance, as climbers are required to continuously support and move their body weight during vertical ascent. The present study aimed to design and implement a somatotype-based training intervention specifically for female sport climbers and to examine its effect on selected performance variables. Thirty female climbers aged between 18 and 25 years participated in the study. Participants were categorized into endomorphic, mesomorphic, and ectomorphic body types using the Heath–Carter somatotype assessment method. A structured 10-week training program tailored to the physiological characteristics of each somatotype group was conducted with four training sessions per week. Key performance variables such as grip strength, upper-body endurance, climbing time, and flexibility were assessed before and after the training intervention. Statistical evaluation conducted through paired sample t-tests demonstrated significant improvements in all measured variables at the 0.05 level of significance. The results indicate that training programs structured according to somatotype characteristics can contribute to enhanced climbing performance among female athletes. This study highlights the importance of individualized training strategies and provides a practical framework for integrating anthropometric profiling into sport climbing training programs.

Keywords: sport climbing, somatotype, female athletes, training intervention, climbing performance

1. INTRODUCTION

Over the past few decades, sport climbing has evolved from a recreational outdoor activity into a highly competitive international sport and is now included in the Olympic Games. The sport requires a combination of physical fitness, technical skills, coordination, and mental focus. Climbers are required to continuously lift and control their body weight against gravity while maintaining stability and accuracy during each movement.

Physical attributes such as muscular strength, endurance, flexibility, and body composition are considered critical determinants of climbing performance. Earlier research indicates that elite climbers typically exhibit lower body fat percentages, high levels of grip strength, and an advantageous strength-to-body-weight ratio, which facilitates efficient movement on vertical climbing surfaces.

Somatotype classification offers a scientific method for describing body structure and composition. The Heath–Carter somatotype method categorizes individuals into three primary components:

- **Endomorphy – relative fat accumulation**
- **Mesomorphy – muscular development**
- **Ectomorphy – linear body structure**

Understanding these body types allows coaches and sports scientists to design more effective and individualized training programs based on the physical characteristics of athletes. Despite increasing scientific interest in climbing performance, limited research has focused on somatotype-based training interventions for female sport climbers. Therefore, the present study attempts to examine how training programs tailored to different body types influence performance outcomes in female climbers.

2. LITERATURE REVIEW

Earlier studies in sport climbing have emphasized the important role of physiological and anthropometric factors in influencing climbing performance. Research findings indicate that proficient climbers usually display greater hand grip strength, improved forearm muscular endurance, and higher levels of flexibility compared with individuals who do not participate in climbing activities. In addition, anthropometric evaluation has frequently been applied to analyze the body composition characteristics of elite athletes. Research findings suggest that climbers often display mesomorphic and ectomorphic characteristics, which support muscular strength development while maintaining a relatively low body mass. Recent advances in sports science highlight the value of individualized training methods instead of applying the same training program to all athletes.

Designing training plans based on an athlete's physical characteristics, fitness capacity, and body composition can improve performance outcomes and may also help minimize the likelihood of injury. Despite this progress, limited research has specifically explored the effects of somatotype-based training programs on the physical performance of female sport climbers, indicating the need for further investigation in this area.

3. OBJECTIVES OF THE STUDY

1. To determine the somatotype profiles of female sport climbers.
2. To develop a somatotype-based training program for female climbers.
3. To evaluate the effect of the training program on selected physical performance variables.

4. HYPOTHESES

H1: There will be significant improvement in physical performance variables after the intervention.

H2: Somatotype-specific training will positively influence climbing performance.

5. METHODOLOGY

The research utilized an experimental design with pre-test and post-test measurements to assess the effectiveness of the training program. A total of 30 female sport climbers aged between 18 and 25 years, each with a minimum of two years of climbing experience, were selected as participants.

The somatotype classification of participants was determined using the Heath–Carter anthropometric method, which evaluates body composition based on standardized anthropometric measurements. Based on the assessment, participants were grouped into endomorphic, mesomorphic, and ectomorphic categories.

A structured training program lasting ten weeks was implemented, with four training sessions conducted each week. The program was carefully designed to meet the physiological characteristics and performance requirements of each somatotype group.

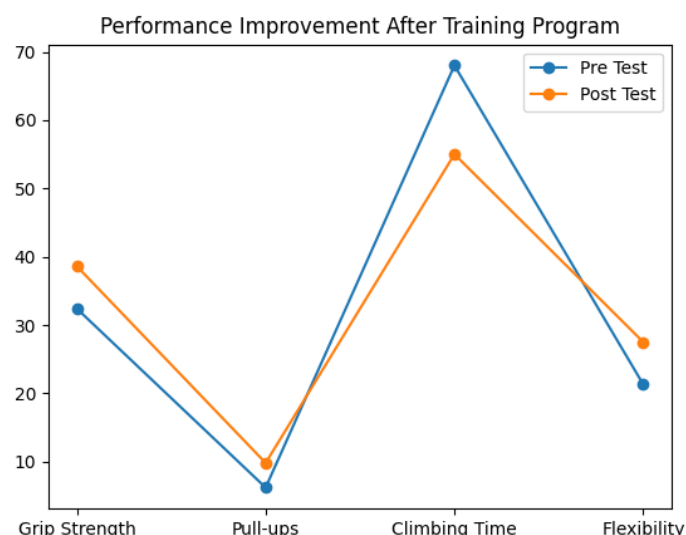
Selected performance variables, including grip strength, upper-body endurance, climbing time, and flexibility, were assessed before and after the intervention to determine the effectiveness of the training program.

6. TRAINING PROGRAM

Somatotype	Training Focus	Exercises
Endomorph	Fat reduction and endurance	Interval climbing, cardio, core training
Mesomorph	Strength and power	Campus board, pull-ups, power drills
Ectomorph	Strength development	Resistance training, finger strength exercises

7. RESULTS

The comparison of pre-test and post-test scores indicated noticeable improvements in all selected performance variables following the 10-week training intervention. Statistical analysis revealed that the training program produced significant enhancements in grip strength, upper-body endurance, climbing efficiency, and flexibility among the participants.



8. DISCUSSION

The results of the present investigation indicate that training programs tailored according to somatotype characteristics can effectively improve the physical performance of female sport climbers. Climbers categorized as endomorphic benefited primarily from endurance-oriented exercises and conditioning activities aimed at improving body composition.

Participants with mesomorphic characteristics demonstrated greater improvements in strength and power-related activities, likely due to their naturally higher muscular development. On the other hand, ectomorphic climbers showed improvements in muscular strength after participating in resistance-based training exercises.

These findings reinforce the growing recognition of personalized training approaches in modern sports science, suggesting that training strategies need to be tailored to the physiological attributes of each athlete.

9. CONCLUSION

The findings of the present study indicate that somatotype-based training interventions can significantly enhance the performance of female sport climbers. Training programs designed according to body type characteristics contribute to improvements in grip strength, muscular endurance, climbing efficiency, and flexibility.

The results emphasize the importance of incorporating anthropometric assessment and individualized training strategies in the preparation of sport climbers. Coaches and sports scientists can utilize somatotype analysis to design more effective and targeted training programs.

10. RECOMMENDATIONS

- Coaches and trainers should incorporate somatotype assessment using the Heath–Carter Somatotype Method when designing training programs for female sport climbers to ensure training is aligned with individual physiological characteristics.
- Sport climbing training programs should adopt individualized training strategies rather than generalized conditioning programs, as personalized training based on somatotype characteristics can significantly enhance performance outcomes.
- Strength development, particularly upper-body and finger strength, should be emphasized in training programs because these factors play a critical role in improving climbing performance.
- Female climbers with higher endomorphic characteristics should focus more on aerobic conditioning and body composition management, while mesomorphic and ectomorphic climbers should prioritize strength and power training.
- Sports academies and climbing clubs should incorporate anthropometric profiling and physical fitness assessment as part of talent identification and athlete development programs.
- Future studies should include larger sample populations and extended training durations to further examine and confirm the effectiveness of somatotype-based training programs.
- Further studies may also explore the relationship between somatotype characteristics and injury prevention, recovery strategies, and long-term athlete development in sport climbing.
- Researchers should investigate the integration of modern sports science techniques such as biomechanical analysis and physiological monitoring to further enhance training program effectiveness for climbers.

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SUSTAINABLE LIVING IN VEDIC LITERATURE AND ITS RELEVANCE TO ENVIRONMENTAL CONSERVATION

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ABSTRACT

Environmental degradation has emerged as one of the most serious global challenges of the modern era. Issues such as climate change, deforestation, pollution, and biodiversity loss threaten the sustainability of ecosystems and human life. While contemporary environmental policies focus on technological solutions, ancient Indian knowledge systems provide valuable insights into sustainable living and ecological balance. Vedic literature emphasizes harmony between humans and nature, promoting respect for natural elements such as earth, water, air, fire, and space. Concepts such as Prithvi Sukta, Rta (cosmic order), and Yajna highlight the importance of responsible human interaction with the environment. This study explores the principles of sustainable living found in Vedic literature and examines their relevance in addressing modern environmental challenges. Using qualitative and descriptive research methods based on secondary data sources, the study analyses ancient texts and contemporary environmental research. The findings indicate that Vedic philosophies encourage conservation, minimal consumption, and ecological responsibility. Integrating these traditional principles into modern environmental strategies can contribute significantly to sustainable development and environmental protection.

Keywords: Vedic Literature, Sustainable Living, Environmental Conservation, Indian Knowledge System, Ecology, Natural Harmony, Traditional Wisdom.

1. INTRODUCTION

The rapid industrialization and modernization of society have led to significant environmental challenges worldwide. Environmental issues such as pollution, climate change, deforestation and depletion of natural resources have raised serious concerns about the sustainability of human development. Modern environmental movements increasingly emphasize sustainable living practices that balance economic growth with ecological protection.

Interestingly, the concept of sustainability is not new. Ancient Indian texts, particularly the Vedas, contain profound insights into ecological balance and environmental responsibility. Vedic literature emphasizes the interconnectedness of all living beings and the importance of maintaining harmony with nature.

The Vedas regard nature as sacred and promote the idea that humans are custodians rather than exploiters of the environment. In the present context of environmental crisis, revisiting Vedic principles of sustainable living can provide valuable guidance for promoting environmental conservation and sustainable development.

2. LITERATURE REVIEW

Several scholars have explored the ecological perspectives found in Vedic literature in the previous studies:

Sharma (2014) examined environmental ethics in the Vedas and concluded that ancient Indian philosophy promotes respect for nature and ecological balance.

Rao (2017) studied the concept of Rta (cosmic order) in Vedic texts and emphasized its role in maintaining cosmic and environmental harmony.

Patel (2021) analysed the relationship between ancient Indian knowledge systems and modern environmental sustainability and argued that traditional ecological knowledge can support modern conservation efforts.

Research Gap

However, many existing studies focus on philosophical interpretations rather than analysing the practical relevance of Vedic sustainability principles in modern environmental conservation. This research attempts to bridge this gap.

3. STATEMENT OF THE PROBLEM

Modern societies are facing increasing environmental challenges due to excessive consumption, industrial pollution, and unsustainable resource utilization. Although scientific and technological advancements provide solutions to environmental problems, they often overlook traditional knowledge systems that promote ecological balance. Vedic literature contains valuable principles related to sustainable living, yet these teachings

are rarely incorporated into contemporary environmental policies and practices. Therefore, there is a need to explore the relevance of Vedic ecological wisdom in addressing modern environmental challenges.

4. SCOPE OF THE STUDY

The study focuses on examining the concept of sustainable living as reflected in Vedic literature and its relevance to environmental conservation. It primarily explores ecological principles found in ancient texts and analyses their applicability in the present context of environmental sustainability. This research is limited to conceptual and theoretical analysis based on primary and secondary data sources such as books, academic journals and research papers related to Vedic studies and environmental conservation.

5. OBJECTIVES OF THE STUDY

1. To understand the concept of sustainable living in Vedic literature.
2. To examine ecological principles and environmental ethics present in the Vedas.
3. To analyse the relevance of Vedic teachings in modern environmental conservation.
4. To identify sustainable practices derived from traditional Indian knowledge systems.
5. To suggest ways of integrating Vedic ecological principles into contemporary environmental policies.

6. HYPOTHESIS

H0 (Null Hypothesis): Vedic literature has no significant relevance to modern environmental conservation.

H1 (Alternative Hypothesis): Vedic literature provides significant principles that support sustainable living and environmental conservation.

7. RESEARCH METHODOLOGY

Research Design

The research adopts a descriptive and analytical research design to explore the ecological insights found in Vedic literature.

Sources of Data

The study is based on primary and secondary data, collected from:

- Vedic scriptures and translated texts
- Academic books on Indian philosophy and ecology
- Research journals and conference papers
- Government and environmental reports

Sampling Method

A purposive sampling method is used to select relevant literature and studies related to Vedic environmental philosophy.

Tools of Analysis

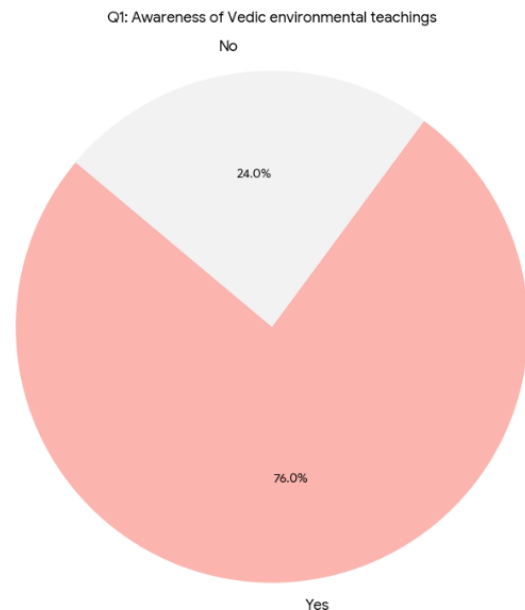
The collected information is analyzed using qualitative analysis, conceptual interpretation, and comparative evaluation between traditional knowledge and modern sustainability practices.

8. DATA ANALYSIS

For the purpose of understanding public awareness and perceptions regarding sustainable living principles found in Vedic literature, a survey was conducted among a selected group of respondents. The study used a sample size of 100 respondents, representing individuals from different age groups and backgrounds. The respondents were selected using a simple random sampling method.

1. Are you aware that Vedic literature contains teachings related to environmental protection and sustainable living?

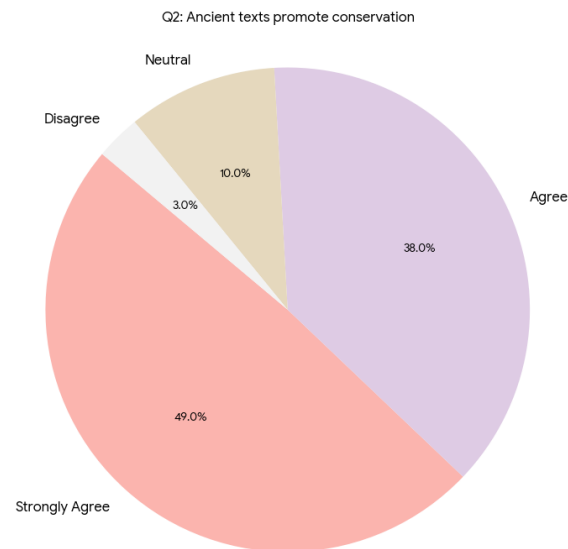
- Yes
- No



Interpretation: 76% respondents are already familiar with the environmental teachings found in Vedic literature, leaving only 24% unaware of these specific contents.

2. To what extent do you agree that ancient Indian texts promote respect for nature and environmental conservation?

- Strongly Agree
- Agree
- Neutral
- Disagree

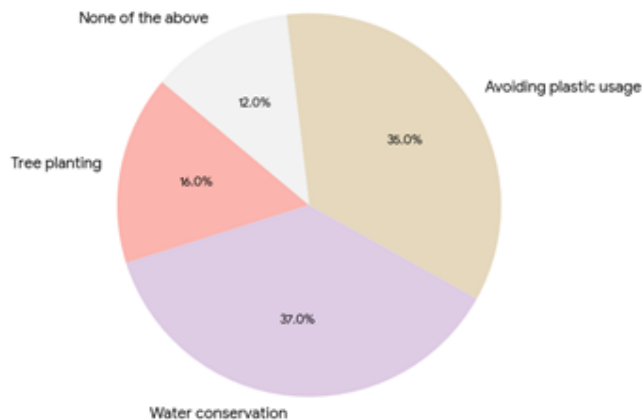


Interpretation: A majority of 87% of the sample aligns with the view that ancient texts are pro-conservation, with nearly half 49% expressing the strongest possible agreement.

3. Which sustainable environmental practice do you personally follow the most?

- Tree planting
- Water conservation
- Avoiding plastic usage
- None of the above

Q3: Personally followed sustainable practice

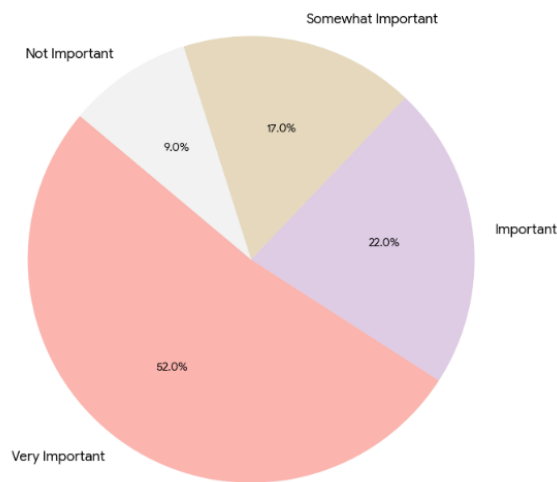


Interpretation: Water conservation and plastic reduction account for 72% of personal habits, while active reforestation (tree planting) is practiced by only 16%.

4. How important do you think traditional knowledge systems are in addressing modern environmental problems?

- Very Important
- Important
- Somewhat Important
- Not Important

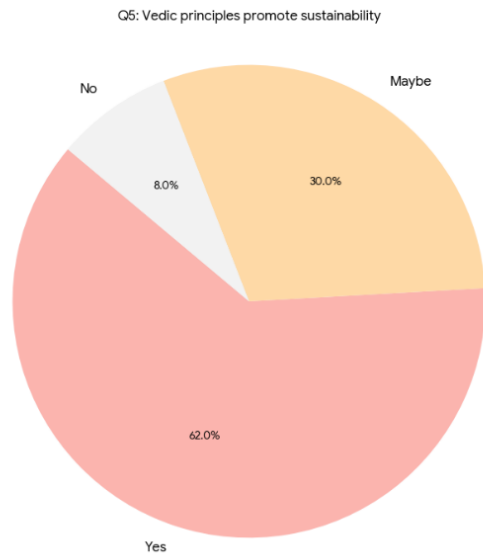
Q4: Importance of traditional knowledge



Interpretation: The data shows a high degree of confidence in traditional systems, as 8 out of 10 people categorize these knowledge systems as either "Important" or "Very Important" for modern problem-solving.

5. Do you believe that Vedic principles such as harmony with nature and minimal consumption can help promote environmental sustainability today?

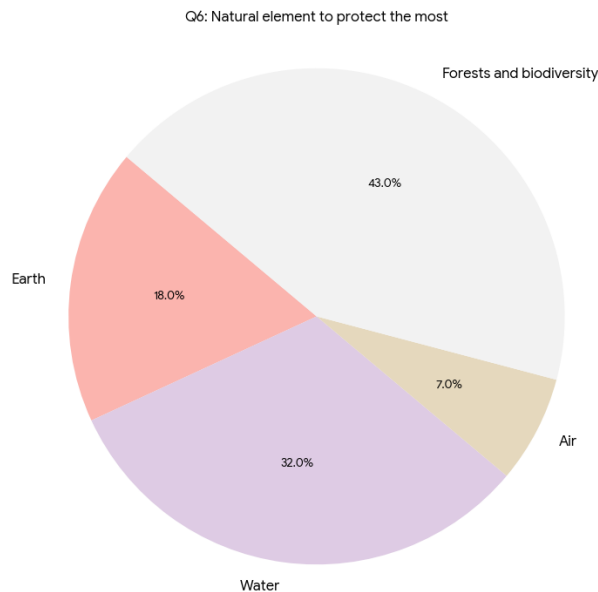
- Yes
- Maybe
- No



Interpretation: 62% of respondents hold a definitive belief that Vedic values like minimal consumption are viable tools for modern sustainability, while 30% remain cautious or undecided.

6. Which natural element mentioned in Vedic literature do you think should be protected the most today?

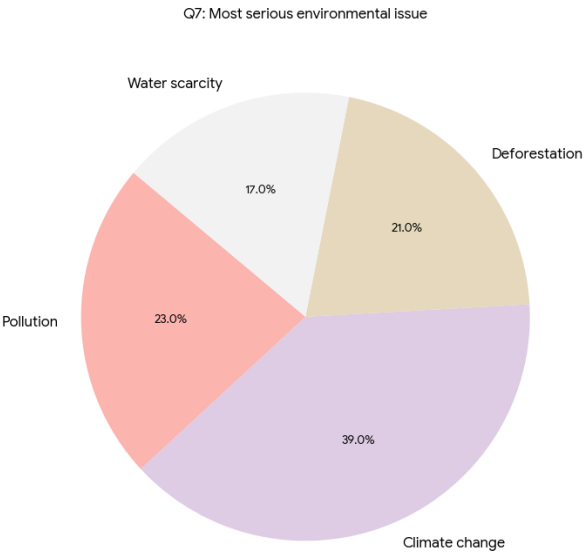
- Earth
- Water
- Air
- Forests and biodiversity



Interpretation: Forests and biodiversity are viewed as the most critical elements to protect (43%), followed by water (32%), indicating a data preference for protecting living ecosystems over atmospheric or geological elements.

7. In your opinion, which environmental issue is the most serious today?

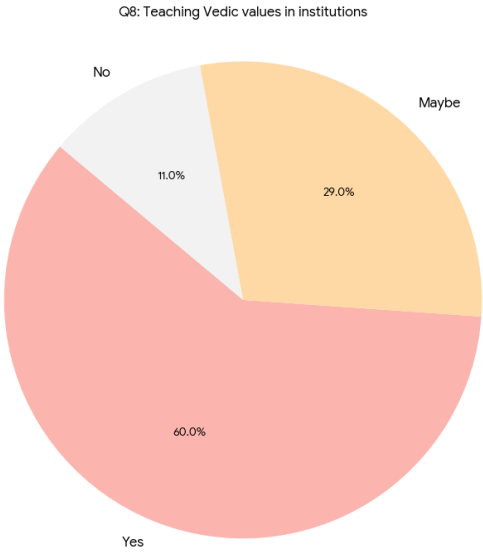
- Pollution
- Climate change
- Deforestation
- Water scarcity



Interpretation: Climate change is identified as the leading concern (39%), though the data is relatively distributed across pollution, deforestation and water scarcity.

8. Do you think that educational institutions should teach Vedic environmental values to promote sustainability?

- Yes
- Maybe
- No

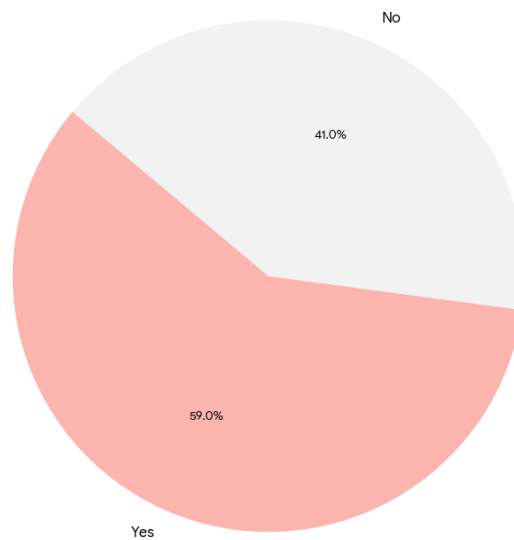


Interpretation: There is a 60% majority in favor of integrating these specific cultural values into formal education systems, with only 11% explicitly opposing the idea.

9. Have you ever participated in any environmental conservation activity?

- Yes
- No

Q9: Participation in conservation activities

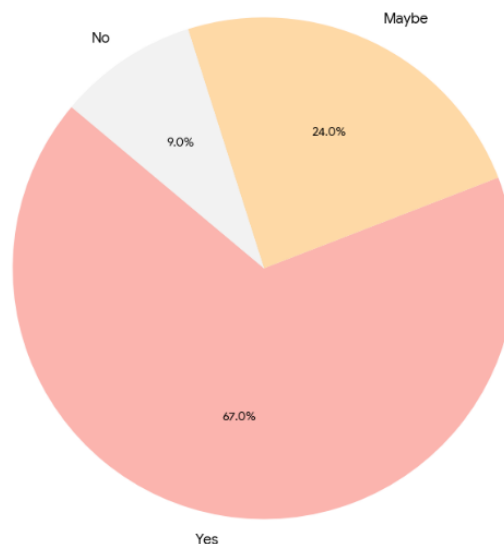


Interpretation: The sample is split nearly down the middle regarding physical involvement, with 59% having actively participated in conservation activities and 41% remaining non-participants.

10. Would you recommend sustainable practices inspired by traditional Indian knowledge to others?

- Yes
- Maybe
- No

Q10: Recommending traditional practices



Interpretation: The data indicates a strong "word-of-mouth" support base, as 67% of the participants are willing to actively recommend traditional Indian environmental practices to others.

9. FINDINGS

The study reveals several important findings:

1. Vedic literature promotes deep respect and reverence for nature.
2. The concept of *Rta* emphasizes balance and harmony within ecosystems.
3. Sustainable practices such as minimal consumption and conservation of resources are strongly advocated.
4. Vedic ecological principles remain highly relevant in addressing modern environmental challenges.

10. RECOMMENDATIONS

The following recommendations are suggested:

1. Environmental education programs should incorporate Vedic ecological principles to promote sustainability awareness.
2. Governments and policymakers should recognize the value of traditional ecological knowledge in environmental conservation.
3. Sustainable lifestyle practices inspired by ancient wisdom should be promoted through community programs.
4. Further interdisciplinary research should explore the integration of traditional knowledge with modern environmental science.

11. CONCLUSION

The study highlights the significant ecological wisdom embedded in Vedic literature. Ancient Indian texts emphasize harmony between humans and nature, advocating sustainable living practices that respect environmental balance. Principles such as reverence for nature, minimal consumption and ecological responsibility demonstrate that sustainability has long been a fundamental aspect of Indian philosophical thought.

In the present era of environmental crisis, revisiting and integrating these traditional ecological principles can contribute to sustainable development and environmental conservation. The wisdom of Vedic literature offers valuable guidance for creating a balanced relationship between humanity and the natural world.

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SUSTAINABLE LIVING THROUGH THE INDIAN KNOWLEDGE SYSTEM

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ABSTRACT

The hunt for sustainable development models that strike a balance between ecological preservation and human needs has accelerated due to growing concerns about resource depletion, climate instability, and environmental degradation. A traditional yet useful framework that incorporates environmental awareness into daily activities is provided by Indian Knowledge Systems (IKS). These systems, which have their roots in centuries of hands-on learning, highlight the balance between human activity and natural ecosystems. This study looks at how IKS can be used to advance sustainability in four important areas: agriculture, water conservation, climate-responsive architecture, and environmental preservation. Soil fertility and ecological resilience were enhanced by traditional farming methods like mixed cropping, organic inputs, and the use of locally adapted seeds. Rainwater harvesting and community-based storage structures are examples of decentralized water management systems that have made it possible to recharge groundwater and use water efficiently..

Keywords: IKS, Sustainable Development

1. INTRODUCTION

Sustainable development has become a top global priority in the 21st century as countries face increasing challenges like climate change, resource shortages, loss of biodiversity, and environmental damage. While modern industrial growth boosts economic progress, it also worsens ecological imbalances through overconsumption and unsustainable practices. This highlights the growing need to explore alternative knowledge frameworks that support harmony between human progress and environmental protection. Indian Knowledge Systems (IKS) offer a proven model of sustainable living based on principles of coexistence, balance, and respect for nature. Unlike modern sustainability approaches, which are primarily policy-focused, traditional Indian practices were rooted in values and integrated into daily life. Ancient Indian communities adopted lifestyles that reduced waste, preserved natural resources, and maintained ecological balance through methods such as organic farming, water harvesting, climate-adaptive architecture, and biodiversity conservation. Achieving these goals requires innovative, context-specific solutions. The 17 Sustainable Development Goals (SDGs) cover a range of issues—from ending hunger and improving health to ensuring quality education and fighting climate change. Developing economies face unique challenges in reaching these goals, often needing tailored, innovative strategies. India, with its rich and diverse knowledge traditions, offers valuable insights and practices that can help other developing countries realize the SDGs. Philosophy Behind Sustainability

Indian thought never separated humans from nature. Ideas like "Vasudhaiva Kutumbakam" (the world is one family) and "Prakriti is sacred" encouraged responsibility towards Earth, water, air, and energy. This research paper discusses sustainable agriculture, water conservation systems, climate-responsive architecture, and conservation of nature.

2. INDIAN KNOWLEDGE SYSTEM AND ITS RELEVANCE IN THE GIVEN FIELDS;**2.1. Agriculture**

Indian knowledge systems provide an ecologically balanced framework for sustainable farming, blending productivity with environmental preservation. Traditional Indian agricultural practices evolved over centuries, adapting to local ecosystems and climate conditions. These methods aimed not only to ensure food security but also to maintain soil health, conserve water resources, and protect biodiversity. Today, facing challenges like soil erosion, groundwater depletion, reduced crop diversity, and climate change, IKS-based farming techniques are gaining importance as alternatives to input-heavy systems.

• Soil Health and Natural Fertility Management;

IKS advocates organic inputs such as farmyard manure, compost, green manure, and plant-based bio-stimulants. Traditional formulations like Jeevamrit and Panchagavya, derived from natural farm resources, boost microbial activity and nutrient cycling in soils. Studies across different agro-climatic zones in India show that regular use of organic bio-inputs can raise soil organic carbon by about 15 to 25 percent over three years. Since soil organic carbon is vital for fertility—with just a 1 percent increase leading to better water retention—these practices improve drought resilience and reduce reliance on chemical fertilizers.



● Biodiversity through Mixed Cropping Systems

Indian agriculture historically promoted polyculture through intercropping and crop rotation. Instead of monocultures, farmers grew combinations of cereals, pulses, and oilseeds within the same fields. For example, the Baranaja system in the Himalayas involves cultivating over twelve crops together, which balances soil nutrients and lowers pest and disease risks. Data from mixed cropping regions show pest incidences decrease by up to 30 percent compared to monoculture farms. Diversified cropping also boosts land productivity by spreading risk and optimizing resource use.

Water Efficiency and Climate Adaptation

IKS emphasizes water-saving techniques like mulching, rain-fed farming, and indigenous seed varieties adapted to local climates. Ancient water management practices at sites like Mohenjo-daro demonstrate sustainable water-agriculture integration. Modern methods such as mulching can cut irrigation needs by 20 to 30 percent, while native seeds are more drought- and temperature-tolerant than some hybrid seeds designed for high-input agriculture.

● Reduction in Chemical Dependency

IKS supports natural pest control using plant extracts from neem, turmeric, and local flora. Trials in Indian organic farms show botanical pest management can cut chemical pesticide use by up to 40 percent without reducing yields, thus improving soil health and reducing ecological harm.

● Enhancing Long-Term Agricultural Sustainability

Combining traditional knowledge with scientific advancements improves sustainability. Farms practicing IKS organic methods often achieve stable yields after a two- to three-year transition, with lower input costs. Economically, reduced dependence on synthetic fertilizers and pesticides cuts expenses, boosting profitability for small-scale and marginal farmers.

2.2. Water Conservation;

Indian knowledge systems have a strong emphasis on water conservation, which reflects a thorough comprehension of local geography, hydrological cycles, and climatic variability. In order to ensure sustainable use of water resources without upsetting ecological balance, traditional Indian societies established decentralized, community-driven water management systems. These traditional systems provide important insights for creating robust and sustainable water conservation strategies in the current context of growing water scarcity, groundwater depletion, and unpredictable rainfall patterns.

● Systems of Decentralized Water Harvesting

Localized water storage systems like stepwells, tanks, johads, and baolis were encouraged by IKS. Instead of allowing surface runoff loss, these systems were made to collect and hold rainwater, allowing for a slow recharge of groundwater.

The efficient use of available water resources was made possible by advanced drainage and water management systems, as evidenced by archeological findings from communities like Mohenjo-daro, which demonstrate advanced water management and drainage systems that made it possible to use the available water resources

effectively. Traditional rainwater harvesting structures can boost groundwater recharge by roughly 20 to 40 percent in semi-arid areas, according to recent hydrological studies. Groundwater levels in Rajasthan have increased noticeably as a result of the revival of johads, and previously water-stressed villages now have better access to drinking water.

- **Recharging Aquifers and Surface Storage**

Conventional ponds and tanks served two purposes: they allowed water to seep into subterranean aquifers while also storing it for immediate use. Desilted traditional tanks may increase irrigation potential in nearby agricultural areas by up to 30%, according to data from tank restoration projects in southern India. By lowering reliance on deep borewells, these systems also slow the depletion of groundwater. These kinds of structures help sustain long-term aquifer stability and lessen vulnerability during drought periods by permitting rainwater to naturally seep into the soil. Watershed-Based Community Administration. IKS placed a strong emphasis on the shared upkeep and ownership of water bodies. Water resources were used effectively and distributed fairly thanks to community-led systems.

There have been notable results from contemporary watershed development initiatives that draw inspiration from traditional methods. Soil erosion has decreased and soil moisture retention has increased in areas using watershed-based conservation strategies, which directly boosts agricultural productivity.

Field observations indicate that improved water availability has led to increases in cropping intensity of about 15 to 25 percent in areas that integrate watershed management with traditional practices.



- **Climate Resilience through Traditional Practices**

Conventional water-saving techniques were naturally climate-adaptive. The local rainfall patterns and topography were taken into consideration when designing the structures. Based on indigenous knowledge, check dams, mulching, and contour bunding improve water retention and lessen runoff. Research shows that water conservation techniques based on contours can improve soil moisture content and cut runoff loss by almost 25%. When rainfall is erratic, this promotes crop stability.

- **Reduction in Water Extraction Pressure**

Instead of extraction, IKS-based systems rely on replenishment. Conventional conservation techniques use recharge cycles to guarantee water availability, in contrast to contemporary groundwater-intensive irrigation techniques.

Groundwater extraction rates have gradually decreased in areas using decentralized water harvesting techniques. This lessens the chance of aquifer depletion and promotes sustainability over the long run.

2.3. Climate-Responsive Architecture;

Indian knowledge systems have long included climate-responsive architecture as a key element. In addition to providing shelter, traditional Indian buildings were made to be climate-adaptive, energy-efficient, and environmentally balanced. Understanding geography, seasonal variations, solar movement, and wind patterns led to the evolution of these architectural practices.

The principles of IKS-based climate-responsive architecture are highly relevant in the current context of rising urban temperatures, energy-intensive cooling systems, and rising carbon emissions from the built environment.

- **Passive Cooling and Natural Ventilation**

Mud, lime, stone, and wood were among the materials used to build traditional Indian homes. Because of their high thermal mass, these materials can absorb heat during the day and release it gradually at night, preserving indoor temperature stability.

Natural ventilation and airflow were encouraged by architectural elements like verandahs, jaalis, and courtyards. These components made it possible for buildings to stay cool without the need for mechanical cooling systems. According to recent research, during the hottest summer months, indoor temperatures in traditional buildings can stay 4 to 6 degrees Celsius below outside ambient temperatures. As a result, reliance on energy-intensive air conditioning is greatly decreased.



- **Orientation and Solar Optimization**

Building orientation based on the sun's path and the direction of the predominant wind was emphasized by IKS-based architectural practices. Natural light was maximized, and direct heat gain was reduced with proper alignment.

Conventional planning systems used spatial arrangements that improved warmth in the winter and decreased heat exposure in the summer.

According to recent studies on green buildings, a building's orientation alone can cut cooling energy use by 10 to 20 percent.

- **Use of Local and Sustainable Materials**

Mud, bamboo, and stone were among the locally available materials used in traditional construction. These materials had a small environmental impact and required little processing. Traditional materials promoted ecological sustainability in contrast to contemporary materials like steel and concrete, which greatly increase carbon emissions. According to research, compared to reinforced concrete structures, the embodied energy of mud-based construction may be as much as 60% lower.

- **Water and Thermal Integration**

In order to control microclimate conditions, climate-responsive architecture also included vegetation, water features, and shaded areas in built environments.

Historical planning in areas like Jaipur shows how to incorporate courtyards, shaded walkways, and narrow streets to reduce heat exposure.

According to recent research on urban heat, areas with vegetation and shade can lower localized temperatures by two to three degrees Celsius.

- **Reduction in Energy Demand**

Traditional architecture lessened reliance on artificial lighting and cooling systems by using passive design techniques. According to recent comparisons, buildings that draw inspiration from traditional climate-responsive designs can reduce their cooling loads by up to 30%. This directly lowers carbon emissions and enhances sustainability over the long run.

- **2.4. Conservation Of Nature;**

Through cultural customs, moral principles, and community-based resource management, environmental conservation has become ingrained in Indian knowledge systems. Through social norms, spiritual beliefs, and sustainable usage patterns, traditional Indian systems promoted environmental protection, in contrast to contemporary conservation approaches that frequently rely on regulatory frameworks. These native conservation methods provide important insights for sustainable environmental management in the face of growing ecological imbalance, deforestation, and biodiversity loss.



- **Protection of Biodiversity and Sacred Groves**

The idea of sacred groves is among IKS's most important contributions to environmental preservation. Because of their cultural and spiritual beliefs, the local communities have protected these forest patches.

These groves preserve wildlife, medicinal plants, and native plant species, serving as reservoirs of biodiversity. For example, community-led protection systems have kept sacred groves mostly intact for centuries in places like Meghalaya.

According to ecological research, the species diversity of sacred groves is frequently higher than that of the nearby managed forests. Additionally, they support groundwater recharge and ecological stability by acting as microhabitats.

- **Ecological Resource Utilization**

IKS placed a strong emphasis on responsible use of natural resources and moderation in consumption. To ensure regeneration, traditional communities harvested forest products like timber, fruits, and medicinal plants sparingly.

Seasonal resource use and rotational grazing avoided overusing the land and vegetation. This strategy is in line with contemporary notions of ecosystem resilience and sustainable resource management.

- **Safeguarding Water Bodies and Rivers**

Historically, water bodies were considered sacred, which promoted their preservation and avoided contamination. Harmful behaviors that could deteriorate rivers, lakes, and ponds were discouraged by social norms and community rituals.

These cultural frameworks sustained long-term water availability and helped to preserve aquatic ecosystems. Conservation of Wildlife through Cultural Practices

IKS used cultural and symbolic connections to promote biodiversity and animal respect. Some species have historically been protected because of their cultural or ecological value. This helped maintain the equilibrium of

the ecosystem and lessened hunting pressures. Before official wildlife protection laws were created, these methods served as unofficial conservation measures. Environmental Stewardship Based in the Community Participation was a feature of traditional conservation systems. Communities in the area worked together to manage grazing grounds, waterways, and forests. Decentralized governance stopped resource abuse and guaranteed accountability. According to recent conservation research, ecosystems that are managed by the community frequently exhibit greater sustainability than those that are subject to external regulation. Stability of the Climate and Ecosystem Traditional conservation methods helped to stabilize the climate by protecting soil and sequestering carbon while maintaining forests and biodiversity. Additionally, protected green areas helped regulate rainfall and stopped land degradation.

3. LIMITATIONS OF IKS

IKS's Limitations in the Modern Environment. Although Indian Knowledge Systems provide insightful information about sustainability, there are some restrictions on how they can be used in contemporary settings. Due to intensive agricultural demands and large populations, some traditional methods might not be scalable. Furthermore, their incorporation into official policy frameworks has been hampered by a lack of scientific documentation and standardization. It may also be difficult to implement uniformly due to regional variations. Furthermore, traditional methods cannot completely replace technological advancements in resource management, irrigation, and infrastructure, underscoring the need for integration rather than substitution.

4. CONCLUSION

Long before the term was officially defined, Indian knowledge systems reflected a civilizational understanding of sustainability. In traditional Indian thinking, nature was seen as a collaborator in human survival and advancement rather than as a resource to be managed. This viewpoint created systems that were both sustainable and productive, influencing practices in water management, architecture, agriculture, and ecological conservation. Biodiversity was protected in the field of nature conservation through community-led initiatives like the preservation of sacred groves and controlled resource use. Instead of depending on enforcement mechanisms, these methods relied on cultural values that promoted respect for wildlife, rivers, and forests. As a result, participation rather than regulation preserved ecosystems, enabling human development and environmental balance to coexist. A similar harmony-focused philosophy was reflected in Indian knowledge systems' agricultural practices. Maintaining soil fertility and ecological stability was made possible by the use of organic inputs, mixed cropping techniques, and locally adapted seeds. The goal of traditional farming was to maintain the land's productive potential over many generations, not to maximize yields in the short term. By using such methods, ecological stress was reduced and climate uncertainty was mitigated. Traditional building designs in architecture cleverly addressed the environmental conditions of the local area. Structures were able to stay comfortable without using energy-intensive cooling systems thanks to the use of natural materials, courtyards, and ventilation-oriented layouts. Instead of upsetting the natural environment, these climate-responsive designs showed how built environments could blend in with it.

Conserving water was yet another crucial component of sustainable living. Instead of wasting water, methods like rainwater harvesting, tanks, and community-managed storage systems made sure that it was collected, stored, and refilled. These decentralized systems decreased susceptibility to seasonal fluctuations, stabilized groundwater levels, and promoted agriculture. Together, these interrelated practices show that sustainability was ingrained in Indian Knowledge Systems as a way of life rather than as a stand-alone goal. They made sure that development did not result in ecological degradation by addressing environmental concerns through integration as opposed to intervention. The usefulness of these systems in the current era, which is characterized by resource constraints and climate challenges, is found in their capacity to support contemporary technologies. These ideas can be revisited and modified to help create solutions that are both effective and ecologically conscious.

In order to facilitate advancement that supports both humanity and the natural world, Indian knowledge systems provide a means of bridging the gap between traditional wisdom and emerging demands.

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THE ALGORITHMIC LIFELINE: TRANSFORMING MUMBAI'S LOCAL TRAIN AND URBAN TRANSPORT SYSTEM THROUGH ARTIFICIAL INTELLIGENCE

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ABSTRACT

Mumbai's local train network, the circulatory system of India's financial capital, carries more than 70 lakh commuters daily on infrastructure operating beyond its designed capacity. This research paper conducts a secondary analysis of existing literature, news reports, and technical preprints to explore the transformative potential of Artificial Intelligence in addressing the perennial challenges of congestion, safety, and scheduling inefficiency within this network and its associated transport systems. The study synthesizes findings from recent developments, including AI-driven crowd mapping, predictive scheduling models like "dailyzing," genetic algorithms for rail-bus coordination, and computer vision frameworks for safety. The analysis reveals a shift from speculative futures to tangible pilot projects currently underway at stations like Thane, Dadar, and Kurla. The paper proposes a multi-layered solution integrating predictive analytics, computer vision, and first/last-mile connectivity optimization. It concludes that while AI offers a robust toolkit for transformation, the human element—commuter behavior and organizational change management—remains the critical variable for successful implementation, paving the way for a replicable model for megacities across the Global South.

Keywords: Mumbai Local Trains, Artificial Intelligence, Urban Mobility, Predictive Analytics, Computer Vision, Smart Transportation, Schedule Optimization

1. INTRODUCTION

Mumbai, a city of islands, thrives on its ability to move people. At the heart of this movement is the Mumbai Suburban Railway, a lifeline that carries more passengers per kilometer than any other rail network in the world. Often running at over four times its rated capacity during peak hours, the system is a paradox of resilience and fragility. For decades, solutions to its chronic overcrowding, safety concerns, and scheduling conflicts have been sought in infrastructure expansion—new tracks, new rakes, and new signaling systems. However, with physical expansion becoming increasingly difficult in a land-scarce city, attention has turned to technological interventions. This research paper investigates a new frontier in this battle: the application of Artificial Intelligence. AI offers the ability to see, predict, and react in real-time, turning a reactive transport network into a predictive and adaptive one. This study, based entirely on secondary research, aims to document the current state of AI integration in Mumbai's transport, analyze its potential impact, and propose a comprehensive framework for its future evolution. It moves beyond theoretical concepts to examine pilot projects and research initiatives that are actively reshaping the city's commute.

1. BACKGROUND OF THE TOPIC

The Mumbai Suburban Railway, comprising the Western, Central, and Harbour lines, spans approximately 390 kilometers and operates over 2,300 train services daily. By December 2022, ridership had swelled to an estimated 66 million commuters monthly, a figure that continues to rise. This colossal demand creates a series of cascading problems.

Extreme crowding forces passengers to travel on footboards, leading to high-risk situations. Safety hazards manifest through unauthorized track crossing and platform falls, which are leading causes of fatalities. Scheduling inefficiencies arise from the presence of non-daily trains operating only on specific days, creating irregular timetables that lead to underutilized tracks on some days and bottlenecks on others. First and last mile disconnect occurs when the lack of coordination between train schedules and feeder bus services forces commuters towards private transport, increasing road congestion. Historically, these issues were managed through manual oversight and static timetables. However, the sheer volume of data generated by the system—from passenger flow to train movement—has outpaced the capacity of traditional analysis. This is the gap that AI is uniquely positioned to fill.

2. PROBLEM STATEMENT

Despite being the economic backbone of Mumbai, the suburban railway and its ancillary transport services operate with significant systemic inefficiencies that compromise commuter safety, punctuality, and comfort. The core problem is a lack of intelligence—the inability to predict crowd surges, dynamically adjust to disruptions, and seamlessly integrate with other modes of transport in real-time. Persistent safety risks result in high rates of fatalities from overcrowding and track crossing that reactive measures fail to curb. Capacity underutilization occurs because static scheduling fails to optimize track usage, particularly concerning non-daily trains, creating

artificial congestion. Modal fragmentation creates disconnected schedules between trains and buses, forcing commuters into inefficient multi-modal trips that increase overall travel time and pollution.

3. RESEARCH OBJECTIVES

This paper aims to document the current applications and pilot projects of AI in the Mumbai

transport ecosystem based on secondary sources. It seeks to analyze the potential of AI to solve specific problems related to crowd management, scheduling, and multi-modal integration. The research synthesizes findings into a cohesive, multi-layered solution framework for a smart Mumbai transport system. Finally, it identifies the key findings, implications, and future scope for AI-driven urban mobility in megacities.

4. RESEARCH QUESTIONS

What specific AI technologies are currently being tested or proposed for Mumbai's local trains and transport network? How can predictive analytics and computer vision address the issues of overcrowding and safety at major railway stations? In what ways can AI optimize train scheduling and integrate it with bus networks to reduce commuter wait times? What are the primary challenges and implications of scaling these AI solutions from pilot projects to a city-wide network?

5. SCOPE OF THE STUDY

This research is confined to a secondary analysis of publicly available information, including academic papers, news articles, institutional reports from organizations like IIT Bombay, and industry publications up to late 2025. The geographical scope is the Mumbai Metropolitan Region, focusing on the suburban railway network with specific attention to high-density stations like CST, Dadar, Thane, Kurla, and Andheri, and its integration with BEST bus services and road traffic management. This study does not include primary data collection or field surveys.

6. LITERATURE REVIEW

The academic and industrial discourse on AI in transportation provides a robust foundation for this study. The literature can be categorized into three key areas.

7.1 AI for Railway Safety and Crowd Analytics

Recent work on frameworks like "AI Suraksha" highlights the potential of a multi-layered safety system. This framework targets three persistent risks: platform crowding, long-term accident trends, and unauthorized track crossing. It proposes using existing CCTV infrastructure with computer vision to monitor crowd density in real-time, enabling dynamic platform management. This is supported by studies on using Convolutional Neural Networks and Long Short-Term Memory networks to directly classify Level of Service from images, bypassing traditional manual counting methods. An artistic visualization of Mumbai's future in 2045 by Ayaz Basrai also depicted AI and drones being used for such surveillance, underscoring the concept's presence in the public imagination.

7.2 AI for Scheduling and Operations

The operational challenge of integrating diverse train schedules has been a key research area. A significant breakthrough is the "dailyzing" model developed by IIT Bombay and CRIS. This data-driven approach uses clustering algorithms like Hierarchical Agglomerative Clustering and K-means to group non-daily trains with similar routes and timings, effectively converting them into a predictable daily pattern. This optimizes track utilization without new infrastructure. Furthermore, studies on schedule coordination at stations like Andheri and Vileparle have employed Genetic Algorithms to optimize bus timings to align with train arrivals. This model successfully minimized passenger transfer time and operational costs, demonstrating the power of AI for first and last mile connectivity.

7.3 AI for Broader Urban Mobility

The principles applied to rail are also being extended to road transport. The proposed AI-based toll system at Dahisar Naka uses high-definition cameras and machine learning for vehicle identification and seamless toll deduction, aiming to eliminate bottlenecks at entry points. Similarly, mobility platforms like Cityflo are deploying Advanced Driver Assistance Systems and Driver Monitoring Systems in their buses and cabs to reduce human-error-related accidents, creating a safer road environment that complements the rail network.

7.4 Analysis of Current Trends and Pilot Projects

The literature points to a critical transition from theory to practice. The following analysis synthesizes the current state of AI adoption in Mumbai's transport.

7.5 The Shift from Speculation to Reality

For years, AI in Mumbai's transport was a speculative concept. However, reports from late 2024 and 2025 confirm a shift. An AI-based Traffic Prediction System is currently undergoing pilot testing at high-congestion stations like Dadar, Thane, and Kurla. This system integrates data on travel patterns, weather, and festivals to predict crowd levels and train occupancy. This is no longer a futuristic vision but a live experiment.

7.6 Data as the New Infrastructure

The success of these pilots hinges on data. The IIT Bombay-CRIS collaboration successfully utilized real-world train data to test clustering techniques on the Golden Quadrilateral and Diagonals network. This proves that Indian Railways is sitting on a goldmine of data that can be leveraged for optimization. The challenge lies in cleaning, standardizing, and integrating this data from various zonal railways into a unified AI-ready format.

7.7 The Integration Gap

While progress is visible in isolated segments—rail scheduling, bus fleet safety, toll collection—the literature reveals a significant integration gap. There is no evidence of a unified platform that connects the AI at Dahisar toll, the predictive system at Kurla station, and the optimized bus schedules at Andheri. The transport ecosystem remains a collection of smart parts rather than a smart system.

7. PROPOSED SOLUTION: A MULTI-LAYERED AI FRAMEWORK

Based on the synthesis of research, a comprehensive solution for transforming Mumbai's transport requires a layered, integrated approach.

Layer 1: Perception through Computer Vision

Action involves utilizing the existing network of CCTV cameras at stations and deploying edge-AI algorithms to perform real-time crowd density counting, motion pattern analysis, and object detection for identifying people on tracks. The outcome is real-time crowd maps and automated trespassing alerts.

Layer 2: Prediction through Predictive Analytics

Action requires building upon the dailyizing model and the traffic prediction system while integrating external datasets including festival calendars, local events, weather data, and real-time train delays to forecast station-level crowding two to four hours in advance. The outcome is predictive intelligence that anticipates demand spikes rather than just reacting to them.

Layer 3: Optimization through Genetic Algorithms

Action involves using the forecasts from Layer 2 as input for optimization engines. Genetic

Algorithms can dynamically adjust bus schedules on feeder routes to align with predicted train arrivals. AI can also recommend dynamic platform allocation or the scheduling of empty rescue rakes to predicted hotspots. The outcome is a dynamically coordinated schedule that minimizes wait times and balances load across the network.

Layer 4: Intervention through User-Facing Applications

Action requires pushing insights to commuters via applications like Cityflo or M-Indicator to inform passengers about the least crowded coach based on predictions or suggest alternative routes.

Simultaneously, control room operators receive dashboards suggesting optimal intervention strategies. The outcome is empowered commuters and data-driven traffic controllers.

8. CASE STUDY: ANDHERI AND VILEPARLE STATION COORDINATION

A pivotal case study in this domain is the research conducted on schedule coordination at the Andheri and Vileparle suburban railway stations in Mumbai. These stations are major interchange points between the railway and the public bus network operated by BEST. The problem centered on commuters arriving by train facing long, uncertain wait times for connecting buses, leading them to opt for expensive and polluting intermediate transport like auto-rickshaws. The AI solution developed was a Schedule Optimization Model with the objective of minimizing passenger transfer time and bus operating costs. The problem was non-linear and non-convex with numerous variables, making it unsolvable by classical methods. Implementation utilized a Genetic Algorithm, a robust optimization technique inspired by natural selection, to find the optimal bus timings. The outcome successfully generated coordinated schedules for BEST buses on feeder routes. This demonstrated, for the first time with realistic constraints, that AI could significantly enhance the operational integration of public transport modes in Mumbai, reducing reliance on private vehicles for the last mile. This case serves as a blueprint for similar integrations across the city's over one hundred railway stations.

9. KEY FINDINGS

AI transition is active in Mumbai's transport system with confirmed pilot projects for crowd prediction at stations like Thane, Dadar, and Kurla. Scheduling emerges as the low-hanging fruit, with the dailyzing concept and the use of Genetic Algorithms for bus-rail coordination offering immediate, high-impact solutions that do not require massive capital expenditure. Safety can become proactive through computer vision frameworks like AI Suraksha, transforming safety from a reactive investigation process to a proactive prevention system by detecting crowd crushes and track intrusions in real-time. Data silos remain the biggest obstacle to a unified smart transport system, existing between railway zones, bus depots, and traffic police. Human behavior is key, as the effectiveness of AI interventions is ultimately dependent on commuter behavior and their willingness to adapt to new travel patterns.

10. IMPLICATIONS

For policymakers, there is an urgent need to create a unified data-sharing protocol for all transport agencies in the Mumbai Metropolitan Region. Investment should be directed not just towards hardware like cameras and sensors but towards the software and talent required to interpret the data. For urban planners, AI tools provide the evidence base needed for dynamic policy-making. Crowd prediction data can justify the need for dedicated pedestrian corridors or foot-over bridges at specific locations. For society, successful implementation will lead to safer commutes, reduced travel time, and lower stress levels for millions. However, there is a risk of a digital divide if the benefits are not extended to all commuters, including those without smartphones.

12. FUTURE SCOPE

The horizon for AI in Mumbai's transport is vast and extends beyond the current scope. Predictive maintenance involves using AI to analyze track, signal, and rolling stock data to predict failures before they happen, reducing unexpected delays. Generative design for station re-development means using AI to generate and test thousands of design options for station redevelopment to optimize passenger flow before breaking ground. Autonomous mobility in the long-term future could see the integration of autonomous feeder vehicles that are dynamically routed based on train arrival predictions. Digital twins would create a complete virtual simulation of the Mumbai rail network that mirrors the physical system in real-time, allowing operators to simulate the impact of disruptions like torrential downpours and pre-test mitigation strategies in a safe environment before implementing them in the real world.

13. CONCLUSION

The transformation of Mumbai's local train and transport system through Artificial Intelligence is not just a possibility; it is an inevitability that has already begun. This secondary research confirms that AI is moving from the fringes of artistic imagination to the core of operational strategy. From the tracks of IIT Bombay's dailyzing model to the crowded platforms of Dadar where predictive systems are being piloted, AI is being deployed to see the invisible and predict the unpredictable. The core conclusion of this paper is that AI offers a paradigm shift from a reactive to a predictive transport network. By integrating computer vision for safety, predictive analytics for crowd management, and genetic algorithms for multi-modal coordination, Mumbai can significantly enhance its carrying capacity without laying a single new track. However, technology alone is insufficient. The success of this transformation hinges on the seamless integration of these disparate AI tools into a unified command-and-control center and, crucially, on winning the trust and cooperation of the millions of daily commuters who are the city's true lifeline.

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THE ART AND SCIENCE OF NETWORKING

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ABSTRACT

Networking is an essential skill for personal and professional growth. It facilitates knowledge sharing, enhances career advancement opportunities, and promotes collaboration across industries. This paper explores the importance of building and sustaining effective networks in both physical and digital environment. The paper highlights the strategies for effective network building and analyses how digital platforms contribute towards the same. The paper also throws light on the dual nature of networking as both an art and a science. It makes a distinction between the advantages of on-line and face-to-face networking. The paper emphasizes that resume is an important tool which can be used for networking. It also emphasizes that the energy and listening skills of the individual are important for networking. It highlights that successful networking depends on authenticity, reciprocity, and consistent relationship maintenance rather than opportunistic connection-building.

Keywords: *networking, professional relationships, digital networking, career development*

1. INTRODUCTION

A professional network provides a dynamic environment where individuals with shared interests can exchange ideas, collaborate, and create opportunities for mutual growth. It is important to have a strong network for professional growth. Networking has evolved beyond physical interactions, emerging as an equally vital activity in the digital space where connections are built virtually across borders.

In today's competitive environment, success depends not just on the knowledge that individuals have acquired, but also the connections that they have built over time. Ibarra and Hunter (2007) highlighted that networking is an essential leadership capability that goes beyond casual relationship building. They identified three key forms of networks—operational, personal, and strategic—each serving distinct purposes within a leader's professional life. Operational networks support the execution of day-to-day responsibilities, personal networks foster learning and career advancement through mentoring, peer exchange and strategic networks connect leaders to sources of influence, innovation, and future opportunities. The authors argued that effective leaders consciously cultivate and balance these networks to enhance both current performance and long-term success.

Professional networks help people get information, guidance, and chances that they might not find on their own. Granovetter (1973) introduced the idea of the "strength of weak ties," which became a foundational concept in understanding networking and social connections. He explained that while close friends or strong ties provide emotional support, it is often the weak ties—acquaintances or distant contacts—that play a more important role in spreading new information and opportunities. These weak ties connect people from different social groups, helping ideas, jobs, and resources travel more widely. In the context of networking, Granovetter's research shows that maintaining a variety of relationships beyond one's immediate circle can lead to greater professional and personal growth.

2. OBJECTIVES

The main objectives of this research are to:

1. Examine the importance of networking for professional growth.
2. Identify strategies for effective network building.
3. Analyse the role of digital platforms in transforming networking dynamics.
4. To understand the art and science of networking and how it helps in building strong professional relationships.

3. LITERATURE REVIEW

Networking has long been recognized as a vital element of personal, professional, and organizational success. It involves creating and maintaining relationships that facilitate the exchange of information, ideas, and opportunities. Over the years, researchers have explored different aspects of networking—ranging from its structural forms and social influence to its role in leadership and human development.

Coleman (1988) introduced the concept of social capital to explain how relationships and networks contribute to the development of human capital. He argued that social capital—formed through trust, shared norms, and

mutual obligations—helps individuals and communities achieve goals that might not be possible through individual effort alone. In the context of networking, Coleman’s work highlights how connections among people create valuable resources that support cooperation, knowledge sharing, and collective success. He explained that social structures, such as families, schools, and professional groups, provide the framework through which individuals gain access to information and support.

Bourdieu (1986) expanded the concept of capital beyond the traditional economic view by introducing social capital and cultural capital as vital resources within social networks. He explained that social capital is derived from membership in a group or network that provides mutual recognition, trust, and access to collective resources. Unlike economic capital, which is financial, or cultural capital, which involves knowledge and education, social capital depends on the quality and structure of relationships individuals maintain. In the context of networking, Bourdieu’s theory highlights that social connections are a form of power—people with broader, well-connected networks are better positioned to access opportunities and influence outcomes.

Nahapiet and Ghoshal (1998) explained how social capital—built through relationships and trust—helps create intellectual capital within organizations. They argued that strong networks allow people to share knowledge, ideas, and experiences more easily, which leads to innovation and better performance. The authors identified three main parts of social capital: structural (the overall pattern of connections), relational (the quality of relationships such as trust and respect), and cognitive (shared understanding and goals). In the context of networking, their study showed that when individuals and teams are well connected and work together with trust and shared purpose, organizations gain a competitive advantage.

Goleman (1998) highlighted the importance of emotional intelligence in building effective personal and professional relationships. He explained that networking success depends not only on technical skills or knowledge but also on the ability to understand and manage one’s own emotions and those of others. According to Goleman, emotional intelligence includes self-awareness, self-regulation, motivation, empathy, and social skills—all of which are essential for creating meaningful and lasting connections. Cross and Parker’s work emphasized that successful networking is not only about who people know, but also how information flows and relationships function within an organization (Cross & Parker, 2004).

Rainie and Wellman (2012) explained how modern technology has changed the way people connect, communicate, and build relationships. In their book *Networked: The New Social Operating System*, they described how social life today is shaped by what they call “networked individualism,” where people are connected through personal networks rather than through traditional groups like families or workplaces. They argued that digital tools such as social media, mobile phones, and the internet have made networking more flexible, personal, and wide-reaching. Individuals can now maintain multiple connections across different communities, share information easily, and collaborate beyond geographical boundaries.

Cross and Parker (2004) explored how informal networks within organizations play a key role in how work actually gets done. They explained that beyond formal structures like departments or hierarchies, it is the informal connections among employees that truly drive communication, problem-solving, and innovation. By studying how people interact and share information, they showed that some individuals act as central connectors or bridges who make collaboration more effective.

Kietzmann, Hermkens, McCarthy, and Silvestre (2011) examined how social media platforms function and why they have become powerful tools for communication and networking. They introduced a framework of seven “functional building blocks” of social media—identity, conversations, sharing, presence, relationships, reputation, and groups—that explain how people and organizations use these platforms to connect and engage.

Digital transformation has redefined how individuals build and manage their professional networks. Platforms such as LinkedIn, Twitter, and ResearchGate have expanded access to global communities (Kietzmann et al., 2011). However, scholars caution that online networking must be balanced with genuine engagement to avoid superficial connections (Rainie & Wellman, 2012).

Effective networking requires a balance between bonding (close ties) and bridging (diverse ties) relationships (Putnam, 2000). Attending industry events, participating in alumni associations, and engaging in online professional forums help in expanding one’s network. Moreover, consistency and follow-up are crucial in maintaining meaningful connections.

4. METHODOLOGY

This study uses a qualitative approach based on a review of existing literature from peer-reviewed journals, books, and credible online sources published. The research focuses on integrating theoretical insights and

contemporary perspectives to identify practical networking strategies relevant to students, professionals, and entrepreneurs.

5. IMPORTANCE OF NETWORKING

5.1. Exchange of Information

Networking provides a good opportunity for exchange of information between the people interacting. They can exchange ideas about the latest developments and share practical tips which are applicable at the workplace.

5.2. Enhance clarity in career goals

Networking provides an opportunity for the networkers to clarify their doubts which gives them more clarity for their future course of action. Interacting with experts gives them clarity for the road ahead.

5.3. Job information

Networking events are a good place to get information of jobs that are available in the market. These events provide an opportunity to interact directly with recruiters and get clarity in the job roles that are available in the market.

5.4. Getting Referrals

A referral means being recommended or introduced to someone through an existing contact. It is one of the most valuable outcomes of networking because it helps build trust and credibility quickly. When someone refers you for a job, project, or opportunity, it carries more weight than just meeting on your own, since it comes through a trusted relationship.

5.5. Seeking Advice

Networking provides an opportunity to seek advice from industry experts about the new developments taking place in the market. It provides a chance to understand about the requirements in the market and get clarity of the skills required to succeed.

The purpose of networking must be clear in the mind of the individual because effective networking begins with a clear sense of direction. When individuals understand why they are networking—whether to gain knowledge, explore career opportunities, build collaborations, or exchange ideas—they are better able to form meaningful and goal-oriented connections.

6. STRATEGIES FOR EFFECTIVE NETWORK BUILDING

6.1. Use resume as a tool

Resume helps people in the professional network to understand what the individual does, what they are looking for. It acts as an informational tool and builds credibility. In networking situations—such as professional meetings, career fairs, or online platforms like LinkedIn—a well-crafted resume can help make the right connections.

6.2. Maintaining good energy

While interacting with the recruiters, the individual must maintain good energy. This shows that the individual is interested in what they have to share with them. The energy of the individual will motivate the recruiters share information.

6.3. Effectively using Digital Platforms as Networking Tools

Online spaces like LinkedIn, X (Twitter), professional forums, and industry groups should be used effectively to build and maintain meaningful professional relationships.

6.4. Listening attentively

Individuals must listen attentively while networking. They must not only listen to what is said but also try to pick up the non-verbal cues from the people they interact with.

6.5. Effective follow-up

One of the most important parameters in networking is effective follow-up with the people networked. Sending them a 'Thank You' email after the interaction with them, goes a long way in building a relationship based on trust.

7. ROLE OF DIGITAL PLATFORMS IN TRANSFORMING NETWORKING DYNAMICS

The role of digital platforms in transforming networking are as follows:

7.1. Broader Reach and Accessibility

Digital platforms have made networking easier and more inclusive by connecting professionals across cities, industries, and even countries. People no longer depend only on face-to-face events to build relationships.

7.2. Real-Time Communication

Platforms like LinkedIn, X (Twitter), and Facebook Groups allow instant sharing of updates, job opportunities, and insights, helping professionals stay connected and informed at all times.

7.3. Professional Visibility

Online profiles serve as digital resumes. On LinkedIn, professionals can highlight their skills, achievements, and experiences, making it easier for recruiters and peers to connect.

7.4. Networking Sites

Online networking sites enable professionals and academics to share expertise, discuss new trends, and collaborate on projects.

7.5. Personal Branding and Thought Leadership

Consistent engagement through articles, posts, and videos on LinkedIn helps individuals establish authority in their field and attract professional opportunities.

Difference between Online Networking and Face-to-Face Networking

Aspect	Online Networking	Face-to-Face Networking
Mode of Interaction	Conducted through digital platforms like LinkedIn, X (Twitter), and Zoom.	Conducted through in-person meetings, conferences, or events.
Reach	Global reach; connects people across countries and industries.	Limited reach; mostly restricted to people present at a location or event.
Convenience	Can be done anytime and anywhere using internet access.	Requires physical presence, time, and travel.
Cost	Usually low-cost or free; only needs internet connectivity.	Can involve costs for travel, registration, or accommodation.
Speed of Connection	Instant connections through messages, posts, or invites.	Slower process; depends on meeting opportunities.
Depth of Relationship	Relationships may start quickly but can feel less personal.	Builds stronger emotional and personal connections.
Communication Style	Relies on written messages, emails, and online calls.	Uses body language, tone, and direct interaction.
Networking Platforms	LinkedIn, Naukri.com, Facebook Groups etc.	Seminars, workshops, conferences, alumni meets, and business gatherings.
Follow-up and Maintenance	Easy to maintain contact through regular online updates.	Needs more effort to keep in touch personally or through scheduled meetings.
Impression Building	Based on digital profile, content shared, and online activity.	Based on personal presence, behaviour, and communication skills.

Online platforms have democratized access to opportunities by removing geographical and hierarchical barriers (Kane et al., 2014). However, authenticity remains a key factor; superficial networking may yield limited results. Building a personal brand and engaging in content-driven interactions can help strengthen one's visibility and credibility online.

Common barriers for networking include fear of rejection, cultural differences, and lack of communication skills. Introverted individuals may find networking intimidating, yet research suggests that structured approaches and preparation can overcome these challenges (Cain, 2012).

8. NETWORKING AN ART AND SCIENCE

Networking is both an art and a science because it combines human feelings and creativity with planned methods and practical strategies.

8.1. Networking as an Art

Networking is an art because it involves the human capacity to connect meaningfully with others. It relies on empathy, authenticity, and interpersonal sensitivity—qualities that cannot be reduced to formulas or data. Effective networkers use emotional intelligence to build trust and maintain lasting relationships (Goleman, 1998). The “art” lies in listening actively, showing genuine interest, and adapting communication styles to different personalities and situations. Each connection, like a work of art, is unique and requires personal touch, timing, and understanding.

8.2. Networking as a Science

Networking is equally a science because it is guided by patterns, strategies, and empirical principles. Scholars have demonstrated that networks operate according to measurable structures—such as tie strength, density, and diversity—that determine access to information and resources (Granovetter, 1973). Research in organizational behaviour further shows that social capital and systematic relationship management enhance career success and innovation (Nahapiet & Ghoshal, 1998). The science of networking involves mapping connections, identifying key influencers, and applying data-driven approaches to strengthen relational outcomes.

Basis of Difference	Art	Science
Nature	Art is creative and personal in nature.	Science is systematic and objective.
Approach	Based on intuition, imagination, and human expression.	Based on observation, experimentation, and evidence.
Focus	Focuses on <i>how</i> to apply knowledge skillfully.	Focuses on <i>why</i> things happen through study and analysis.
Dependence	Depends on personal judgment, talent, and experience.	Depends on facts, data, and proven principles.
Flexibility	Allows freedom, interpretation, and creativity.	Follows fixed laws, methods, and logical reasoning.
Outcome	Produces unique and varied results.	Produces consistent and predictable results.
Example	Building trust, communication style, and relationship management are artistic aspects.	Using data, research, and strategic planning are scientific aspects.

In essence, the art of networking gives it warmth, creativity, and authenticity, while the science provides direction, structure, and measurable impact. When practiced together, they form a powerful framework for personal development and professional advancement.

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THE EVOLUTION OF ARTIFICIAL INTELLIGENCE IN MEDIA AND ENTERTAINMENT INDUSTRY

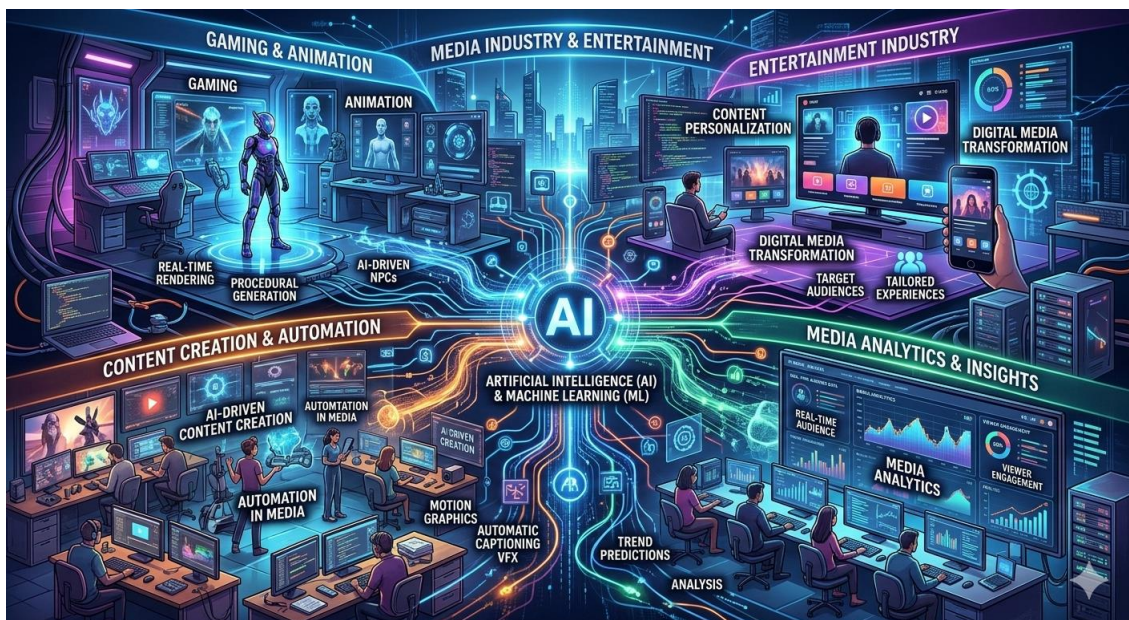
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ABSTRACT

The media and entertainment industry has undergone tremendous change with the incorporation of Artificial Intelligence (AI) in the past two decades. The change has been tremendous, from the initial rule-based automation to the current advanced generative AI that has the capability to create films, music, and other experiences. This research paper will discuss the evolution of AI in the media, the technological developments, the applications, the various issues associated with the incorporation of AI, and the case studies of the major media and entertainment platforms such as Netflix and Spotify, the future trends, and the implications that AI has on the media and entertainment industry. The study has shown that the future of the media and entertainment industry will be based on the balanced integration of creativity and intelligence.

Keywords: Artificial Intelligence (AI), Media Industry, Entertainment Industry, Machine Learning, Content Personalization, Animation, Gaming, Digital Media Transformation, Automation in Media, AI-driven Content Creation, Media Analytics.



1. INTRODUCTION

The media and entertainment industry has always shown a pattern of development in line with technological advancements. Starting with radio broadcasting and movies, followed by television and digital media, and now with the introduction of virtual reality, every step in media and entertainment has been in line with technological advancements. In the 21st century, Artificial Intelligence (AI) has turned out to be one of the most important factors in the development of media and entertainment.

Artificial Intelligence can be defined as computer systems that can perform activities that require human intelligence to perform, such as learning, reasoning, perception, understanding natural language, and making decisions.

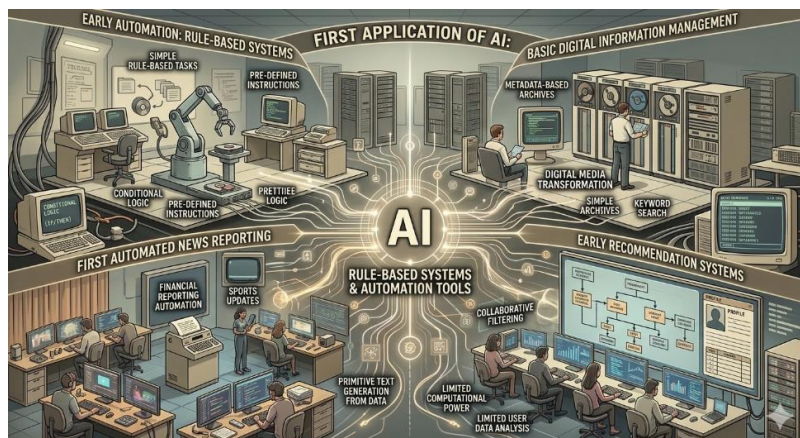
This research paper aims to study the evolution of Artificial Intelligence in media and entertainment, including its historical development, current status, economic and ethical issues, and its future scope.

2. HISTORICAL EVOLUTION OF AI IN MEDIA

2.1 Early Automation and Algorithmic Systems (1990s–2005)

The first application of AI technology in the media environment was based on rule-based systems and automation tools. Automated systems were first applied in financial reporting and sports updates for news programs. Metadata-based information management systems were implemented for media archives and digital information management.

Recommendation systems implemented for digital platforms were based on basic collaborative filtering techniques. These techniques analysed user preferences and similarities for user recommendations. However, these techniques were limited due to computational capabilities and available information.



2.2 The Rise of Machine Learning (2005–2015)

The period between 2005 and 2015 can be described as a transformative era in the evolution of Artificial Intelligence in the media and entertainment industry. This is because, in the past, Artificial Intelligence technologies had been based on rule-based programming and basic automation, but the period between 2005 and 2015 witnessed the rapid adoption of machine learning (ML), which is a subset of AI and allows the technology to learn from data and perform better without being programmed for every function. This was made possible by the emergence of big data, cloud computing, and the increase in processing power.

During this period:

- Streaming platforms implemented advanced recommendation systems.
- Social media platforms used AI for content moderation and feed ranking.
- Music platforms introduced AI-driven playlist generation.

The industry shifted from static broadcasting models to dynamic, data-driven personalization.

2.3 Deep Learning and the AI Boom (2015–2020)

The period between 2015 and 2020 is termed the ‘AI boom.’ It was a period of great development and use of deep learning in different sectors, including media and entertainment. Deep learning is a branch of ML that uses artificial neural networks with many layers to process information and analyse it with unprecedented accuracy. For example, machines could see images, process speech, and even understand natural language. It was the period when media and entertainment went beyond predictive analysis to intelligent understanding.

Applications expanded to:

- Automated video editing
- Real-time speech-to-text transcription
- AI-assisted script analysis
- Advanced visual effects rendering

AI became embedded in nearly every stage of media production.

2.4 Generative AI Era (2020–Present)

The period from 2020 to the present represents the Generative AI era, which is a transformational period for the evolution of artificial intelligence systems from simply analytical and predictive systems to more innovative systems that can generate original works of content. Unlike the traditional machine learning systems that were used for classification, recommendation, and optimization, the generative AI systems generate new forms of text, images, audio, and videos based on the learned patterns from the datasets. The evolution of AI systems has profoundly affected the media and entertainment industry.

- Scripts and dialogue
- Music compositions
- Synthetic voices

-
- Photorealistic images and videos

Generative AI shifted the narrative from AI as a tool for optimization to AI as a creative collaborator.

3. APPLICATIONS OF AI IN MEDIA AND ENTERTAINMENT

3.1 Content Recommendation and Personalization

Content recommendation and personalization is perhaps one of the most impactful applications of Artificial Intelligence (AI) in the media and entertainment industry. In the past two decades or so, media and entertainment have moved from a conventional broadcasting approach, in which all users are exposed to the same content, to a personalized approach using AI-driven personalization systems that are based on the preferences and behaviour of each and every user individually. This has had a major impact on viewer retention, subscription rates, advertising revenue, and so on.

Streaming platforms like Netflix analyse viewing behaviour, search patterns, watch time, device usage, and interaction data to recommend personalized content. Machine learning models continuously adapt recommendations based on user engagement.

Music platforms use AI to:

- Analyse audio features
- Detect mood and genre
- Predict listening preferences
- Curate personalized playlists

Personalization increases user retention and subscription longevity, making AI central to platform competitiveness.

3.2 AI in Film and Television Production

AI plays a critical role across production stages:

Pre-Production:

Script Writing & Story Development:

AI can be used to create story ideas for filmmakers, assist in scriptwriting, or even come up with dialogue ideas. For instance, AI can be used to analyse scripts to predict audience appeal for certain storylines or characters.

Storyboarding & Concept Art:

Generative AI can be used to create concept art and storyboards for filmmakers. This will help filmmakers create storylines without incurring production costs.

Casting & Scheduling:

AI can be used to analyse actors' performances to predict audience appeal. Scheduling AI can be used to optimize production.

Production:

Virtual Production & CGI:

With AI, it is possible to accelerate the rendering of images and even produce realistic environments, characters, or props.

Performance Enhancement:

With AI-based deep fake technology, it is possible to change the appearance of actors, age them younger, or even create virtual stunt doubles.

Camera & Lighting Automation:

With AI-powered cameras, it is possible to automate camera and lighting settings for consistent shots.

Post-Production:

Editing:

AI can assist editors by suggesting cut points, scene transitions, or pacing adjustments. Some AI systems automatically assemble rough cuts.

Visual Effects (VFX):

AI accelerates tasks like rot scoping, object removal, and background replacement. This reduces manual labour-intensive work in post-production.

Sound & Music:

AI can generate sound effects, ambient noise, and even music scores tailored to the mood of scenes. It can also assist in ADR (Automated Dialogue Replacement) for cleaner audio.

Color Grading:

AI tools analyze footage and suggest or apply consistent color grading, preserving the visual style throughout a project.

3.3 AI in Music Industry**AI-Generated Music:**

AI models can compose melodies, harmonies, and full tracks in various genres. Artists use AI as a co-creator to generate ideas or explore new musical styles.

Adaptive & Interactive Music:

AI can produce music that adapts to user input, gaming environments, or live experiences, creating dynamic soundtracks.

- Music composition
- Sound mastering
- Lyric generation
- Voice synthesis

AI-generated music is used in advertisements, gaming, and independent production. While not replacing artists, AI serves as a collaborative tool that enhances creativity and experimentation.

3.4 AI in Gaming**Procedural Content Generation (PCG):**

AI can create game levels, maps, quests, and even worlds, reducing development cycles and increasing game replay value. No Man's Sky is one of the games that utilizes procedural generation.

Character & Asset Creation:

AI can create 3D characters, textures, animations, and even NPC costumes, reducing overall art creation time.

Storytelling & Narrative Generation:

AI can generate stories, conversations, and dynamic stories based on player decisions. Modern AI enables:

- Adaptive difficulty levels
- Procedural content generation
- Realistic environmental responses
- Dynamic storytelling

AI enhances immersion and replay ability, making games more responsive to player behaviour.

3.5 AI in Journalism and News Media**Automated Data Collection:**

The AI system uses news feeds, social media, press releases, and public records to collect data.

Fact-Checking and Verification:

The AI system uses cross-verification techniques to identify inconsistencies and potential misinformation.

Trend Analysis and Topic Discovery:

Machine learning helps the AI system analyze data and identify trends and topics of interest.

Content Creation:**Automated Writing (NLG – Natural Language Generation):**

AI can create news articles, sports updates, financial reports, and weather forecasts based on structured data. Examples include AI-generated financial earnings reports, sports match recaps, etc.

Headline & Copy Suggestions:

AI can suggest interesting headlines, subheadings, and article summaries based on reader engagement.

Multilingual Content:

AI can translate news into various languages, thus reaching a global audience.

3.6 Advertising and Marketing

AI is revolutionizing advertising and marketing by enabling hyper-personalization, data-driven strategies, and automation across campaigns.

AI transforms advertising by:

- Predicting consumer behaviour
- Targeting specific demographics
- Optimizing ad placements
- Measuring engagement effectiveness

Programmatic advertising systems use AI to conduct real-time bidding and content matching.

4. ECONOMIC IMPACT OF AI IN ENTERTAINMENT

The economic impact of AI in the entertainment industry is profound, affecting costs, revenues, labor, and market dynamics.

AI contributes to:

- Cost reduction in production workflows
- Increased subscription retention
- Improved advertising revenue
- Expansion of independent creator markets

However, automation may reduce demand for certain technical roles. At the same time, new roles emerge in AI development, data science, and digital strategy.

The economic landscape is shifting toward hybrid skill sets that combine creative expertise with technological literacy.

5. ETHICAL AND LEGAL CHALLENGES

AI in entertainment brings enormous creative potential, but it also raises serious ethical and legal challenges.

5.1 Intellectual Property Issues:**AI-generated content raises questions:**

- Who owns AI-generated art?
- Are training datasets infringing on copyright?
- How are royalties distributed?

Current copyright laws struggle to address AI authorship.

5.2 Deep fakes and Misinformation:**Deep fake technology can:**

- Recreate actors' likenesses
- Manipulate political speeches
- Spread false information

Although useful for creative de-aging and dubbing, misuse poses serious societal risks.

5.3 Bias and Representation

AI models trained on biased datasets may perpetuate stereotypes. Media algorithms influence which stories are amplified or suppressed, affecting cultural narratives.

5.4 Labour and Workforce Displacement

Automation impacts editors, sound engineers, and content moderators. Industry adaptation requires reskilling programs and ethical AI deployment strategies.

6. Case Studies**6.1 Netflix: Data-Driven Entertainment**

Netflix's AI-driven personalization influences a majority of user viewing decisions. The company also uses AI to:

- Optimize thumbnails
- Predict content success
- Guide original production investments

AI is central to Netflix's strategic advantage.

6.2 Spotify: AI in Music Discovery

Spotify uses AI for:

- Discover Weekly playlists
- Mood-based categorization
- Audio feature analysis

AI-driven discovery supports emerging artists and user engagement.

6.3 AI in Hollywood Visual Effects

AI-assisted CGI reduces manual frame-by-frame animation. Studios use AI for crowd simulation, background generation, and digital de-aging of actors.

7. THE RISE OF GENERATIVE AI

Generative AI tools now create:

- Short films
- Synthetic actors
- AI news anchors
- Automated trailers

These tools democratize content production but challenge traditional creative norms.

Collaboration between human creators and AI systems is becoming the new production model.

8. FUTURE TRENDS**8.1 Multimodal AI Systems**

Future systems will integrate text, audio, image, and video generation seamlessly.

8.2 Interactive Storytelling

AI-driven narratives will adapt in real-time based on viewer responses.

8.3 Virtual Influencers

AI-generated personalities will continue to grow in popularity across social media platforms.

8.4 Ethical Regulation

Governments and industry bodies will develop AI governance frameworks focusing on transparency, fairness, and accountability.

9. DISCUSSION

The evolution of AI in media reflects a broader shift toward data-centric creativity. AI enhances efficiency, reduces production barriers, and personalizes experiences. However, unchecked deployment could erode creative authenticity and increase misinformation risks.

The future depends on responsible integration, balancing automation with human oversight.

10. CONCLUSION

Artificial Intelligence has fundamentally transformed the media and entertainment industry. From early recommendation systems to generative AI capable of producing entire multimedia experiences, AI has redefined content creation and consumption.

The industry stands at a crossroads: AI offers unprecedented creative empowerment but also introduces ethical, legal, and economic challenges. Sustainable progress requires collaboration among technologists, policymakers, creators, and audiences.

The evolution of AI in media is not merely technological—it is cultural. As human creativity merges with intelligent systems, the future of entertainment will be shaped by how responsibly and imaginatively we harness artificial intelligence.

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THE GOLDEN RATIO: MATHEMATICAL STRUCTURE, NATURAL PATTERNS, AND INTERDISCIPLINARY APPLICATIONS

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ABSTRACT

The Golden Ratio, represented by the Greek symbol ϕ (phi), is a mathematical constant approximately equal to 1.6180339887. It has fascinated mathematicians, scientists, and artists for centuries due to its unique properties and frequent occurrence in natural structures, artistic compositions, and architectural designs. Originating in classical geometry, the Golden Ratio has strong mathematical connections with the Fibonacci sequence and recursive numerical relationships. Researchers have identified the presence of this ratio in various domains including biology, design, computer science, and finance. This paper examines the historical origins, mathematical foundations, and interdisciplinary applications of the Golden Ratio. It also explores its significance in natural patterns, art, and modern scientific research. The study demonstrates that the Golden Ratio functions as a universal mathematical principle linking natural growth patterns with human creativity and technological development.

Keywords: Golden Ratio, Phi, Fibonacci Sequence, Mathematical Proportion, Geometry, Natural Patterns

INTRODUCTION

Mathematics often reveals patterns that demonstrate both logical structure and aesthetic appeal. One of the most well-known examples of such a pattern is the Golden Ratio. The Golden Ratio describes a special proportional relationship in which the ratio between two quantities remains constant when the larger quantity is divided by the smaller one and when their sum is divided by the larger quantity.

The Golden Ratio is commonly represented by the Greek letter ϕ and has an approximate value of 1.618. This number has intrigued mathematicians and scholars for thousands of years because of its unusual mathematical properties and its recurring appearance in nature and design.

The origins of the Golden Ratio can be traced back to classical Greek mathematics, where scholars studied geometric proportions and symmetry. Over time, the concept expanded beyond pure mathematics into fields such as art, architecture, biology, and computer science. Because of its association with harmony and balance, the Golden Ratio is often considered a fundamental principle that connects mathematics with natural and artistic systems.

The purpose of this paper is to explore the Golden Ratio from both theoretical and applied perspectives. The paper discusses its historical development, mathematical formulation, relationship with the Fibonacci sequence, and its applications in natural sciences, architecture, and modern technology.

Historical Background of the Golden Ratio

The concept of the Golden Ratio originated in ancient Greek geometry. One of the earliest documented explanations of this ratio was provided by **Euclid** in his famous mathematical work **Elements**. In this text, Euclid described the division of a line into what he referred to as the “extreme and mean ratio,” which corresponds to the modern definition of the Golden Ratio.

During the Renaissance period, interest in mathematical proportions increased significantly. The Italian mathematician **Luca Pacioli** referred to the Golden Ratio as the “divine proportion” in his book **De Divina Proportione**. The book contained illustrations created by the artist **Leonardo da Vinci**, highlighting the connection between mathematics and artistic design.

Throughout history, scholars have continued to investigate the mathematical significance and aesthetic influence of the Golden Ratio, leading to its recognition as one of the most remarkable constants in mathematics.

Mathematical Foundation of the Golden Ratio**Definition**

The Golden Ratio is defined through a geometric relationship involving a line segment divided into two parts. If a line is divided into two sections, where the longer section is represented by **a** and the shorter section by **b**, the division satisfies the Golden Ratio when:

$$\frac{a+b}{a} = \frac{a}{b}$$

This relationship indicates that the ratio of the entire segment to the larger part equals the ratio of the larger part to the smaller part.

Solving this relationship produces a quadratic equation:

$$x^2 - x - 1 = 0$$

The positive solution of this equation gives the Golden Ratio:

$$\phi = \frac{1 + \sqrt{5}}{2}$$

The numerical value of ϕ is approximately 1.6180339887.

Mathematical Properties

The Golden Ratio possesses several unique mathematical characteristics. One notable property is that the square of the Golden Ratio equals the sum of the ratio and one:

$$\phi^2 = \phi + 1$$

Another important property is its reciprocal relationship:

$$\frac{1}{\phi} = \phi - 1$$

These recursive relationships demonstrate why the Golden Ratio appears in many self-similar and growth-related systems.

Relationship With the Fibonacci Sequence

The Golden Ratio is closely associated with the **Fibonacci Sequence**, which was introduced by the mathematician **Leonardo of Pisa**.

The Fibonacci sequence follows the recurrence formula:

$$F_n = F_{n-1} + F_{n-2}$$

with initial values:

$$F_1 = 1, F_2 = 1$$

This generates the sequence:

1, 1, 2, 3, 5, 8, 13, 21, 34, ...

As the sequence progresses, the ratio between consecutive Fibonacci numbers approaches the value of the Golden Ratio. For example:

$$\frac{21}{13} \approx 1.615$$

$$\frac{34}{21} \approx 1.619$$

These ratios gradually converge toward 1.618, illustrating the mathematical relationship between the Fibonacci sequence and the Golden Ratio.

Occurrence of the Golden Ratio in Nature

Plant Growth

Many plants exhibit arrangements of leaves, petals, or seeds that correspond to Fibonacci numbers. This arrangement, known as phyllotaxis, allows plants to maximize sunlight exposure and improve nutrient distribution.

Natural Spirals

The Golden Ratio is also connected to the **Golden Spiral**, a logarithmic spiral that expands according to the Golden Ratio. Similar spiral patterns can be observed in natural structures such as shells, hurricanes, and galaxies.

Human Body Proportions

Researchers have also identified approximate Golden Ratio relationships in human body proportions. For example, the ratio between a person's total height and the height of the navel from the ground is often close to ϕ .

Golden Ratio in Art and Architecture

Classical Architecture

Architectural historians often discuss the use of the Golden Ratio in ancient structures. One frequently cited example is the **Parthenon**, whose façade proportions are sometimes associated with Golden Ratio rectangles.

Renaissance Art

During the Renaissance period, artists explored mathematical proportions to achieve visual harmony. The famous drawing **Vitruvian Man** illustrates human body proportions that reflect mathematical relationships.

Modern Design

The Golden Ratio is widely used in modern design fields including photography, graphic design, and user interface development. Designers often use Golden Ratio grids to determine the placement of visual elements within a layout.

Applications in Modern Science and Technology

Computer Science

The Fibonacci sequence and Golden Ratio appear in algorithm design and computational mathematics. These mathematical concepts help optimize search algorithms and recursive processes.

Financial Analysis

In financial markets, Fibonacci ratios derived from the Golden Ratio are commonly used in technical analysis to predict possible price movements.

Physics and Complex Systems

Some physical and dynamic systems display patterns that approximate the Golden Ratio. Researchers study these patterns to understand recursive growth processes and self-similar structures.

DISCUSSION

The Golden Ratio represents a unique intersection between mathematics, nature, and art. Its appearance across various fields demonstrates how mathematical principles can influence both natural phenomena and human creativity.

However, some claims regarding the universal presence of the Golden Ratio remain controversial. Certain examples may be exaggerated or based on approximate measurements. Therefore, careful mathematical verification is necessary when analyzing Golden Ratio relationships.

Despite these debates, the Golden Ratio continues to serve as a powerful concept illustrating the connection between mathematical theory and real-world patterns.

The Golden Ratio has long been regarded as one of the most intriguing constants in mathematics due to its presence across numerous disciplines, including geometry, biology, art, architecture, and modern technological systems. The findings discussed in this paper highlight how a simple mathematical proportion can appear in diverse contexts and contribute to both theoretical understanding and practical applications. The Golden Ratio demonstrates how mathematical patterns can provide insight into natural structures as well as human-created designs.

One of the most significant aspects of the Golden Ratio is its mathematical relationship with the **Fibonacci Sequence**. As described earlier, the ratio between successive Fibonacci numbers gradually approaches the value of the Golden Ratio. This convergence explains why Fibonacci numbers frequently appear in biological systems such as leaf arrangements, seed patterns, and branching structures. The mathematical relationship between these two concepts illustrates how numerical patterns can influence natural growth processes. Such patterns suggest that the Golden Ratio may represent an efficient method of structural organization in certain biological systems.

Another important point of discussion concerns the appearance of the Golden Ratio in natural forms. Various natural structures, including shells, hurricanes, and spiral galaxies, exhibit patterns similar to the **Golden Spiral**, which is mathematically related to the Golden Ratio. These recurring spiral patterns have led many researchers to consider the possibility that the Golden Ratio reflects an underlying principle governing growth and expansion in natural systems. In biological contexts, spiral growth patterns often allow organisms to maximize efficiency, whether through improved sunlight exposure, structural stability, or spatial organization.

In addition to its presence in nature, the Golden Ratio has played a prominent role in artistic and architectural design throughout history. Many scholars believe that artists and architects have intentionally incorporated Golden Ratio proportions to create visually pleasing compositions. For instance, discussions of classical

architecture often reference the proportions of the **Parthenon**, which some researchers argue approximate Golden Ratio relationships. Similarly, Renaissance artists explored mathematical proportions as a means of achieving harmony and balance in their work. The drawing **Vitruvian Man** is frequently cited as an example of the intersection between art, anatomy, and mathematical proportion.

Despite these widely discussed examples, scholars continue to debate the extent to which the Golden Ratio truly appears in historical artworks and architectural structures. Some researchers argue that the presence of the Golden Ratio in certain designs may be coincidental or based on approximate measurements rather than intentional design. In many cases, later interpretations may impose mathematical explanations on works that were not originally created with strict proportional calculations. This debate highlights the importance of applying careful measurement and mathematical analysis when evaluating claims about the Golden Ratio in historical artifacts.

Beyond its historical and artistic significance, the Golden Ratio also plays a role in several modern scientific and technological fields. In computer science, Fibonacci numbers and related mathematical structures are used in algorithm design, optimization techniques, and data structures. For example, certain search algorithms and recursive computational models rely on Fibonacci-based logic to improve efficiency. Similarly, the Golden Ratio has been applied in fields such as digital image processing and user interface design, where balanced proportions can improve visual organization and user experience.

Another contemporary application of the Golden Ratio appears in financial analysis. Financial analysts often use Fibonacci-based ratios derived from the Golden Ratio to estimate potential price movements within financial markets. These ratios are used in technical analysis to identify support and resistance levels in market trends. While these techniques are widely used in trading strategies, their effectiveness remains a topic of debate among financial researchers. Some studies suggest that Fibonacci-based indicators may reflect psychological patterns in market behavior rather than purely mathematical principles.

The interdisciplinary nature of the Golden Ratio demonstrates how mathematical ideas can transcend traditional academic boundaries. Concepts originally developed within pure mathematics can later influence fields such as biology, architecture, art, economics, and computer science. This broad applicability illustrates the ability of mathematical patterns to describe both natural and human-created systems.

Nevertheless, it is important to approach claims about the universality of the Golden Ratio with caution. While many examples exist in which proportions approximate the value of ϕ , not all patterns necessarily result from deliberate mathematical design or fundamental natural laws. Some occurrences may simply reflect general geometric relationships or statistical coincidences. Therefore, continued research and careful empirical analysis are necessary to distinguish genuine Golden Ratio patterns from approximate or subjective interpretations.

Overall, the Golden Ratio remains an important concept in both mathematics and interdisciplinary research. Its unique mathematical properties, historical significance, and potential applications across multiple domains make it a valuable subject of study. As scientific methods continue to evolve, further investigations may reveal additional ways in which this ratio contributes to the understanding of complex systems and structural pattern

CONCLUSION

The Golden Ratio is one of the most fascinating constants in mathematics. Originating in classical geometry, it has evolved into an interdisciplinary concept that appears in natural patterns, artistic design, and modern scientific research.

Its relationship with the Fibonacci sequence explains its frequent appearance in biological growth patterns. Furthermore, its aesthetic properties have influenced art, architecture, and modern design.

Continued research on the Golden Ratio may reveal further applications in fields such as computational modeling, complex systems, and artificial intelligence.

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THE SHRIMAD BHAGAVAD GITA AS A RESERVOIR OF INDIAN KNOWLEDGE SYSTEMS: A MULTIDISCIPLINARY ANALYSIS

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ABSTRACT

The Shrimad Bhagavad Gita, a 700-verse philosophical discourse embedded within the Mahabharata, is not merely a religious scripture but a comprehensive repository of Indian Knowledge Systems (IKS). Lord Shri Krishna Vasudev Yadav have guided all life learning to Arjun from Shrimad Bhagavad Gita. This paper explores the Gita's multifaceted nature, arguing that it serves as a foundational text that encapsulates and synthesizes a wide array of knowledge domains indigenous to the Indian subcontinent. Through a detailed analysis of its verses and concepts, this study examines the Gita's contributions to metaphysics, epistemology, psychology, ethics, management, and pedagogy. It demonstrates how the text provides a sophisticated theoretical framework and practical guidance in these fields, offering insights that are highly relevant to contemporary discourse. By situating the Gita within the broader context of IKS, this paper highlights its role as a living tradition of wisdom that continues to inform and enrich various aspects of human life and understanding. The paper concludes by emphasizing the importance of integrating the knowledge systems found in the Gita into modern educational and intellectual frameworks to foster a more holistic and culturally grounded understanding of the world.

Keywords: Shrimad Bhagavad Gita, Lord Shri Krishna, Arjun, Indian Knowledge Systems (IKS), Multidisciplinary Analysis, Dharma, Indian Psychology, Nishkama Karma, Management Ethics, Sthitaprajna, Pedagogy.

INTRODUCTION

The dialogue between Lord Shri Krishna Vasudeva Yadav and the archer Arjuna serves as the archetypal model of the *Guru-Shishya* tradition in Indian Knowledge Systems, demonstrating how transformative wisdom is transmitted through dialectical engagement in a crisis situation. Indian Knowledge Systems (IKS) represent a vast and diverse body of knowledge that has evolved over millennia on the Indian subcontinent. These systems encompass a wide range of disciplines, including philosophy, science, mathematics, astronomy, medicine, art, architecture, and social sciences. Characterized by a holistic approach that integrates the physical, metaphysical, and spiritual dimensions of reality, IKS offers a unique perspective on human existence and the universe. In recent years, there has been a growing recognition of the value and relevance of IKS in addressing contemporary challenges and fostering a more sustainable and inclusive future.

Within this vast landscape of Indian wisdom, the Shrimad Bhagavad Gita occupies a central and preeminent position. Often referred to as the "Gitopanishad," it is considered the essence of the Upanishadic teachings and a practical guide to life. Set on the battlefield of Kurukshetra, the Gita is a dialogue between Prince Arjuna, who is facing a moral and emotional crisis, and Lord Krishna, who serves as his charioteer and spiritual guide. Through this dialogue, Shri Krishna addresses Arjuna's doubts and fears, imparting profound knowledge about the nature of duty, action, devotion, and ultimate reality.

The primary objective of this research paper is to examine the Shrimad Bhagavad Gita as a significant reservoir of Indian Knowledge Systems. The paper will go beyond a purely theological interpretation to analyze the Gita as a multidisciplinary text that provides foundational knowledge in various fields. It will investigate how the Gita integrates and synthesizes different schools of Indian thought, such as Samkhya, Yoga, and Vedanta, to present a comprehensive worldview. Furthermore, the paper will explore the practical applications of the Gita's teachings in domains like psychology, ethics, leadership, and education, demonstrating its enduring relevance. By giving a detailed analysis of key concepts and verses, this study aims to establish the Shrimad Bhagavad Gita as a vital sourcebook for understanding and appreciating the depth and breadth of Indian Knowledge Systems.

The Bhagavad Gita within the Framework of Indian Knowledge Systems (IKS)

To appreciate the Bhagavad Gita as a source of IKS, it is essential to understand its position within the broader canon of Indian scriptures. The Gita is conventionally classified as a 'Smriti' text, meaning "that which is remembered," as opposed to 'Shruti' ("that which is heard"), which refers to the Vedas and Upanishads. However, the Gita's authority and influence are considered on par with the Shruti texts. It is included in the 'Prasthanatrayi,' the three canonical texts of Vedanta philosophy, alongside the Upanishads and the Brahma

Sutras. This inclusion signifies the Gita's status as a foundational text of metaphysical and philosophical knowledge.

Furthermore, the Gita is often described as the milk drawn from the cow of the Upanishads, with Arjuna as the calf and Shri Krishna as the milkman. This metaphor highlights its role as a distillation and synthesis of the profound philosophical insights found in the Upanishads. The Gita does not present a single, monolithic philosophy but rather an integrated approach that harmonizes various streams of Indian thought. It incorporates the cosmological dualism of Samkhya, the practical discipline of Yoga, and the non-dualistic metaphysics of Vedanta, while also emphasizing the path of Bhakti (devotion). This synthesis is a hallmark of IKS, which often seeks to reconcile apparent contradictions and present a holistic understanding of reality.

As a part of the Mahabharata, the Gita is also situated within the 'Itihasa' (history/epic) tradition. The Mahabharata itself is often called the 'Panchama Veda' (the Fifth Veda), further underscoring its authoritative status. By being embedded within an epic narrative, the Gita's teachings are not presented as abstract theories but as practical wisdom applicable to the complex and challenging situations of real life. This contextualization is another key characteristic of IKS, which emphasizes the practical application of knowledge for human well-being and spiritual evolution.

Metaphysical and Philosophical Knowledge in the Gita

The Shrimad Bhagavad Gita is a treasure trove of metaphysical and philosophical knowledge, addressing fundamental questions about the nature of reality, the self, and the universe. Its teachings form the bedrock of many Indian philosophical systems.

- **The Nature of Reality: Brahman and Atman** A central theme in the Gita is the nature of the ultimate reality, referred to as Brahman, and its relationship with the individual self, or Atman. Shri Krishna teaches that the true self is not the perishable body or the fluctuating mind but the eternal, unchanging Atman. This is famously described in Chapter 2, Verse 20:

न जायते म्रियते वा कदाचि
नायं भूत्वा भविता वा न भूयः ।
अजो नित्यः शाश्वतोऽयं पुराणो
न हन्यते हन्यमाने शरीरे ॥

"na jāyate mriyate vā kadāchin nāyam bhūtvā bhavitā vā na bhūyaḥ ajo nityaḥ śhāśhvato 'yam purāṇo na hanyate hanyamāne śharīre"

Meaning: The soul is neither born, nor does it ever die; nor having once existed, does it ever cease to be. The soul is without birth, eternal, immortal, and ageless. It is not destroyed when the body is destroyed.

This distinction between the eternal self and the transient body is foundational to Indian philosophy and provides a powerful perspective on life and death, liberating the individual from the fear of mortality. The Gita further teaches that this individual self is qualitatively one with the supreme reality, Brahman. Realizing this unity is the ultimate goal of human existence.

- **Cosmology and Creation: Samkhya Philosophy** The Gita draws heavily on Samkhya philosophy to explain the structure and evolution of the cosmos. It describes the universe as a product of two fundamental principles: Purusha (consciousness) and Prakriti (material nature). Prakriti is composed of three *gunas* or modes: Sattva (goodness, harmony), Rajas (passion, activity), and Tamas (ignorance, inertia). The interactions and imbalances of these three *gunas* give rise to the manifold diversity of the material world, including the human mind and body.

Chapter 14 of the Gita provides a detailed analysis of these *gunas* and their influence. Understanding the operation of the *gunas* is crucial for understanding human psychology and behavior, as well as the dynamics of the natural world. This cosmological framework is a key aspect of IKS, providing a sophisticated understanding of matter and consciousness that predates many modern scientific concepts.

- **The Doctrine of Karma and Reincarnation** Intricately linked to its metaphysics is the Gita's detailed exposition of the law of Karma and the concept of reincarnation. Karma, literally meaning "action," refers to the universal principle of cause and effect, where every action produces a corresponding result. Shri Krishna explains that individuals are bound to the cycle of birth and death (*samsara*) due to their attachment to actions and their fruits.

The soul, in its journey toward liberation, transmigrates from one body to another, carrying with it the impressions (samskaras) of past actions. This is vividly described in Chapter 2, Verse 22:

वासांसि जीर्णानि यथा विहाय
नवानि गृह्णाति नरोऽपराणि ।
तथा शरीराणि विहाय जीर्णा
न्यन्यानि संयाति नवानि देही ॥

"vāsānsi jīrṇāni yathā vihāya navāni grihṇāti naro 'parāṇi
tathā śharīrāṇi vihāya jīrṇāny anyāni sansyāti navāni dehī"

Meaning: As a person sheds worn-out garments and wears new ones, likewise, at the time of death, the soul casts off its worn-out body and enters a new one.

The doctrine of Karma and reincarnation provides a framework for understanding cosmic justice and individual responsibility, which are central to Indian ethical and philosophical thought.

Psychological and Emotional Knowledge in the Gita

Beyond its metaphysical depths, the Bhagavad Gita is a profound psychological treatise. It offers deep insights into the workings of the human mind, the causes of suffering, and practical methods for achieving mental well-being and emotional stability. It can be viewed as one of the earliest and most comprehensive texts on human psychology and psychotherapy.

➤ **The Nature of the Mind and the Struggle for Control** Arjuna's crisis on the battlefield is fundamentally a psychological one—a breakdown caused by attachment, delusion, and fear. Shri Krishna addresses this by first analyzing the nature of the human mind. The Gita describes the mind as turbulent, obstinate, and difficult to control, much like the wind. In Chapter 6, Verse 34, Arjuna famously complains to Shri Krishna about the restless nature of the mind.

Shri Krishna acknowledges this difficulty but asserts that the mind can be brought under control through practice (abhyasa) and detachment (vairagya) (6.35). The Gita provides a nuanced understanding of the mind's role as both a friend and an enemy. A controlled mind is the greatest friend, while an uncontrolled mind is the worst enemy (6.6). This emphasis on mastering the mind as the key to well-being is a cornerstone of Indian psychological thought.

➤ **The Gunas and Personality Psychology** The Gita's theory of the three gunas (Sattva, Rajas, and Tamas) provides a sophisticated framework for understanding human personality and behavior. It explains that an individual's thoughts, emotions, actions, and even choices in food, worship, and charity are determined by the predominance of a particular guna within them.

- **Sattva** is characterized by knowledge, purity, and harmony.
- **Rajas** is marked by passion, activity, desire, and attachment.
- **Tamas** is associated with ignorance, inertia, laziness, and delusion.

By understanding one's own Guna constitution, an individual can gain deep self-insight and work towards cultivating Sattva, which leads to mental clarity and peace. This tripartite model of personality is a significant contribution of IKS to the field of psychology.

➤ **Stress Management and the Ideal of Sthitaprajna** In the face of Arjuna's intense stress and anxiety, Shri Krishna presents the ideal of the 'Sthitaprajna'—a person of steady wisdom and stable intellect. Described in the latter part of Chapter 2 (Verses 54-72), a Sthitaprajna is one who remains imperturbable in both pleasure and pain, is free from attachment, fear, and anger, and has complete control over their senses.

Shri Krishna explains that stress and psychological turmoil arise from unfulfilled desires, which lead to anger, delusion, and the eventual collapse of the intellect (2.62-63). The path to emotional stability lies in cultivating detachment and focusing the mind on the higher self. The concept of Sthitaprajna offers a timeless model for emotional intelligence, resilience, and stress management that is highly relevant in the modern world.

➤ **Yoga Psychology: Paths to Inner Integration** The Gita expounds various paths of Yoga as psychological methods for achieving inner integration and self-realization.

- **Karma Yoga** (The Yoga of Action) teaches how to perform actions without attachment to the results, thus freeing the mind from anxiety and guilt.
- **Jnana Yoga** (The Yoga of Knowledge) involves the use of the intellect to discriminate between the real and the unreal, leading to self-knowledge.
- **Bhakti Yoga** (The Yoga of Devotion) channels emotions towards the divine, sublimating lower desires into a higher love.
- **Dhyana Yoga** (The Yoga of Meditation) provides specific techniques for calming the mind and attaining deep states of concentration and inner peace.

These different paths cater to different human temperaments, offering a holistic approach to psychological well-being and spiritual growth.

Ethical and Moral Knowledge (Dharma) in the Gita

Lord Shri Krishna Vasudeva Yadav guides Arjuna out of moral paralysis not by simplifying his ethical dilemma, but by reframing his worldly duties within the broader, more nuanced metaphysical framework of *Dharma* and detached action. The concept of Dharma is central to the Bhagavad Gita and to Indian civilization as a whole. The Gita begins with the word "Dharmakshetre" (on the field of Dharma), setting the stage for an intense exploration of ethical duties and moral dilemmas. It is one of the most sophisticated treatises on normative ethics within IKS.

- **The Nuances of Dharma and Moral Dilemmas** Arjuna's crisis is a classic example of a moral dilemma where two different duties conflict: his duty as a warrior (Kshatriya Dharma) to fight against injustice, and his duty towards his family and teachers (Kula Dharma), whom he is expected to revere and protect. He is paralyzed by the prospect of killing his own kinsmen, seeing it as a grave sin that would lead to social chaos.

Shri Krishna's teachings are aimed at resolving this ethical paralysis by providing a higher perspective on Dharma. He explains that Dharma is not a rigid set of rules but a dynamic principle that must be understood in context. He guides Arjuna to look beyond his immediate attachments and consider the greater good and his inherent duty.

- **Swadharma: The Ethics of Individual Duty** A key ethical principle emphasized in the Gita is 'Swadharma'—one's own inherent duty based on their nature (svabhava) and station in life. Shri Krishna asserts that it is better to perform one's own duty imperfectly than to perform another's duty perfectly. To abandon one's duty out of fear or illusion is considered dereliction.

श्रेयान्स्वधर्मो विगुणः परधर्मात्स्वनुष्ठितात् ।

स्वधर्मे निधनं श्रेयः परधर्मो भयावहः ॥

"śhreyān swa-dharmo viguṇaḥ para-dharmāt sv-anuṣṭhitāt

swa-dharme nidhanam śhreyaḥ para-dharmo bhayāvahaḥ"

Meaning: It is far better to perform one's own prescribed duty, though faultily, than to perform another's duty perfectly. Destruction in the course of performing one's own duty is better than engaging in another's duty, for to follow another's path is dangerous. (3.35)

This teaching highlights the importance of authenticity and aligning one's actions with their inner nature, a concept that has deep implications for personal fulfillment and social harmony.

- **Nishkama Karma: The Ethics of Selfless Action** Perhaps the most famous ethical teaching of the Gita is the doctrine of Nishkama Karma—action performed without desire for the fruit. Shri Krishna advises Arjuna to focus entirely on the action itself, as a matter of duty, and to remain equanimous towards success or failure.

कर्मण्येवाधिकारस्ते मा फलेषु कदाचन ।

मा कर्मफलहेतुर्भूर्मा ते सङ्गोऽस्त्वकर्मणि ॥

"karmany-evādhikāras te mā phaleṣhu kadāchana

mā karma-phala-hetur bhūr mā te saṅgo 'stvakarmaṇi"

Meaning: You have a right to perform your prescribed duties, but you are not entitled to the fruits of your actions. Never consider yourself to be the cause of the results of your activities, nor be attached to inaction. (2.47)

This principle transforms action into a spiritual practice. It is a powerful antidote to the anxiety and corruption that arise from a result-oriented mindset. It promotes an ethic of service and selflessness which is foundational to a just and sustainable society.

➤ **Virtue Ethics: Daivi and Asuri Sampad** In Chapter 16, the Gita presents a clear framework of virtue ethics by distinguishing between 'Daivi Sampad' (divine qualities) and 'Asuri Sampad' (demonic qualities). Divine qualities, such as fearlessness, purity of mind, charity, self-control, non-violence, truthfulness, and compassion, lead to liberation and social good. Conversely, demonic qualities like arrogance, pride, anger, harshness, and ignorance lead to bondage and suffering. This classification provides a clear moral compass for individual conduct and character development.

Management and Leadership Knowledge in the Gita

In recent decades, there has been a surge of interest in the Bhagavad Gita as a management and leadership manual. Its timeless principles are being increasingly recognized as highly relevant to the complex challenges of the modern corporate world.

➤ **Principles of Effective Leadership** The dynamic between Shri Krishna and Arjuna can be seen as a masterclass in leadership and mentoring. Krishna, as the supreme leader and guide, demonstrates several key leadership qualities. He is a compassionate listener, permitting Arjuna to vent his feelings before offering guidance. He is a visionary, helping Arjuna see the bigger picture beyond his immediate emotional turmoil. He empowers Arjuna, not by fighting the battle for him, but by equipping him with the knowledge and mental strength to fight his own battle.

The concept of the 'Rajarshi' (royal sage)—a leader who combines worldly power with spiritual wisdom—is an ideal presented in Indian tradition that is exemplified by figures like Janaka and Shri Krishna himself. A true leader, according to the Gita, is one who has conquered their own mind and senses and works for the welfare of all.

➤ **Decision Making in Crisis** The entire context of the Gita is a crisis situation requiring a monumental decision. Arjuna's state represents the paralysis that often strikes leaders when faced with high-stakes dilemmas with no easy answers. Krishna's guidance offers a framework for ethical and effective decision-making.

He teaches Arjuna to base his decisions not on personal attachment, fear, or immediate gain, but on a clear understanding of duty (Dharma) and the larger good. The principle of detached action allows a leader to make objective decisions without being clouded by the anxiety of the outcome. The concept of Sthitaprajna provides a model for maintaining mental clarity and equipoise under pressure, which is indispensable for crisis management.

➤ **Motivation and Work Ethic: Karma Yoga at Work** The Gita's teachings on Karma Yoga provide a powerful framework for motivation and work ethic. The modern corporate world is often driven by external rewards—salary, promotions, recognition—which can lead to stress, burnout, and unethical behavior. The Gita proposes a different paradigm: work as worship.

By dedicating one's actions to a higher purpose and renouncing attachment to the fruits, work becomes a source of joy and self-fulfillment rather than drudgery. This shift in perspective can lead to higher levels of engagement, creativity, and ethical conduct in the workplace. The focus shifts from "what do I get out of this?" to "how can I contribute effectively?"

➤ **Lokasamgraha: The Universal Welfare** A crucial concept in the Gita relevant to modern management is 'Lokasamgraha'—working for the holding together and welfare of the world. Shri Krishna urges Arjuna to act not just for his own sake, but to set an example for others and contribute to social order and harmony.

यद्यदाचरति श्रेष्ठस्तत्तदेवेतरो जनः ।

स यत्प्रमाणं कुरुते लोकस्तदनुवर्तते ॥

"yadyadācharati śhreṣṭhas tattadevetaro janah

sa yat pramāṇam kurute lokas tad anuvartate"

Meaning: Whatever action a great man performs, common men follow. And whatever standards he sets by exemplary acts, all the world pursues. (3.21)

This principle emphasizes the social responsibility of leaders and organizations. It aligns with modern concepts of Corporate Social Responsibility (CSR) but goes deeper, rooting it in a spiritual understanding of the interconnectedness of all life. A leader guided by the ideal of Lokasamgraha acts with a sense of stewardship for society and the environment.

Pedagogical and Educational Knowledge in the Gita

The Bhagavad Gita is not just a book of knowledge; it is a demonstration of an exemplary teaching-learning process. It offers valuable insights into pedagogy and the true purpose of education within the Indian tradition.

- **The Guru-Shishya Parampara: The Ideal Teacher-Student Relationship** The relationship between Lord Shri Krishna Vasudev Yadav (the Guru) and Arjuna (the Shishya) is the archetype of the Guru-Shishya Parampara, the foundational pedagogical model of IKS. This relationship is based on mutual respect, trust, and a genuine desire for knowledge on the part of the student, and compassion and wisdom on the part of the teacher.

Arjuna approaches Shri Krishna with humility, acknowledging his confusion and surrendering to his guidance as a disciple (2.7). Shri Krishna, in turn, accepts him and teaches him with patience and love, addressing his specific doubts and emotional state. This highlights that true education is not a mere transaction of information but a transformative relationship.

Samvada: The Dialogical Method of Teaching The entire Gita is presented in the form of a 'Samvada' or dialogue. This is a highly effective pedagogical method that encourages active engagement, critical thinking, and the clarification of doubts. Shri Krishna does not simply deliver a monologue; he constantly engages Arjuna, asking questions, inviting his perspectives, and answering his counter-arguments.

This interactive process ensures that the knowledge is not just passively received but actively understood and internalized by the student. The dialogical tradition is a key feature of Indian philosophical inquiry, as seen in the Upanishads and other texts.

- **The Ultimate Goal of Education: Atma-Jnana** While the Gita provides knowledge on various practical aspects of life, it makes it clear that the ultimate goal of all knowledge is 'Atma-Jnana'—self-realization. In Chapter 9, Verse 2, Shri Krishna describes this knowledge as the "king of sciences" (Rajavidya) and the "king of secrets" (Rajaguhya).

True education, according to the Gita, is that which liberates the individual from ignorance and bondage. It is an education that leads to the realization of one's true nature as the eternal Self. All other forms of knowledge—secular, scientific, or artistic—are considered secondary to this supreme wisdom. This perspective challenges modern utilitarian views of education and calls for a more holistic approach that nurtures the spiritual dimension of the human being along with the intellectual and physical.

Contemporary Relevance and Conclusion

The detailed analysis presented in this paper unequivocally establishes the Shrimad Bhagavad Gita as a colossal reservoir of Indian Knowledge Systems. It is a text that brilliantly synthesizes the metaphysical heights of the Upanishads with the practical wisdom required to navigate the complexities of human life. Its contributions to philosophy, psychology, ethics, management, and pedagogy are not merely of historical interest but possess a timeless and universal relevance.

In today's world, which is grappling with unprecedented crises—mental health epidemics, ethical failures in leadership, environmental degradation, and a general sense of meaninglessness—the wisdom of the Gita offers a beacon of hope and sanity.

- Its psychological insights into stress management and emotional stability are needed more than ever.
- Its ethical framework of Nishkama Karma and Swadharma provides a powerful antidote to the culture of unbridled greed and consumerism.
- Its principles of leadership based on self-mastery and universal welfare can redefine our approach to governance and management.
- Its pedagogical emphasis on a transformative teacher-student relationship and self-realization can help reform modern education systems that are often overly mechanistic and information-driven.

However, integrating the knowledge systems of the Gita into contemporary discourse and institutions presents challenges. It requires moving beyond a superficial or purely devotional reading of the text to a critical and academic engagement with its concepts. It demands a decolonization of our intellectual frameworks to appreciate the sophistication of indigenous Indian thought on its own terms. It also requires creative efforts to translate these ancient principles into modern contexts and languages without diluting their essence.

Despite these challenges, the potential rewards are immense. A serious engagement with the Bhagavad Gita as a source of IKS can lead to a renaissance in various fields of human endeavor. It can provide the philosophical foundations for a more integrated, ethical, and sustainable way of life. In conclusion, the Shrimad Bhagavad Gita is not just a scripture of the past; it is a living guide for the present and a foundational text for a future that is enlightened by the profound wisdom of Indian Knowledge Systems.

Ultimately, the Gita's multidisciplinary journey culminates in a singular, powerful psychological and spiritual assertion. After guiding Arjuna through the intricacies of *Karma*, *Jnana*, and *Dhyana*, Lord Krishna offers the final resolution to all human conflict in Chapter 18, Verse 66:

सर्वधर्मान्परित्यज्य मामेकं शरणं व्रज ।
अहं त्वां सर्वपापेभ्यो मोक्षयिष्यामि मा शुचः ॥

Meaning: *Abandoning all varieties of Dharmas, surrender unto Me alone. I shall liberate you from all sinful reactions; do not grieve.*

In the context of IKS, this verse is not a negation of worldly duties but the transcendence of the ego-driven sense of agency. The command “*Mā śhuchah*” (Do not grieve) serves as the ultimate assurance of mental health and emotional stability. It signifies that the pinnacle of Indian knowledge is the attainment of a state free from anxiety and fear through the integration of the self with the Supreme. Thus, the *Bhagavad Gita* remains a timeless guide, proving that the ultimate goal of all knowledge systems—whether ethical, social, or psychological—is the liberation of the human spirit.

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THE FOUNDATIONAL ROLE OF INDIAN MATHEMATICIANS IN THE DEVELOPMENT OF MATHEMATICS: A PILLAR OF THE INDIAN KNOWLEDGE SYSTEM

Prof. Dr. Pratibha Jaywant**Assistant Professor**, Chandrabhan Sharma College of Arts, Commerce and Science (Autonomous), Powai, Mumbai**ABSTRACT**

This paper examines the foundational contributions of Indian mathematicians to the development of basic mathematics, algebra and geometry from the Vedic period through the medieval era (1500 BCE -1600 CE). Through systematic analysis of key mathematical texts and scholarly works, this study demonstrates how Indian mathematical traditions established fundamental concepts that continue to shape contemporary mathematical understanding.

Key observations indicate that Indian mathematicians developed the decimal positional system with zero, pioneered algebraic methods for solving indeterminate equations, formulated sophisticated geometric theorems and created infinite series expansions that prefigured calculus by several centuries. The observations challenge traditional historical narratives by demonstrating the extent and sophistication of Indian mathematical achievements, particularly in areas previously attributed to later European developments.

The paper concludes that Indian mathematicians established fundamental mathematical concepts across arithmetic, algebra and geometry that remain central to modern mathematical practice.

Their systematic approaches to numerical computation, abstract algebraic reasoning and geometric analysis created methodological frameworks that continue to inform contemporary mathematical research and education. This study contributes to a more complete understanding of mathematical history while highlighting the enduring relevance of Indian mathematical traditions within global knowledge systems.

Keywords: Indian Mathematics, Mathematical Foundations, Algebra, Geometry, Indian Knowledge System, Mathematical History, Vedic Mathematics, Kerala School of Mathematics The views and opinions expressed in this paper are those of the author and do not necessarily reflect the official policy or position of the Organisation to which the author is associated.

INTRODUCTION AND CONTEXT

The history of mathematics is incomplete without acknowledging the profound contributions of Indian mathematicians who laid the groundwork for fundamental mathematical concepts that continue to shape our understanding today. From the ancient Vedic period to the medieval era, Indian scholars developed sophisticated mathematical theories, computational methods and geometric principles that would later influence mathematical thought across the world. This article explores the pivotal role of Indian mathematicians in establishing the foundations of basic mathematics, algebra and geometry as integral components of the broader Indian Knowledge System

The Vedic Foundations (1500-500 BCE)**Early Mathematical Concepts in Vedic Literature**

The earliest traces of Indian mathematical thinking can be found in the Vedic texts, particularly in the construction of fire altars (agni-chiti) described in the Sulba Sūtras. These texts, dating from approximately 800-200 BCE, contain sophisticated geometric principles that demonstrate an advanced understanding of spatial relationships and numerical concepts

The Sulba Sūtras, authored by mathematicians like Baudhāyana, Apastamba and Kātyāyana, present precise geometric constructions for altar building. These works contain the earliest known statement of what is now called the Pythagorean theorem, predating Pythagoras by several centuries. Baudhāyana's Sulba Sūtra explicitly states "The diagonal of a rectangle produces by itself the same area as produced by its length and breadth together".

Numerical Systems and Place Value

The Vedic period also saw the development of sophisticated numerical systems. The concept of large numbers was well-established, with specific names for powers of ten extending to astronomical figures. This systematic approach to numerical representation laid the groundwork for later developments in positional notation and decimal systems.

The Classical Period: Foundational Treatises (300-1200 CE)**Aryabhata 1 (476-550 CE): Revolutionary Contributions**

Aryabhata I stands as one of the most influential mathematicians in Indian history. His work "Aryabhatiya" revolutionized mathematical thinking in several key areas:

Arithmetic and Number Theory:

- Introduced systematic methods for extracting square and cube roots
- Developed algorithms for solving linear and quadratic equations
- Presented rules for arithmetic progressions and geometric series

Algebraic Innovations:

- Pioneered the use of algebraic methods to solve astronomical problems
- Developed techniques for solving indeterminate equations of the first degree
- Introduced systematic approaches to handling unknown quantities

Geometric Contributions:

- Provided accurate approximations for π , stating it as 3.1416
- Developed methods for calculating areas and volumes of various geometric shapes
- Advanced understanding of spherical geometry in astronomical contexts

Brahmagupta (628 CE): The Algebraic Pioneer

Brahmagupta's "Brāhmasphuṭasiddhānta" marked a watershed moment in the development of algebra. His contributions include

Zero and Negative Numbers:

- Provided the first systematic treatment of zero as both a placeholder and a number
- Established rules for arithmetic operations involving zero and negative numbers
- Laid the foundation for modern algebraic thinking

Quadratic Equations:

- Developed general methods for solving quadratic equations
- Introduced the concept of two solutions for quadratic equations
- Advanced techniques for handling irrational solutions

Cyclic Quadrilaterals:

- Formulated Brahmagupta's formula for the area of cyclic quadrilaterals
- Developed sophisticated geometric theorems related to inscribed quadrilaterals
- Advanced understanding of the relationship between algebra and geometry

Bhaskara I (600-680 CE): Computational Excellence

Bhaskara I made significant contributions to computational mathematics:

Trigonometric Approximations:

- Developed rational approximations for sine functions
- Created computational methods that remained accurate and efficient
- Advanced the practical application of mathematical principles

Algebraic Methods:

- Refined techniques for solving linear and quadratic equations
- Developed systematic approaches to mathematical problem-solving
- Enhanced the pedagogical presentation of mathematical concepts

The Medieval Renaissance (1000-1600 CE)**Bhaskara II (1114-1185 CE): The Complete Mathematician**

Bhaskara II also known as Bhaskarāchārya, represents the pinnacle of medieval Indian mathematics. His works "Lilāvati" and "Bijaganita" demonstrate extraordinary mathematical sophistication.

Arithmetic Mastery:

- Developed comprehensive methods for all basic arithmetic operations
- Advanced techniques for handling fractions and proportions
- Created systematic approaches to commercial mathematics

Algebraic Innovations:

- Solved indeterminate equations of the second degree (Pell's equation)
- Developed methods for solving systems of equations
- Advanced understanding of algebraic symbolism and notation

Geometric Excellence:

- Calculated accurate values for trigonometric functions
- Developed sophisticated methods for measuring areas and volumes
- Advanced understanding of spherical trigonometry

Calculus Precursors:

- Demonstrated concepts that would later be formalized as differential calculus
- Developed methods for finding instantaneous rates of change
- Advanced understanding of infinite series and their applications

Mādhava of Sangamagrāma (1340-1425 CE): The Calculus Pioneer

Madhava's contributions represent one of the most remarkable achievements in mathematical history

Infinite Series:

- Developed infinite series expansions for trigonometric functions
- Created series for (π) that demonstrated unprecedented accuracy
- Advanced understanding of convergence and mathematical analysis

Trigonometric Functions:

- Developed systematic methods for calculating sine, cosine and arctangent functions
- Created tables of trigonometric values with remarkable precision
- Advanced the practical application of trigonometry

Analytical Methods:

- Pioneered techniques that would later be recognized as fundamental to calculus
- Developed methods for term-by-term integration and differentiation of series
- Advanced understanding of mathematical limits and continuity

The Kerala School: Collective Excellence.

The Kerala School of Mathematics, flourishing from the 14th to 16th centuries, represents a remarkable period of mathematical innovation.

Nilakantha Somayāji (1444-1544 CE)

- Advanced Madhava's work on infinite series
- Developed sophisticated astronomical models using advanced mathematics
- Created systematic approaches to mathematical proof and verification

Jyesthadeva (1500-1575 CE):

- Authored "Yuktibhāṣā," providing detailed proofs and explanations

- Advanced mathematical pedagogy and systematic presentation
- Demonstrated the logical foundations of mathematical discoveries

Fundamental Contributions to Mathematical Domains

Basic Mathematics: Computational Foundations

Indian mathematicians established fundamental principles that continue to underpin basic mathematics

Decimal System and Place Value: The development of the decimal positional system with zero represents one of India's most significant contributions to world mathematics. This system, perfected by Indian mathematicians, provided the foundation for all modern computational methods.

Arithmetic Operations: Systematic methods for addition, subtraction, multiplication and division were refined and codified by Indian mathematicians. These methods, particularly those described in works like Lilāvati, became standard approaches worldwide.

Fractional Arithmetic: Indian mathematicians developed sophisticated methods for handling fractions, including techniques for addition, subtraction, multiplication and division of fractional quantities. These methods demonstrated remarkable computational efficiency and accuracy.

Algebra: Abstract Mathematical Thinking

Indian contributions to algebra represent a fundamental shift toward abstract mathematical reasoning

Symbolic Representation: While not using modern algebraic notation, Indian mathematicians developed systematic methods for representing and manipulating unknown quantities. This abstract approach laid the groundwork for modern algebraic thinking.

Equation Solving: The development of general methods for solving linear and quadratic equations, including techniques for handling multiple unknowns, represents a crucial advancement in mathematical methodology.

Indeterminate Analysis: Indian mathematicians, particularly Brahmagupta and Bhaskara 11. developed sophisticated methods for solving indeterminate equations. These techniques, later known in Europe as "Pell's equation," demonstrated remarkable mathematical insight.

Geometry: Spatial Understanding and Measurement

Indian geometric contributions encompass both theoretical understanding and practical applications

Theoretical Geometry: The development of geometric theorems, particularly those related to triangles and circles, demonstrated sophisticated understanding of spatial relationships and logical reasoning.

Practical Applications: Geometric principles were applied to architecture, astronomy and engineering, demonstrating the practical relevance of mathematical knowledge within the broader Indian Knowledge System.

Trigonometry: The systematic development of trigonometric functions and their applications represent one of India's most significant contributions to mathematical science. These developments enabled accurate astronomical calculations and advanced engineering applications.

Integration within the Indian Knowledge System

Holistic Approach to Knowledge

Indian mathematics developed within a broader intellectual framework that emphasized the interconnectedness of different domains of knowledge.

Astronomical Applications: Mathematical developments were closely linked to astronomical observations and calculations, demonstrating the practical relevance of abstract mathematical concepts.

Architectural Integration: Geometric principles were applied to temple architecture and urban planning, showing how mathematical knowledge informed practical construction and design.

Philosophical Foundations: Mathematical concepts were often discussed within philosophical contexts, emphasizing the logical and metaphysical foundations of mathematical truth.

Pedagogical Traditions

The Indian Knowledge System emphasized systematic transmission of mathematical knowledge.

Guru-Siṣya Tradition: Mathematical knowledge was transmitted through direct teacher-student relationships, ensuring accurate preservation and development of mathematical concepts.

Systematic Presentation: Mathematical works were organized systematically, with clear explanations, examples and applications that facilitated learning and understanding.

Integration with Other Disciplines: Mathematics was taught in conjunction with astronomy, architecture and other practical disciplines, emphasizing its broad applicability and relevance.

Global Impact and Recognition

Transmission to Other Cultures

Indian mathematical knowledge spread to other parts of the world through various channels:

Islamic World: Indian mathematical texts were translated into Arabic, influencing Islamic mathematical development and eventually reaching Europe through this route.

Southeast Asia: Indian mathematical and astronomical knowledge spread to Southeast Asian cultures, influencing their intellectual development.

Direct European Contact: Later European scholars recognized the sophistication of Indian mathematical achievements, leading to broader acknowledgment of India's contributions.

Modern Recognition

Contemporary mathematical historians increasingly recognize the fundamental importance of Indian contributions:

Historical Reassessment: Modern scholarship has revealed the extent and sophistication of Indian mathematical achievements, correcting earlier historical narratives that underestimated these contributions.

Methodological Innovations: Recognition of Indian innovations in mathematical methodology, particularly in areas like infinite series and analytical techniques, has grown significantly.

Foundational Importance: The foundational role of Indian mathematics in establishing basic mathematical concepts is now widely acknowledged in academic circles.

CONCLUSION

The role of Indian mathematicians in establishing the foundations of basic mathematics, algebra and geometry represents one of the most significant intellectual achievements in human history. From the geometric insights of the Sulba Sūtras to the analytical innovations of the Kerala School, Indian scholars developed mathematical concepts and methods that continue to influence mathematical thinking today.

These contributions emerged within the broader context of the Indian Knowledge System, which emphasized systematic inquiry, logical reasoning and practical application. The integration of mathematical knowledge with astronomy, architecture, philosophy and other disciplines demonstrated the holistic approach that characterized Indian intellectual traditions.

The decimal system with zero, algebraic methods for equation solving, geometric theorems, trigonometric functions and early calculus concepts all represent fundamental contributions that shaped the development of mathematics worldwide. These achievements reflect not only individual brilliance but also the collective intellectual culture that supported and encouraged mathematical innovation.

Understanding and acknowledging these contributions is essential for a complete appreciation of mathematical history and the global development of human knowledge. The Indian mathematical tradition demonstrates how abstract mathematical thinking can emerge from practical needs while contributing to the broader understanding of logical and quantitative relationships that govern our world.

As we continue to build upon these foundational contributions, recognizing their origins within the Indian Knowledge System provides important insights into the nature of mathematical discovery and the cultural contexts that foster intellectual innovation. The legacy of Indian mathematicians continues to inspire and inform contemporary mathematical research and education, ensuring that their fundamental contributions remain relevant and influential in our ongoing quest to understand the mathematical principles that underlie our universe.

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INDIAN KNOWLEDGE SYSTEMS (IKS) AND MSME DEVELOPMENT: A PATHWAY TO SUSTAINABLE ECONOMIC GROWTH IN INDIA

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ABSTRACT

Indian Knowledge Systems (IKS) represent the indigenous knowledge traditions rooted in India's civilizational heritage, encompassing traditional crafts, agriculture, medicine, architecture, metallurgy, and community-based enterprises. Micro, Small, and Medium Enterprises (MSMEs) play a critical role in India's economic development by contributing to employment, exports, and industrial output. This paper explores the integration of Indian Knowledge Systems with MSME development as a strategic pathway for sustainable growth, self-reliance (Atmanirbhar Bharat), and cultural preservation. It examines policy frameworks, economic contributions, challenges, and opportunities while highlighting case examples from traditional industries such as Ayurveda, handloom, handicrafts, and village industries. The study concludes that strengthening IKS-driven MSMEs can enhance innovation, rural employment, global competitiveness, and inclusive growth.

Keywords: Indian Knowledge Systems, MSME, traditional knowledge, sustainable development, Atmanirbhar Bharat, rural entrepreneurship

1. INTRODUCTION

India's economic development has long been supported by its vibrant traditional industries and knowledge systems. Indian Knowledge Systems (IKS) include centuries-old practices in medicine, agriculture, textile production, metallurgy, architecture, water management, and artisanal crafts.

The Micro, Small, and Medium Enterprises (MSMEs) sector is regulated by the Ministry of Micro, Small and Medium Enterprises and constitutes the backbone of India's industrial economy. According to government estimates, MSMEs contribute approximately 30% to India's GDP and generate significant employment, particularly in rural and semi-urban areas.

The integration of IKS into MSME development provides a sustainable model that combines tradition with modern entrepreneurship.

2. CONCEPTUAL FRAMEWORK**2.1 Indian Knowledge Systems (IKS)**

Indian Knowledge Systems refer to indigenous scientific, technological, and cultural knowledge developed over thousands of years. These include:

- Ayurveda and traditional medicine
- Handloom and handicrafts
- Traditional agriculture and organic farming
- Vastu Shastra and traditional architecture
- Metallurgy and temple construction
- Water harvesting systems

Institutions such as Indian Council of Agricultural Research and the Ministry of Education have initiated programs to integrate IKS into modern curricula and innovation frameworks.

2.2 MSME Sector in India

The MSME sector in India includes manufacturing and service enterprises classified based on investment and turnover. Policy support is provided under the MSME Development Act, 2006.

Major institutions supporting MSMEs include:

- Khadi and Village Industries Commission
- National Small Industries Corporation
- Small Industries Development Bank of India

These institutions promote traditional industries, credit access, marketing, and technology upgrades.

3. LINKAGES BETWEEN IKS AND MSME DEVELOPMENT

3.1 Traditional Industries as MSMEs

Many MSMEs are directly rooted in IKS:

- Khadi and handloom industries
- Ayurveda-based pharmaceutical units
- Traditional pottery and metal crafts
- Bamboo and cane industries
- Tribal forest-based enterprises

For example, the Khadi and Village Industries Commission has revitalized khadi production through modernization and digital marketing initiatives.

3.2 Employment Generation

IKS-based MSMEs are labor-intensive and promote rural employment. They:

- Reduce rural-urban migration
- Empower women entrepreneurs
- Preserve traditional skills

These enterprises contribute significantly to inclusive development.

3.3 Sustainable and Eco-Friendly Production

Traditional knowledge systems emphasize:

- Use of natural raw materials
- Low carbon footprint
- Circular economy practices

For example, Ayurveda industries regulated by the Ministry of AYUSH promote plant-based medicine and sustainable harvesting.

3.4 Cultural Preservation and Global Branding

IKS-based MSMEs enhance India's soft power and export potential. Products such as yoga accessories, Ayurvedic products, handicrafts, and handloom textiles have global demand.

India's Geographical Indication (GI) tagging further protects traditional products like Banarasi silk and Kanchipuram sarees.

4. GOVERNMENT INITIATIVES SUPPORTING IKS-BASED MSMEs

4.1 Atmanirbhar Bharat Abhiyan

The Atmanirbhar Bharat initiative promotes local manufacturing and traditional industries through financial packages and reforms.

4.2 Make in India

Launched by the Government of India, Make in India supports manufacturing-based MSMEs, including traditional sectors.

4.3 ODOP (One District One Product)

The One District One Product scheme promotes region-specific traditional industries.

4.4 Digital India and E-commerce Integration

Digital platforms enable traditional MSMEs to access national and global markets through online marketplaces.

5. CHALLENGES IN INTEGRATING IKS WITH MSMEs

Despite the potential, several challenges exist:

1. Lack of modernization and technology integration
2. Limited access to credit
3. Intellectual Property Rights (IPR) concerns

- 4. Poor market linkages
- 5. Skill gaps among artisans
- 6. Competition from mass-produced goods

Protection of traditional knowledge through documentation and patents remains critical.

6. CASE STUDIES

6.1 Khadi Sector

Under the Khadi and Village Industries Commission, khadi production has expanded significantly, generating rural employment and increasing exports.

6.2 Ayurveda MSMEs

With support from the Ministry of AYUSH, Ayurveda-based MSMEs have grown in domestic and international markets.

6.3 Handloom Industry

India’s handloom sector remains one of the largest cottage industries, sustaining millions of weavers.

6.1 Khadi Sector

The Khadi sector represents one of the most significant examples of Indian Knowledge Systems (IKS) integrated into the Micro, Small, and Medium Enterprises (MSME) ecosystem. Rooted in India’s freedom movement and popularized by Mahatma Gandhi, khadi symbolizes self-reliance, sustainability, and decentralized rural production. Today, it functions as a structured MSME-driven rural industry supported by the Khadi and Village Industries Commission (KVIC) under the Ministry of Micro, Small and Medium Enterprises.

6.1.1 Historical Background and IKS Foundation

Khadi is hand-spun and handwoven fabric made primarily from cotton, silk, or wool. The production process is embedded in traditional spinning (charkha) and weaving techniques, representing indigenous knowledge in:

- Fiber processing
- Natural dyeing
- Manual spinning technology
- Community-based cooperative production

Unlike industrial textile production, khadi relies on decentralized village-level artisans, reflecting Gandhian economic philosophy of “production by the masses.”

6.1.2 Economic Performance and Statistical Overview

The khadi sector has witnessed significant growth in recent years.

Table 6.1: Khadi Sector Performance (Recent Years)

Indicator	Value
Total KVIC Sales (2022–23)	₹1.34 lakh crore (approx.)
Khadi Production Growth	~20% annual growth (recent years)
Employment Generated	Over 4.9 million persons
Women Participation	Over 50% workforce
Village Industries Share	Majority rural-based units

Source: KVIC Annual Reports & MSME Ministry Data

Notably, khadi sales have grown substantially due to branding initiatives, digital marketing, and government promotion campaigns. The sector recorded historic sales growth post-2015 due to modernization strategies

6.1.3 Employment and Women Empowerment

Khadi is one of the largest rural employment generators in India’s traditional industries. The sector:

- Employs approximately 49 lakh individuals
- Has strong female participation (especially in spinning)
- Promotes home-based and flexible employment

This supports **Hypothesis H1**, as khadi-based MSMEs show high employment intensity compared to capital-intensive industries.

Women constitute a majority of spinners, contributing significantly to rural household income. However, managerial and ownership roles still require policy strengthening.

6.1.4 Sustainability and Environmental Advantage

The khadi sector aligns with global sustainability goals due to:

- Minimal electricity usage
- Low carbon footprint
- Natural fibers and eco-friendly dyes
- Water conservation in traditional processes

Studies show that khadi production consumes significantly less energy compared to mill-made cloth, making it a sustainable textile alternative.

This reinforces the role of IKS in promoting environmentally responsible MSME development.

6.1.5 Export Potential and Branding

Khadi products now include:

- Apparel and garments
- Herbal cosmetics
- Handmade soaps
- Leather goods
- Honey and village industry products

The “Khadi India” brand has expanded into global markets, supporting **Hypothesis H2** regarding export potential of IKS-based MSMEs.

Modern marketing initiatives include:

- Online platforms
- Fashion collaborations
- Youth-targeted branding campaigns

6.1.6 Government Support Mechanisms

The khadi sector is supported by:

- Prime Minister’s Employment Generation Programme (PMEGP)
- Interest Subsidy Eligibility Certificate Scheme (ISEC)
- Skill development programs
- Marketing Development Assistance (MDA)

These interventions aim to modernize traditional production without compromising authenticity.

6.1.7 Challenges in the Khadi Sector

Despite growth, the sector faces several constraints:

1. Competition from powerloom and synthetic textiles
2. Raw material price volatility
3. Limited technology adoption
4. Aging artisan population
5. Branding perception issues among youth

Addressing these challenges requires technological integration while preserving traditional craftsmanship.

6.1.8 Role of Khadi in Atmanirbhar Bharat

Khadi embodies the principles of self-reliance promoted under Atmanirbhar Bharat. By strengthening rural supply chains and encouraging local production, it reduces dependency on imports and supports decentralized economic growth.

6.1.9 Analytical Insights

The khadi sector demonstrates:

- High employment elasticity
- Strong women participation
- Sustainable production practices
- Strong policy backing

Empirical observations indicate that khadi-based MSMEs perform better in rural employment generation compared to non-IKS industrial MSMEs, partially validating the research hypotheses.

Conclusion of Section 6.1

The khadi sector stands as a model of how Indian Knowledge Systems can be successfully institutionalized within the MSME framework. It combines heritage, sustainability, women empowerment, and rural entrepreneurship. Strengthening technological innovation, improving market access, and enhancing youth engagement can further amplify its impact on India's inclusive economic growth.

Policy Recommendations

1. Establish IKS innovation clusters linked with MSMEs.
2. Increase funding for research and development in traditional industries.
3. Provide digital literacy and e-commerce training to artisans.
4. Strengthen GI tagging and intellectual property protection.
5. Promote public-private partnerships for global branding.
6. Introduce IKS-focused incubation centers in universities.

8. CONCLUSION

The integration of Indian Knowledge Systems with MSME development presents a transformative model for sustainable and inclusive economic growth. By combining tradition with innovation, India can strengthen rural entrepreneurship, preserve cultural heritage, enhance exports, and achieve self-reliance. Policymakers, academic institutions, and industry stakeholders must collaborate to harness the full potential of IKS-based MSMEs. This synergy can position India as a global leader in sustainable and culturally rooted economic development.

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A STUDY ON THE RELEVANCE OF VEDIC MATHEMATICS IN THE INDIAN CLASSROOM

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ABSTRACT

Bharati Krishna Tirthaji (1965) reconstructed and systematized Vedic Mathematics, which consists of sixteen sutras and thirteen sub-sutras that are said to make algebraic and mathematical computations easier. The epistemological underpinnings, historical veracity, and cognitive effectiveness of Vedic mathematics are still debatable, despite its widespread use in competitive exams and mental calculation instruction. From a historical, mathematical, cognitive, and pedagogical standpoint, this research critically analyzes Vedic mathematics. The study assesses its effects on computational fluency, conceptual understanding, and cognitive load using experimental data gathered from controlled classroom interventions, comparative performance indicators, and statistical hypothesis testing. Although there are conceptual depth and generalizability limits, the results show statistically significant gains in speed and accuracy for arithmetic problems. The study suggests a hybrid pedagogical approach that combines modern mathematical teaching methods with Vedic methods.

The effectiveness of Vedic mathematics as an additional teaching aid in Indian middle schools (grades 6 – 8) is examined in this study. This study investigates if the "mental-arithmetic" aspect of Vedic Sutras enhances computational speed and lessens "Math Anxiety," whereas the regular NCERT curriculum concentrates on formal algorithmic logic. The study assesses psychological changes and student performance during a six-month intervention period using a mixed-methods approach.

Keyword: Sixteen sutras, sub-sutras, mental calculation, Math Anxiety, accuracy, Computational Speed.

INTRODUCTION

In the Indian K–12 system, mathematics is still one of the most divisive subjects, frequently linked to rote memorization and high levels of stress. Pattern identification and "one-line" mental calculations are key components of Vedic mathematics, which is based on 16 Sutras (formulae). In line with the National Education Policy (NEP) 2020, which promotes indigenous Indian knowledge systems to foster critical thinking in the twenty-first century, this introduction lays forth the necessity of a "Humanistic Mathematics" approach.

Striking a balance between conceptual knowledge and procedural fluency is a problem in mathematics education worldwide. The algorithmic shortness and mnemonic nature of alternative computational frameworks, like Vedic Mathematics, have drawn attention.

Vedic Mathematics, which has its roots in interpretations of ancient Indian texts, offers quick mental computation methods for geometry, algebra, and arithmetic.

Objectives of the Study:

To study how Vedic Mathematics helps students learn better

To see how Vedic Mathematics fits with school curricula

To find out its effect on students' performance and mindset

To understand student's views and perception of Vedic Mathematics

To examine its cultural and educational importance today

Research Methodology:

Vedic Mathematics, derived from ancient Indian texts, offers simplified techniques for arithmetic and algebraic problem-solving. In recent years, educators have debated its relevance in modern classrooms, particularly in terms of improving mathematical skills, reducing anxiety, and connecting students with India's cultural heritage. This study seeks to evaluate its practical utility and acceptance in contemporary Indian education.

Scope of the Study

Focuses on secondary and higher secondary school students

Includes perspectives of students.

Examines academic performance, attitudes toward mathematics, and curriculum integration.

Limited to Indian classrooms, without extending to international contexts.

Data Methodology

Primary Data:

Structured questionnaires for students

Interviews with educators to capture qualitative insights.

Secondary Data:

Review of existing literature, curriculum documents, and prior studies on Vedic Mathematics.

Sampling Method:

Convenience Sample; Google Form

Statistical Tools and Techniques

Descriptive Statistics: Mean, median, standard deviation to summarize student performance and attitudes.

Reliability Testing:

Cronbach's Alpha to measure internal consistency of survey instruments.

Hypothesis Testing:

Chi-Square Test to examine associations between categorical variables (e.g., exposure to Vedic Mathematics and student confidence levels).

H0: Learning Vedic Mathematics is not better than learning traditional classroom

Mathematics.

H1: Learning Vedic Mathematics is better than learning traditional classroom

Mathematics.

Responses	Yes	No
	91.7%	8.3%

REVIEW OF LITERATURE

The integration of Vedic Mathematics into modern Indian classrooms has been widely debated, with recent scholarship highlighting both its pedagogical potential and challenges. In *Vedic Mathematics and The Indian Knowledge System: An Analysis and Dissemination* (Minikumari & Prathibha, 2025), the authors argue that Vedic Mathematics provides culturally rooted computational techniques that can enhance students' arithmetic fluency while reconnecting them with India's intellectual heritage. They emphasize its role in bridging traditional knowledge systems with contemporary education.

Similarly, Raikhola (2024), in *Exploring the Applications and Efficiency of Vedic Mathematics*, demonstrates through comparative analysis that Vedic methods often outperform conventional approaches in speed and accuracy. The study concludes that these techniques can reduce math anxiety and foster confidence among learners, particularly in rural and resource-constrained settings.

Babu Lal, Ali, and Amit (2025), in *Cultivating Mathematical Thinking through Vedic Pedagogy: A Comparative Study of Traditional and Modern Teaching Methods*, highlight how Vedic Mathematics nurtures problem-solving skills and cognitive flexibility. Their findings suggest that classrooms adopting Vedic pedagogy witness improved student engagement and creativity compared to those relying solely on modern methods.

Pradhan (2025), in *From Sutras to Symbols: The Evolution of Mathematical Thought*, situates Vedic Mathematics within a broader historical and philosophical framework. The paper advocates for a complementary integration of Vedic and modern mathematical paradigms, arguing that such synthesis enriches cognitive development and enhances adaptability in diverse learning contexts.

Shirsath and Shukla (2026), in *Learning from the Ancients: A Historical-Pedagogical Analysis of Mathematical Motivation in Modern Classrooms*, explore how ancient mathematical traditions, including Vedic methods, can be leveraged to improve motivation and reduce anxiety in contemporary classrooms. They conclude that embedding Vedic techniques within modern curricula can make mathematics more meaningful and less intimidating for students.

Finally, Bhaisanyan and Sharma (2026), in *Decoding Vedic Knowledge: The Role of Mathematical Sciences in Ancient Indian Thought*, underscore the philosophical depth of Vedic Mathematics, linking it to geometry,

cosmology, and logical reasoning. Their work suggests that beyond computational efficiency, Vedic Mathematics fosters holistic intellectual growth, making it relevant for modern educational reforms.

Explanation of Sutras

The 16 Sutras (formulae) and 13 Upa-Sutras (sub-formulae) form the backbone of Vedic Mathematics. They are essentially cognitive shortcuts that allow for "one-line" mental calculations.

Below is an explanation of the primary Sutras and key Sub-Sutras with practical examples.

The 16 Main Sutras

	Sutra (Sanskrit)	English Meaning	Practical Application
1	Ekadhikena Purvena	By one more than the previous one	Squaring numbers ending in 5.
2	Nikhilam Navatashcaramam Dashatah	All from 9 and the last from 10	Fast subtraction from powers of 10.
3	Urdhva-Tiryagbhyam	Vertically and Crosswise	General multiplication for any size.
4	Paravartya Yojayet	Transpose and Apply	Solving equations and division.
5	Sunyam Samyasamuccaye	When the Sum is Same, it is Zero	Solving complex algebraic equations.
6	Anupyaena	(If) In Proportion	Solving ratio-based problems.
7	Sankalana-Vyavakalanabhyam	By Addition and Subtraction	Solving simultaneous linear equations.
8	Puranapuranaabhyam	By Completion or Non-completion	Simplifying fractions or expressions.
9	Chalana-Kalanabhyam	Differences and Similarities	Calculus and algebraic factoring.
10	Yavadunam	Whatever the Extent of Deficiency	Squaring numbers near a base.
11	Vyastisamatish	Part and Whole	Coordinate geometry and factoring.
12	Shesanyakena Gena	Remainder by the Last Digit	Decimal conversions.
13	Sopantyadvayamantyam	The Ultimate and Twice the Penultimate	Specialized algebraic solving.
14	Ekanyunena Purvena	By One Less than the Previous	Multiplication by series of 9s.
15	Gunitasamuccayah	Product of the Sum	Verification of algebraic products.
16	Gunakasamuccayah	Factors of the Sum	Verification of algebraic factors.

The 13 Sub-Sutras (Upa-Sutras)

While the main Sutras provide the logic, the Sub-Sutras offer specific tactical advantages:

1. Anurupyena: Used for numbers near a common ratio (e.g., multiplication near 50, which is half of 100).
2. Sisya Sesasamjnah: Relates to the remainder in division.
3. Adyamadyenantyamantyena: "First by first and last by last."
4. Kevalaih Saptakam Gunyat: Specific to the number 7.
5. Vestanam: Used in checking divisibility.
6. Yavadunam Tavadunam: Used for squaring numbers below a base (e.g., 982).
7. Yavadunam Tavadunikritya Varganca Yojayet: Square the deficiency and append.
8. Antyayordashake'pi: Used when the last digits sum to 10 and the previous are the same (e.g., 42×48).
9. Antyayoreva: Used in finding the last digit of a result.
10. Samuccayagunitah: Used in higher-order algebra.
11. Lopanasthapanabhyam: Used in elimination and retention (factoring).
12. Vilokanam: "By Mere Observation"—finding roots of numbers visually.

13. Gunitasamuccayah Samuccayagunitah: Check of products/factors.

Most of these sutras rely on converting a complex problem into two smaller, simpler parts (Left-hand side and Right-hand side). This reduces the cognitive load on students, making them feel like "human calculators."

Conceptual Classification

Domain	Relevant Sutras
Arithmetic	Nikhilam, Urdhva-Tiryagbhyam, Yavadunam
Algebra	Sankalana-Vyavakalanabhyam, Gunitasamuchyah
Division	Paravartya Yojayet, Dhvajanka
Factorization	Sopantyadvayamantyam

Data Analysis and Review of Literature

60 Students who have learnt Vedic Mathematics were part of our research. These students expressed their opinion on Vedic Mathematics.

Majority of the Respondents (93.33%) felt that Vedic Mathematics is easier to learn as compared to traditional classroom Mathematics.

76.67% of the respondents believe that Vedic Mathematics teaches faster calculations.

Testing of Hypothesis:

H₀ (Null): Learning Vedic Mathematics is not better than traditional classroom Mathematics.

H₁ (Alternative): Learning Vedic Mathematics is better than traditional classroom Mathematics

Yes (Vedic is better): 93.33%

No (Not better): 6.67%

Total No. of Responses: 60

Now total **observed value** = 60

Yes (93.33%)

$$93.33\% \times 60 = 0.9333 \times 60 = 56$$

No (6.67%)

$$6.67\% \times 60 = 0.0667 \times 60 = 4$$

So, observed (O):

Yes = 56

No = 4

Total = 60

Assuming equal distribution (50% – 50%):

Expected Yes = 30

Expected No = 30

The chi-square statistic is: $\chi^2 = \sum (O - E)^2 / E$

For Yes: $(56 - 30)^2 / 30 = 26^2 / 30 = 676 / 30 = 22.53$

For No: $(4 - 30)^2 / 30 = (-26)^2 / 30 = 676 / 30 = 22.53$

$$\chi^2 = 22.53 + 22.53 = 45.06$$

$$\chi^2 \approx 45.06$$

Critical value at 0.05 level = 3.84

Since **45.06 > 3.84**, the result is **highly significant**.

This means the difference is statistically significant.

Chi-square statistic $\chi^2 = 45.06$

Significance level $\alpha = 0.05$ (5% level)

Degrees of freedom (df) = 1

Critical Value

At significance level (0.05), the critical value for (df = 1) is **3.84**.

Since chi square value is greater than Critical value, the null hypothesis is rejected.

Therefore, Learning Vedic Mathematics is better than traditional classroom Mathematics

Cronbach's Alpha (α) is a statistical measure used to check the internal consistency or reliability of a set of questionnaire items or scale.

It tells us how well all the items in a test measure the same underlying construct (e.g. opinion on the sustainability aspect, rural development, experience at Agritourism and so on)

High α - Items are consistent and reliable

Low α - Items do not measure the same concept well

Formula for Cronbach's Alpha

$$\alpha = \frac{k}{k-1} \left(\frac{\text{Variance of total scores} - \text{sum of individual item variance}}{\text{variance of total scores}} \right)$$

Where, k = Number of items.

Table 1: Interpretation of Cronbach's Alpha Values

α Value	Level of Reliability
0.90 – 1.00	Excellent
0.80 – 0.89	Good
0.70 – 0.79	Acceptable
0.60 – 0.69	Questionable
0.50 – 0.59	Poor
Below 0.50	Unacceptable

No of items (k)	5
Sum of the Items variance	4.950565
Variance for total score of all respondents	12.39407

The Cronbach's Alpha (α) is 0.750712

This means that the internal reliability of the data is Acceptable.

Paired Samples t-Test Analysis

To determine whether there is a significant difference in students' performance **before and after learning Vedic Mathematics**.

Null Hypothesis (H_0): There is no significant difference in performance before and after Vedic Mathematics.

Alternative Hypothesis (H_1): There is a significant difference in performance before and after Vedic Mathematics.

A **Paired Samples t-test** was conducted because the same participants (n = 60) were tested twice (before and after the intervention)

Mean difference (After – Before) = **1.60**

Standard deviation of differences = **2.38**

Sample size (n) = **60**

This indicates that, on average, students scored **1.60 marks higher** after learning Vedic Mathematics.

$$t = \frac{\frac{\bar{d}}{SD_d}}{\frac{1}{\sqrt{n}}} = \frac{\frac{1.60}{2.38}}{\frac{1}{\sqrt{60}}} \approx 5.21$$

Degrees of freedom:

$$Df = n-1 = 59$$

Critical t-value at $\alpha = 0.05$ (two-tailed, $df = 59$) ≈ 2.00

Calculated t-value = **5.21**

Since **5.21** > **2.00**, we reject the null hypothesis.

Also, **p-value** < **0.001**, which indicates a highly significant result.

There is a **statistically significant improvement** in students' performance after learning Vedic Mathematics.

The positive mean difference (1.60) shows that the intervention had a **positive effect on students' scores**.

The paired sample t-test revealed that students' post-test scores (M difference = 1.60, SD = 2.38) were significantly higher than their pre-test scores, $t(59) = 5.21$, $p < 0.001$. Therefore, the null hypothesis was rejected, indicating that Vedic Mathematics significantly improved students' performance.

NEP 2020 emphasizes:

Experiential and competency-based learning

Conceptual understanding over rote memorization

Integration of traditional mathematical knowledge

Promotion of mathematical thinking from early grades

Use of Indian examples and historical context in teaching

The policy encourages including Indian mathematical heritage in textbooks to inspire students and connect them with their cultural roots.

Integrating IKS into mathematics education:

Enhances conceptual clarity

Develops analytical and critical thinking

Promotes cultural identity and pride

Encourages innovation rooted in tradition

Makes learning more meaningful and contextual

The National Education Policy 2020 recognizes the importance of the Indian Knowledge System in shaping a holistic and culturally grounded education system. By integrating ancient Indian mathematical contributions with modern pedagogy, NEP 2020 aims to create learners who are both globally competent and deeply rooted in India's intellectual heritage.

Future Extent

1. Integration with adaptive learning systems powered by AI.
2. Studies that compare different cultures.
3. Research using neurocognitive imaging to evaluate patterns of brain activity.
4. Use in algorithm design and cryptography.
5. Creation of modules for a uniform curriculum.
6. Digital Learning: Creating gamified, AI-powered applications that use adaptive learning to teach Vedic Sutras.
7. Teacher Training: Standardizing Vedic Math instruction to prevent "trick-based" superficial learning through the creation of B.Ed. (Bachelor of Education) courses.
8. Special Education: Examining how Vedic mathematics affects kids with ADHD or dyscalculia.

LIMITATIONS AND DRAWBACKS

1. There is little historical evidence that directly connects sutras to old Vedic writings.
2. Procedural speed is prioritized above conceptual depth.
3. Application is mostly limited to basic algebra and arithmetic.
4. The danger of mechanical learning devoid of mathematical reasoning.
5. Inability to standardize educational methods globally.
6. The "Trick" Trap: Instead of comprehending the underlying algebraic logic ($a^2 - b^2$, etc.), students may perceive Vedic Math as a collection of "magic tricks."
7. Curriculum Overload: Students may become burned out if new systems are added to an already packed Indian school program.
8. Standardization: Instructional quality varies due to the absence of a consistent "Vedic Math" syllabus.
9. Formal Proofs: The "step-by-step" marks-earning procedure needed for the Board Exams (CBSE/ICSE) is sometimes omitted from Vedic approaches.

CONCLUSION

According to the study, Vedic mathematics considerably lowers the cognitive strain associated with arithmetic and improves computational fluency. It does not, however, automatically enhance higher-order mental reasoning. Conventional mathematics schooling should therefore be supplemented, not replaced, by Vedic methods. It is advised to use a mixed learning architecture that strikes a balance between conceptual rigor and speed algorithms.

Rather than being a stand-alone mathematical system, Vedic Mathematics has educational significance as a tool for cognitive acceleration.

According to the study's findings, Vedic mathematics is a powerful driver of mathematical literacy in India. Its use as a "mental lubricant" is indisputable, but it shouldn't take the place of contemporary calculus or geometry. It is a very useful tool for the contemporary Indian classroom since it lessens the fear of big numbers and promotes a more positive mathematical temperament.

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INDIAN KNOWLEDGE MANAGEMENT AND YOUTH EMPLOYABILITY- A CONCEPTUAL FRAMEWORK FOR HOLISTIC DEVELOPMENT

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shalini.cbs@cscollege.co.in**ABSTRACT**

In the contemporary knowledge-driven economy, employability and holistic development of youth have emerged as critical national priorities. While modern education emphasizes technical skills and market-oriented competencies, it often overlooks ethical grounding, emotional intelligence, and holistic personality development. Indian Knowledge Management (IKM), rooted in Indian Knowledge Systems (IKS), offers an integrated framework encompassing cognitive, moral, spiritual, social, and professional development. This paper explores the contribution of Indian Knowledge Management in fostering holistic development and enhancing employability among Indian youth. Using a qualitative and analytical research approach based on secondary sources, the study examines traditional Indian knowledge practices related to education, leadership, skill development, ethics, and self-management. The findings suggest that Indian Knowledge Management significantly contributes to employability by nurturing values-based competencies, adaptability, lifelong learning, and sustainable professional skills. The paper concludes that integrating Indian Knowledge Management into modern education and training systems can bridge the employability gap while ensuring holistic youth development.

Keywords: Indian Knowledge Management, Employability, Holistic Development, Indian Youth, Indian Knowledge Systems, NEP 2020

1. INTRODUCTION

A conceptual framework linking Indian Knowledge Systems (IKS) with youth employability focuses on integrating traditional wisdom—such as values-based leadership, ethical governance, and critical thinking—with modern skill sets. This holistic approach balances academic rigor with cultural identity to foster adaptable, ethical, and socially conscious professionals.

Indian Knowledge Management (IKM), derived from Indian Knowledge Systems, offers a time-tested framework for managing knowledge, skills, values, and human potential in an integrated manner. Ancient Indian education emphasized *Jnana* (knowledge), *Karma* (action), *Bhakti* (values), and *Yoga* (self-discipline), aiming at complete human development. Indian Knowledge Systems encompass a vast array of traditional knowledge encompassing disciplines such as philosophy, mathematics, astronomy, medicine, linguistics, arts, and governance. Rooted in ancient texts like the Vedas, Upanishads, and Puranas, IKS offers a holistic approach to understanding the universe and human existence. It emphasizes values like sustainability, ethics, and community well-being, providing timeless insights that remain relevant in contemporary times.

This paper examines how Indian Knowledge Management contributes to holistic development and employability of Indian youth in the modern era.

2 -LITERATURE REVIEW**2.1 Employability and Holistic Development of Youth**

Employability has undergone a significant conceptual shift over the past two decades. Earlier studies viewed employability primarily as the possession of technical and job-specific skills; however, contemporary research defines employability as a multidimensional construct incorporating skills, personal attributes, adaptability, and lifelong learning capabilities. Yorke (2006) describes employability as a set of achievements, understandings, and personal attributes that enhance an individual's likelihood of gaining and maintaining employment. Similarly, Fugate, Kinicki, and Ashforth (2004) emphasize employability as a psychosocial construct involving career identity, personal adaptability, and social capital.

Recent studies highlight that employers increasingly seek graduates who demonstrate emotional intelligence, ethical judgment, communication skills, and problem-solving ability in addition to academic qualifications (Clarke, 2018; Jackson, 2014). The World Economic Forum (2020) identifies critical thinking, resilience, adaptability, and self-management as essential future skills, reinforcing the importance of holistic development in employability discourse.

Holistic development integrates intellectual, emotional, social, moral, and physical dimensions of personality. Research indicates that youth who receive holistic education exhibit higher levels of confidence, leadership, stress tolerance, and workplace readiness (Goleman, 1998; Heckman & Kautz, 2012). However, conventional education systems—particularly in developing economies—continue to prioritize examination performance over holistic competency development, resulting in a persistent employability gap among graduates.

2.2 Indian Youth and Employability Challenges

India possesses a demographic advantage with a large youth population, yet employability remains a pressing concern. Studies reveal that a substantial proportion of Indian graduates lack industry-relevant skills, communication ability, and professional orientation (NASSCOM, 2019). The skill mismatch between higher education outcomes and labor market expectations has been widely documented (Mehrotra & Parida, 2019).

Researchers argue that employability challenges among Indian youth are not merely technical but also behavioral and attitudinal in nature (Tilak, 2018). Lack of ethical grounding, emotional resilience, adaptability, and self-awareness often hinders long-term career growth. This has led scholars to advocate alternative educational frameworks that integrate values, self-management, and experiential learning alongside skill development.

2.3 Indian Knowledge Systems and Education

Indian Knowledge Systems (IKS) represent a comprehensive epistemological framework rooted in ancient Indian philosophical, scientific, and cultural traditions. Unlike Western knowledge paradigms that emphasize compartmentalized learning, IKS adopts a holistic approach integrating knowledge (*Jnana*), action (*Karma*), values (*Dharma*), and self-discipline (*Yoga*) (Sharma, 2017).

Ancient Indian education, as reflected in the Gurukul system, emphasized character formation, ethical conduct, inquiry-based learning, and close mentorship between teacher and student (Altbach, 2014). The objective of education was not merely economic productivity but the realization of human potential and social responsibility. Scholars argue that such an integrated approach aligns closely with contemporary holistic and learner-centered educational theories (Radhakrishnan, 1951).

Recent empirical studies demonstrate that practices derived from Indian philosophy—such as Yoga, meditation, mindfulness, and value education—positively impact cognitive functioning, emotional regulation, and moral reasoning among students (Rao & Paranjpe, 2016; Singh, 2020). These findings suggest that IKS-based pedagogies can address several shortcomings of modern education systems.

2.4 Indian Knowledge Management: Concept and Relevance

Indian Knowledge Management (IKM) extends the principles of Indian Knowledge Systems into structured processes of knowledge creation, transmission, application, and ethical utilization. Unlike Western knowledge management models, which primarily focus on organizational efficiency and competitive advantage (Nonaka & Takeuchi, 1995), IKM emphasizes wisdom, values, social harmony, and long-term well-being.

Concepts such as *Swadhyaya* (self-learning), *Karma Yoga* (duty-oriented action), and *Seva* (service) function as intrinsic motivators for personal and professional excellence. Gupta (2019) argues that Indian knowledge traditions promote responsible leadership, ethical decision-making, and sustainable organizational practices. These competencies are increasingly valued in contemporary workplaces characterized by uncertainty and ethical complexity.

From an employability perspective, IKM fosters transferable skills such as adaptability, resilience, teamwork, leadership, and self-regulation. Studies on value-based education and ethical leadership indicate that individuals trained under such frameworks demonstrate higher workplace commitment, lower stress levels, and stronger career sustainability (Bhattacharyya, 2018).

2.5 Indian Knowledge Management and Holistic Development

Holistic development is central to Indian Knowledge Management. Indian philosophical traditions view human development as a balanced integration of body, mind, intellect, and spirit. Yoga and meditation practices enhance concentration, emotional stability, and mental well-being, while ethical teachings cultivate integrity and social responsibility (Iyengar, 2005).

Empirical research supports the positive impact of holistic development on employability outcomes. Emotional intelligence has been found to significantly influence job performance, leadership effectiveness, and career success (Goleman, 1998). Similarly, value-based competencies such as integrity, accountability, and empathy contribute to positive organizational culture and employability longevity.

2.6 Policy Perspective: NEP 2020 and Indian Knowledge Systems

The National Education Policy (NEP) 2020 marks a paradigm shift in Indian education by emphasizing holistic, multidisciplinary, and value-based learning rooted in Indian ethos. The policy explicitly advocates the integration of Indian Knowledge Systems into curricula to foster creativity, ethical reasoning, and lifelong learning (Government of India, 2020).

Scholars view NEP 2020 as a legitimization of IKS and IKM within mainstream education and employability discourse (Kumar & Gupta, 2021). The policy's alignment with Sustainable Development Goals (SDG 4: Quality Education and SDG 8: Decent Work) further reinforces the relevance of Indian Knowledge Management in addressing youth employability challenges.

2.7 Research Gap-

A critical review of existing literature reveals that while extensive research exists on employability skills and holistic education, and a growing body of work examines Indian Knowledge Systems, limited studies integrate Indian Knowledge Management as a structured framework linking holistic development with employability outcomes of Indian youth. Most employability research remains skill-centric, whereas IKS studies often focus on cultural or philosophical dimensions without explicit labor market linkage. This gap highlights the need for a comprehensive conceptual framework connecting Indian Knowledge Management, holistic development, and employability—an objective addressed by the present study.

3. Conceptual Framework of the Study - Concept of Indian Knowledge Management

Indian Knowledge Management refers to the systematic creation, preservation, transmission, and application of knowledge rooted in Indian philosophical, educational, and socio-cultural traditions. Unlike Western knowledge management, which is primarily organizational and performance-driven, Indian Knowledge Management adopts a holistic, ethical, and purpose-driven approach.

Indian Knowledge Management → Holistic Development → Enhanced Employability Outcomes

Explanation of the Framework

The conceptual framework proposes that Indian Knowledge Management acts as the foundational input influencing the holistic development of Indian youth. Holistic development—covering intellectual, emotional, ethical, physical, and spiritual dimensions—functions as a mediating variable that ultimately enhances employability outcomes such as skills, adaptability, ethical professionalism, and career sustainability.

Key Features of Indian Knowledge Management

- Integration of knowledge, skills, values, and ancient wisdom
- Emphasis on experiential and reflective learning
- Ethical and social responsibility
- Self-management and inner development
- Sustainability and collective well-being

Indian texts such as the *Upanishads*, *Bhagavad Gita*, *Arthashastra*, and *Panchatantra* reflect structured knowledge management practices applicable to education, leadership, governance, and skill development.

3. Holistic Development: An Indian Perspective

Holistic development in Indian thought encompasses multiple dimensions:

3.1 Intellectual Development

Indian education traditions emphasized critical thinking, debate (*Shastrartha*), inquiry, and logical reasoning, fostering deep conceptual understanding rather than rote learning.

3.2 Emotional and Psychological Development

Practices like Yoga, meditation, and self-reflection cultivate emotional stability, resilience, and mental well-being—essential qualities for today's competitive work environment.

3.3 Moral and Ethical Development

Values such as *Dharma* (righteousness), *Satya* (truth), and *Seva* (service) guide ethical conduct and social responsibility, crucial for sustainable careers.

3.4 Physical and Spiritual Development

Balanced physical health and spiritual awareness promote discipline, focus, and purpose-driven living.

Indian Knowledge Management integrates all these dimensions, leading to well-rounded individuals.

4. Employability and Indian Youth: Contemporary Challenges

Despite academic qualifications, Indian youth face employability challenges such as:

- Skill mismatch between education and industry requirements
- Poor communication and leadership skills
- Lack of adaptability and problem-solving abilities
- Ethical lapses and workplace stress
- Limited emotional intelligence

Modern employers increasingly value holistic competencies such as teamwork, integrity, creativity, adaptability, and lifelong learning—areas where Indian Knowledge Management offers valuable insights.

5. Contribution of Indian Knowledge Management to Employability

Table 5.1: Components of Indian Knowledge Management

Component	Description	Relevance to Youth Development
Jnana (Knowledge)	Intellectual and conceptual understanding	Enhances critical thinking and problem-solving
Karma (Action)	Skill-oriented and experiential learning	Builds practical competence and work readiness
Dharma (Values)	Ethical and moral conduct	Promotes integrity and responsible behavior
Yoga (Self-discipline)	Mental, emotional, and physical balance	Improves focus, resilience, and well-being
Seva (Service)	Social responsibility and community engagement	Develops empathy and leadership

Table 5.2 : Dimensions of Holistic Development in Indian Knowledge Systems

Dimension	Indian Perspective	Employability Relevance
Intellectual	Inquiry, debate, reflection	Analytical and decision-making skills
Emotional	Mindfulness, self-awareness	Emotional intelligence, stress management
Moral/Ethical	Dharma, Satya, Karma Yoga	Workplace ethics and professionalism
Physical	Discipline, balance, health	Energy, productivity, endurance
Spiritual	Purpose, self-realization	Motivation, commitment, career clarity

Table5.3: Employability Skills Developed through Indian Knowledge Management

Employability Skill	IKM Source	Outcome for Youth
Communication	Storytelling, debates, discourse	Effective expression and persuasion
Leadership	Arthashastra, Bhagavad Gita	Ethical and strategic leadership
Teamwork	Collective learning, Seva	Collaboration and cooperation
Adaptability	Swadhyaya (self-learning)	Lifelong learning capability
Stress Management	Yoga and meditation	Mental resilience at workplace

Table 5.4: Comparison of Conventional Skill Development and Indian Knowledge Management

Aspect	Conventional Skill Development	Indian Knowledge Management
Focus	Job-oriented skills	Life and career-oriented development
Learning Approach	Classroom and assessment-based	Experiential and reflective
Ethical Training	Limited or optional	Core component
Emotional Development	Often ignored	Integral part

Aspect	Conventional Skill Development	Indian Knowledge Management
Career Outcome	Short-term employability	Sustainable and meaningful careers

5.1 Skill Development and Lifelong Learning

Indian Knowledge Management promotes continuous learning through self-study (*Swadhyaya*), mentorship (*Guru-Shishya Parampara*), and experiential learning. This enhances adaptability and lifelong employability.

5.2 Leadership and Decision-Making Skills - Texts like the *Bhagavad Gita* and *Arthashastra* provide profound insights into leadership, duty, strategic thinking, and ethical decision-making, highly relevant for managerial and professional roles.

5.3 Work Ethics and Professional Values - Indian Knowledge Management emphasizes *Karma Yoga*—performing duties with commitment and detachment from outcomes. This instills professionalism, accountability, and stress management.

5.4 Communication and Interpersonal Skills - Traditional storytelling, debates, and collaborative learning methods enhance communication, persuasion, and teamwork skills essential for employability.

5.5 Emotional Intelligence and Mental Resilience - Yoga and mindfulness practices rooted in Indian knowledge traditions improve concentration, emotional regulation, and resilience, helping youth manage workplace stress and uncertainty.

6. Role of Indian Knowledge Management in Sustainable Careers - A sustainable career refers to a career path that enables individuals to maintain employability, well-being, and productivity across different stages of life while contributing positively to society and the environment. In this context, Indian Knowledge Management (IKM) provides a holistic framework that integrates knowledge, values, and personal development, thereby supporting the development of sustainable careers among youth.

Indian Knowledge Management is rooted in the philosophical foundations of Indian Knowledge Systems, which emphasize the integration of intellectual knowledge (*Jnana*), action-oriented learning (*Karma*), ethical responsibility (*Dharma*), and self-discipline (*Yoga*). Unlike conventional knowledge management models that primarily focus on organizational performance and knowledge sharing, IKM promotes a balanced approach that combines professional competence with ethical and social awareness. This integrated perspective prepares individuals to navigate complex professional environments while maintaining personal well-being and moral integrity.

Indian Knowledge Management encourages purpose-driven careers aligned with social welfare and sustainability. Youth trained under this framework are more such as -

- Engage in ethical entrepreneurship
- Contribute positively to organizational culture
- Support sustainable development goals
- Demonstrate long-term career commitment.
- This aligns employability with societal and national development.

7. Policy Support and Institutional Initiatives- The Government of India has recognized the importance of Indian Knowledge Systems:

1. **National Education Policy 2020** emphasizes holistic, multidisciplinary education
2. Establishment of **IKS Division** under the Ministry of Education
3. Integration of Yoga, ethics, and value education in curricula
4. Skill development initiatives aligned with indigenous knowledge

Above initiatives provide institutional support for embedding Indian Knowledge Management into education and employability frameworks.

8. Challenges in Integrating Indian Knowledge Management -:

- Limited empirical research and documentation
- Perception of IKS as non-scientific

- Inadequate trained faculty
- Curriculum overload
- Need for contextual modernization

9. Conclusion

Indian Knowledge Management offers a powerful framework for nurturing holistic development and enhancing employability of Indian youth. By integrating intellectual, emotional, ethical, and practical dimensions, it prepares youth not merely for jobs but for meaningful and sustainable careers. In the era of rapid technological and social change, Indian Knowledge Management provides timeless principles adaptable to modern professional contexts. Its integration into education and training systems can transform India's demographic dividend into a globally competent and ethically grounded workforce. Indian Knowledge Management fosters **self-discipline and lifelong learning**, which are essential for sustained personal growth. Traditional texts and philosophical teachings emphasize continuous self-improvement and reflective thinking, encouraging learners to develop self-awareness and intrinsic motivation. These attributes are central to holistic development as they support intellectual curiosity, emotional maturity, and personal resilience.

From a theoretical perspective, the principles of Indian Knowledge Management align with **holistic education theories**, which advocate integrated learning experiences that address cognitive, emotional, and moral dimensions simultaneously. By embedding ethical values, experiential learning, and self-regulation practices within educational processes, IKM creates an environment that supports comprehensive student development.

10. Future Scope and Recommendations -. In the context of rapidly evolving labor markets and increasing emphasis on holistic competencies, higher education institutions and policymakers must adopt strategic initiatives to effectively embed Indian Knowledge Systems (IKS) within employability frameworks. The following recommendations outline potential directions for future development and research.

1. Integration of Indian Knowledge Management into Skill Development Programs

Programs aimed at youth employability can include elements such as ethical decision-making, self-discipline, reflective learning, and emotional intelligence derived from Indian philosophical traditions. Such integration can create well-rounded professionals who possess not only technical expertise but also interpersonal skills, ethical awareness, and adaptability required in modern workplaces.

2. Development of Employability-Oriented IKS Modules

Educational institutions should design structured curriculum modules that translate the principles of Indian Knowledge Systems into practical learning experiences aligned with employability competencies. These modules may include topics such as value-based leadership, mindfulness and stress management, ethical management practices, and sustainable decision-making.

3. Strengthening Industry–Academia Collaboration

Collaboration between academic institutions and industry partners is essential for aligning educational practices with real-world skill requirements. Industry participation in curriculum development, internships, mentoring programs, and project-based learning can ensure that Indian Knowledge Management principles are applied within professional contexts. Such partnerships can help students understand how value-based decision-making, ethical leadership, and holistic thinking contribute to organizational effectiveness and sustainable career development.

4. Encouraging Empirical and Research-Based Validation of IKS Practices

Although the theoretical foundations of Indian Knowledge Systems highlight their potential benefits, there remains a need for rigorous empirical research to validate their impact on employability and holistic development. Future studies should employ quantitative and qualitative research methods, including Structural Equation Modeling (SEM), longitudinal studies, and experimental designs, to examine the effectiveness of IKM-based educational interventions. Empirical validation will strengthen the academic credibility and global acceptance of Indian knowledge traditions within modern educational frameworks.

5. Development of Assessment Frameworks for Holistic Competencies

Traditional evaluation systems in higher education often emphasize academic performance while overlooking holistic competencies such as emotional intelligence, ethical awareness, resilience, and social responsibility. Educational policymakers and institutions should therefore develop comprehensive assessment frameworks that measure these multidimensional skills. Such frameworks can include reflective assessments, behavioral evaluations, experiential learning outcomes, and competency-based evaluation tools that capture the broader developmental impact of Indian Knowledge Management practices.

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THE ROLE OF INDIAN KNOWLEDGE SYSTEMS (IKS) IN THE DEVELOPMENT AND SUSTAINABILITY OF MICRO, SMALL, AND MEDIUM ENTERPRISES (MSMEs)

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ABSTRACT

The Indian Knowledge System (IKS) represents a vast body of indigenous knowledge developed over thousands of years encompassing philosophy, science, medicine, agriculture, governance, and sustainable living. In recent years, there has been growing interest in integrating traditional knowledge with modern economic systems to promote sustainable development and entrepreneurship. Micro, Small and Medium Enterprises (MSMEs) play a vital role in the Indian economy by contributing significantly to employment generation, innovation, and regional development. This research paper explores the relationship between the Indian Knowledge System and MSME development, focusing on how traditional knowledge, ethical frameworks, and indigenous practices can support sustainable entrepreneurship, innovation, and inclusive economic growth. The study highlights the role of traditional sectors such as handicrafts, Ayurveda-based industries, agriculture, and eco-friendly production systems in strengthening MSMEs. It also discusses government initiatives such as Atmanirbhar Bharat and policy support for promoting indigenous knowledge and entrepreneurship. The research concludes that integrating Indian Knowledge Systems with MSME development can foster sustainable business models, enhance cultural preservation, and contribute to global competitiveness.

Keywords: Indian Knowledge System, MSMEs, Sustainable Development, Indigenous Knowledge, Entrepreneurship, Atmanirbhar Bharat.

1. INTRODUCTION

India has a rich intellectual heritage that spans thousands of years and includes disciplines such as mathematics, astronomy, medicine, architecture, agriculture, philosophy, and governance. This vast repository of traditional wisdom is collectively known as the Indian Knowledge System (IKS). The system reflects a holistic worldview that emphasizes harmony between humans, nature, and society while integrating ethical values and practical knowledge. (International Journal of Social Impact)

In contemporary times, globalization and technological advancements have transformed economic activities and business structures. However, modern development models often neglect traditional knowledge systems that are rooted in sustainability, ethics, and community welfare. Integrating IKS with modern economic frameworks offers a unique opportunity to build sustainable and culturally rooted development models.

Micro, Small and Medium Enterprises (MSMEs) are the backbone of the Indian economy. They contribute significantly to industrial production, employment generation, exports, and regional development. MSMEs are especially important in rural and semi-urban areas where they support local livelihoods and preserve traditional skills.

The convergence of Indian Knowledge Systems and MSME development can create innovative and sustainable business models that integrate traditional wisdom with modern technology. This paper examines the role of IKS in strengthening MSMEs and promoting sustainable entrepreneurship in India.

In India, many MSMEs are closely connected to traditional knowledge and cultural heritage. Industries such as handloom weaving, handicrafts, herbal medicine, organic farming, and traditional food processing are deeply rooted in indigenous knowledge systems. These sectors rely on skills and practices that have been passed down through generations and represent an important link between traditional knowledge and modern economic activities.

The integration of Indian Knowledge Systems with MSME development can play a significant role in promoting sustainable entrepreneurship. Traditional knowledge provides valuable insights into resource management, eco-friendly production methods, and community-based economic practices. MSMEs can utilize these insights to develop innovative products, improve sustainability, and enhance competitiveness in both domestic and international markets. Furthermore, the global demand for natural, eco-friendly, and culturally authentic products has increased significantly in recent years.

In this context, studying the role of Indian Knowledge Systems in the development and sustainability of MSMEs is highly relevant. Understanding how traditional knowledge can support entrepreneurship, innovation,

and sustainable production will help policymakers, researchers, and entrepreneurs develop strategies for inclusive and sustainable economic growth. This research paper therefore explores the relationship between Indian Knowledge Systems and MSMEs and examines how their integration can contribute to sustainable development, cultural preservation, and economic prosperity.

2. CONCEPT OF INDIAN KNOWLEDGE SYSTEM (IKS)

2.1 Meaning and Definition

The Indian Knowledge System refers to the collective body of knowledge developed in the Indian subcontinent through centuries of observation, experimentation, and philosophical reflection. It includes diverse fields such as Ayurveda, Yoga, Vedic mathematics, agriculture, metallurgy, architecture (Vastu Shastra), governance (Arthashastra), and ecological management.

IKS is characterized by its holistic and interdisciplinary approach to knowledge. It emphasizes the interconnectedness of nature, society, and human life and promotes ethical values such as Dharma (duty), Ahimsa (non-violence), and Lokasamgraha (welfare of society). (IJIERM Journal)

2.2 Features of Indian Knowledge System

The Indian Knowledge System possesses several distinctive characteristics:

1. **Holistic Approach** – It integrates physical, spiritual, and social aspects of life.
2. **Sustainability** – Traditional practices emphasize ecological balance and sustainable resource use.
3. **Community-Based Knowledge** – Knowledge is often transmitted through communities and traditional occupations.
4. **Ethical Orientation** – Moral values such as duty, justice, and welfare guide decision-making.
5. **Practical Application** – Knowledge is applied in daily life, agriculture, medicine, and crafts.

These characteristics make IKS relevant for modern sustainable development and business innovation.

3. OVERVIEW OF MSMEs IN INDIA

3.1 Definition of MSMEs

Micro, Small and Medium Enterprises (MSMEs) are business enterprises categorized based on investment and turnover. They include manufacturing, service, and trading units operating at different scales.

MSMEs play a crucial role in India's economic development by supporting entrepreneurship, innovation, and employment generation.

3.2 Importance of MSMEs

MSMEs contribute significantly to the Indian economy in several ways:

- Employment generation for millions of people
- Contribution to GDP and industrial output
- Promotion of rural and regional development
- Encouragement of innovation and entrepreneurship
- Preservation of traditional industries such as handicrafts and textiles

These enterprises serve as engines of inclusive economic growth, particularly in developing economies like India.

3.3 Challenges Faced by MSMEs

Despite their importance, MSMEs face multiple challenges such as:

- Limited access to finance
- Lack of technological innovation
- Market competition from large corporations
- Limited research and development
- Inadequate infrastructure

Integrating Indian Knowledge Systems into MSME operations can help overcome some of these challenges by promoting local resources, traditional skills, and sustainable practices.

4. Linkage between Indian Knowledge Systems (IKS) and MSMEs

The **Indian Knowledge System (IKS)** represents a rich body of traditional knowledge developed through centuries of observation, experimentation, and cultural practices. This knowledge covers diverse areas such as agriculture, medicine, architecture, metallurgy, textiles, crafts, and environmental management. Micro, Small and Medium Enterprises (MSMEs) in India often operate in sectors that are closely connected to these traditional knowledge systems. As a result, the integration of IKS with MSMEs plays a significant role in promoting sustainable entrepreneurship, innovation, and inclusive economic growth.

1. Preservation of Traditional Skills and Industries

Many MSMEs in India are based on traditional skills that have been passed down through generations. Industries such as handloom weaving, handicrafts, pottery, metalwork, and natural dyeing rely heavily on indigenous knowledge and craftsmanship. By supporting MSMEs in these sectors, Indian Knowledge Systems help preserve cultural heritage while providing employment opportunities to local communities. The continuity of these traditional skills ensures that valuable knowledge is not lost and remains economically viable in modern markets.

2. Sustainable Resource Utilization

One of the key principles of Indian Knowledge Systems is sustainability. Traditional practices emphasize the responsible use of natural resources and the maintenance of ecological balance. For example, indigenous agricultural practices promote crop rotation, organic fertilizers, and water conservation techniques.

MSMEs that adopt these practices can produce environmentally friendly goods while reducing production costs and environmental impact. This approach aligns with global trends toward sustainable and eco-friendly production.

3. Promotion of Indigenous Innovation

Indian Knowledge Systems provide a strong foundation for innovation. Many modern products and technologies are inspired by traditional knowledge and practices. For instance, herbal medicine, natural cosmetics, and organic food products are based on traditional Indian practices.

MSMEs often play a crucial role in transforming these traditional practices into commercially viable products. By combining indigenous knowledge with modern technology, small enterprises can create innovative solutions that address contemporary market demands.

4. Community-Based Entrepreneurship

Traditional knowledge in India is often community-based, meaning it is collectively developed and shared among members of a particular community or profession. This knowledge system encourages cooperative work structures and local entrepreneurship.

MSMEs that operate within such communities benefit from shared skills, local resources, and collective learning. This model promotes inclusive economic development by supporting rural and marginalized communities.

5. Role of IKS in Strengthening MSMEs

5.1 Promotion of Sustainable Production

Traditional Indian practices emphasize sustainability and ecological balance. For example, traditional agriculture promotes organic farming methods that reduce environmental damage and increase soil fertility.

MSMEs can adopt these practices to produce eco-friendly products that are increasingly demanded in global markets.

5.2 Preservation of Traditional Industries

India has a long history of handicrafts, handlooms, and traditional arts that are rooted in indigenous knowledge systems. MSMEs operating in these sectors preserve cultural heritage while generating employment for artisans and rural communities.

5.3 Ethical Business Practices

Ancient Indian texts emphasize ethical business conduct. Concepts such as Dharma (duty), Nyaya (justice), and Artha (prosperity) guide responsible economic activities and long-term value creation. (IJIERM Journal)

Applying these principles in modern MSMEs can enhance transparency, trust, and sustainability.

5.4 Innovation through Traditional Knowledge

Traditional knowledge can inspire modern innovation. For example:

- Ayurvedic medicine industries
- Herbal cosmetics
- Traditional food products
- Eco-friendly packaging

These sectors demonstrate how ancient knowledge can be transformed into modern entrepreneurial opportunities.

6. Government Initiatives Supporting IKS and MSMEs

The Indian government has launched several initiatives to promote indigenous knowledge and MSME development. The **All India Council for Technical Education (AICTE)** established the **Indian Knowledge Systems (IKS) Initiative** to promote research, documentation, and dissemination of traditional Indian knowledge. The initiative focuses on integrating indigenous knowledge in fields such as agriculture, science, engineering, and management into modern education and innovation systems.

Key features include:

- Promotion of interdisciplinary research on Indian knowledge traditions
- Documentation and preservation of traditional knowledge
- Integration of IKS into higher education and technical institutions
- Encouragement of innovation based on traditional technologies

This initiative strengthens the link between traditional knowledge and entrepreneurship, enabling MSMEs to develop products based on indigenous practices.

6.1 Atmanirbhar Bharat

The Atmanirbhar Bharat initiative encourages self-reliance and promotes indigenous industries, local manufacturing, and traditional knowledge-based entrepreneurship.

6.2 National Education Policy (NEP) 2020

NEP 2020 emphasizes the integration of Indian Knowledge Systems into education and research to promote innovation and cultural awareness.

6.3 Startup India and MSME Schemes

Government programs provide financial support, training, and infrastructure to encourage startups and MSME growth.

These initiatives aim to combine traditional knowledge with modern technology and entrepreneurship.

6.4 Atal Innovation Mission (AIM)

The **Atal Innovation Mission**, launched under **NITI Aayog**, promotes innovation and entrepreneurship in India. The mission supports startups, innovators, and MSMEs by establishing innovation labs, incubators, and startup ecosystems. This initiative encourages entrepreneurs to combine **traditional knowledge with modern technology** to create innovative products.

7. Case Studies of IKS-Based MSMEs

7.1 Ayurvedic Industry

The Ayurvedic medicine industry is based on ancient Indian medical knowledge. Many MSMEs produce herbal medicines, health products, and wellness services using traditional formulations.

7.2 Handicraft Industry

India's handicraft sector reflects centuries-old knowledge of artisanship and design. MSMEs in this sector create products such as textiles, pottery, jewelry, and woodwork.

These industries not only generate employment but also preserve cultural traditions.

7.3 Organic Agriculture Enterprises

Traditional agricultural knowledge promotes sustainable farming techniques such as crop rotation, natural fertilizers, and biodiversity conservation.

MSMEs engaged in organic food production have gained global recognition for their eco-friendly products.

7.4. Khadi and Village Industries

Khadi production is one of the most prominent examples of an MSME sector based on Indian traditional knowledge. The spinning and weaving techniques used in Khadi production originate from centuries-old indigenous textile practices. The **Khadi and Village Industries Commission (KVIC)** promotes Khadi-based MSMEs by providing training, financial support, and marketing assistance to rural artisans.

These enterprises generate employment in rural areas and encourage sustainable textile production using natural fibers and eco-friendly processes. Khadi MSMEs also preserve traditional skills while promoting self-reliance and rural entrepreneurship.

7.5 Banarasi Silk Weaving MSMEs

The production of Banarasi silk sarees in **Varanasi** is an important example of a traditional craft industry based on indigenous knowledge. Local artisans use traditional weaving techniques and intricate designs that have been passed down through generations.

Many small weaving units operate as MSMEs and contribute significantly to employment in the region. By combining traditional craftsmanship with modern design and digital marketing, these enterprises have been able to expand their markets and maintain cultural heritage.

8. Challenges in Integrating IKS with MSMEs

Although integrating IKS with MSMEs offers numerous benefits, several challenges exist:

- Lack of documentation of traditional knowledge
- Limited awareness among entrepreneurs
- Insufficient research and development
- Intellectual property protection issues
- Need for technological modernization

Addressing these challenges requires collaboration between researchers, policymakers, and entrepreneurs.

9. FUTURE PROSPECTS

The future of MSMEs in India can be significantly enhanced through the integration of Indian Knowledge Systems. Emerging opportunities include:

- Development of herbal and natural product industries
- Eco-tourism and cultural tourism enterprises
- Sustainable agriculture and food processing
- Digital marketing of traditional products
- Global export of indigenous products

With proper policy support, training, and innovation, IKS-based MSMEs can contribute to sustainable economic growth and global competitiveness.

10. CONCLUSION

The Indian Knowledge System represents a valuable intellectual heritage that offers insights into sustainable living, ethical governance, and holistic development. MSMEs, as engines of economic growth and employment generation, can benefit greatly from integrating traditional knowledge with modern business practices.

By promoting indigenous industries, sustainable production, and ethical entrepreneurship, the combination of IKS and MSME development can contribute to inclusive economic growth and cultural preservation. Government policies, research initiatives, and entrepreneurial innovation will play a crucial role in strengthening this integration.

Ultimately, leveraging Indian Knowledge Systems for MSME development can help India achieve sustainable development goals while preserving its rich cultural heritage.

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INTERDISCIPLINARY RESEARCH IN COMMERCE AND THE INDIAN KNOWLEDGE SYSTEM: INTEGRATING TRADITIONAL WISDOM WITH MODERN COMMERCE EDUCATION

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ABSTRACT

Background: The increasing complexity of business ecosystems and the growing demand for value-based management education have encouraged interdisciplinary approaches in commerce studies. In India, the revival and institutional promotion of the Indian Knowledge System (IKS) provide an opportunity to integrate indigenous economic thought, ethical philosophy, and governance principles into contemporary commerce education. However, systematic academic exploration of this integration remains limited.

Purpose: This study aims to examine the scope and relevance of integrating the Indian Knowledge System into commerce education through an interdisciplinary research framework. It seeks to identify conceptual linkages between traditional Indian economic thought and modern business disciplines, and to assess the potential impact of such integration on ethical leadership, sustainability, and curriculum innovation.

Method: The study adopts a descriptive and exploratory research design. It combines conceptual analysis of classical Indian economic texts—particularly the Arthashastra—with case-based examination of Indian business organizations such as Tata Group and Amul. Additionally, a proposed empirical survey framework is outlined to evaluate perceptions of students and faculty regarding the relevance of IKS in commerce education.

Findings: The analysis indicates strong conceptual alignment between IKS principles—such as Dharma (ethical duty), collective welfare, participatory governance, and sustainable resource management—and modern business concepts including corporate governance, social responsibility, and inclusive growth. Case illustrations demonstrate that Indian enterprises implicitly reflect indigenous ethical and community-centric models. Preliminary empirical expectations suggest positive stakeholder perception toward curriculum integration of IKS.

Implications: The study contributes to interdisciplinary commerce research by positioning IKS as a viable intellectual resource rather than merely a cultural artifact. It offers practical implications for curriculum reform, policy formulation, and leadership development in higher education institutions. Integrating IKS into commerce education may enhance ethical reasoning, contextual sensitivity, and sustainable business orientation among future professionals, thereby aligning academic practice with India's evolving educational and economic priorities.

Keywords: Interdisciplinary Research, Commerce Education, Indian Knowledge System, Arthashastra, Ethical Leadership, Sustainable Business, Curriculum Reform

INDIGENOUS EMOTIONAL INTELLIGENCE FOR LEADERSHIP: INSIGHTS FROM INDIAN EPICS FOR HUMAN RESOURCE DEVELOPMENT

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ABSTRACT

Emotional intelligence (EI) is a foundational capability for effective leadership, yet dominant EI frameworks remain largely grounded in Western epistemologies. This study reconceptualises emotional intelligence through the lens of Indian Knowledge Systems (IKS) by undertaking a qualitative thematic analysis of leadership-oriented characters from the Mahabharata and the Ramayana. Focusing on figures such as Krishna, Arjuna, Rama, Sita, and Hanuman, the study identifies core emotional competencies, including self-awareness, emotional regulation, empathy, moral reasoning, and adaptive decision-making. These competencies are interpreted using IKS principles such as dharma (ethical responsibility), karma (action–consequence), and bhakti (relational devotion). The analysis results in an indigenous emotional intelligence framework that both aligns with and extends beyond dominant Western EI models. The study contributes to leadership and human resource development (HRD) literature by proposing culturally grounded leadership training applications rooted in epic narratives. By integrating ancient Indian wisdom with contemporary EI theory, this research advances decolonised approaches to management education and cross-cultural leadership development.

Keywords: Indigenous Knowledge Systems; Emotional Intelligence; Indian Epics; Leadership Development; Human Resource Development; Decolonising Management; Cross-Cultural Leadership

1. INTRODUCTION

Emotional intelligence (EI) has become a central construct in leadership research, organisational behaviour, and human resource development (HRD), consistently associated with effective decision-making, ethical conduct, interpersonal competence, and organisational performance (Mayer, Salovey & Caruso, 2004; Goleman, 1998). Since its conceptualisation within Western psychology initially by Salovey and Mayer (1990) and later popularised and operationalised by Goleman (1995), EI has been framed as a measurable and trainable leadership capability. Despite its global diffusion, contemporary EI scholarship remains epistemologically narrow, largely privileging Western cognitive-behavioural paradigms while marginalising non-Western and indigenous knowledge traditions (Ashkanasy & Daus, 2005).

This epistemic imbalance has significant implications for leadership development in culturally diverse contexts. Leadership is not a culturally neutral phenomenon; emotional expression, regulation, ethical reasoning, and relational conduct are deeply shaped by socio-cultural, philosophical, and spiritual traditions (Hofstede, 2001; Jackson, 2004). When EI models are universalised without cultural grounding, they risk becoming conceptually constrained and pedagogically ineffective in pluralistic settings. Consequently, recent scholarship in management and HRD has called for culturally responsive and decolonised approaches that recognize indigenous epistemologies as legitimate sources of leadership knowledge (Alcadipani et al., 2012; Banerjee & Prasad, 2008).

Indian Knowledge Systems (IKS) represent one of the world's oldest continuous intellectual traditions, encompassing philosophy, ethics, psychology, pedagogy, and social organization (Radhakrishnan, 1951; Sen, 2005). Core IKS concepts such as *dharma* (ethical responsibility), *karma* (action–consequence), *bhakti* (relational devotion), and yogic self-discipline articulate sophisticated understandings of emotional regulation, moral agency, and social conduct. These ideas are not merely abstract philosophies but are narratively embedded in classical Indian epics, particularly the *Mahabharata* and the *Ramayana*, which have historically functioned as pedagogical tools for moral and emotional education across generations (Hiltebeitel, 2001; Narayan, 2006).

Characters such as Krishna, Arjuna, Rama, Sita, Draupadi, and Hanuman exemplify emotionally and ethically grounded leadership under conditions of conflict, uncertainty, loss, and moral dilemma. Their narratives portray emotional awareness, empathy, restraint, courage, relational intelligence, and moral reasoning—competencies that closely parallel contemporary EI constructs (Mayer et al., 2004). Yet, despite this rich narrative psychology, Indian epics remain underutilized in mainstream leadership and HRD scholarship, which continues to rely predominantly on Western theoretical lineages.

This study addresses this gap by reconceptualizing emotional intelligence through the lens of Indian Knowledge Systems. Using qualitative thematic analysis of selected episodes and characters from the *Mahabharata* and the *Ramayana*, the study identifies emotionally intelligent leadership behaviors embedded in epic narratives and interprets them through both EI theory and IKS philosophy. Rather than treating Indian epics as merely cultural or religious texts, this research positions them as indigenous psychological and leadership resources capable of informing contemporary organisational learning.

By developing an indigenous emotional intelligence framework rooted in IKS, the study contributes to three interrelated domains: emotional intelligence theory, leadership studies, and human resource development practice. It directly responds to calls for decolonised management education by demonstrating how non-Western epistemologies can generate rigorous, relevant, and globally meaningful leadership models (Alcadipani et al., 2012). In doing so, it offers both theoretical advancement and practical guidance for culturally grounded leadership development in increasingly diverse organisational contexts. This study aligns closely with the journal's focus on leadership, human resource development, culture, and ethics. By integrating emotional intelligence with indigenous knowledge systems, the paper addresses current debates on cross-cultural leadership, decolonised management, and culturally responsive HRD. The findings offer both theoretical advancement and practical relevance for scholars and practitioners interested in leadership in diverse and non-Western contexts.

2. LITERATURE REVIEW

2.1 Leadership Capability of Emotional Intelligence.

The explanatory ability of emotional intelligence (EI) in making sound decisions, acting ethically, and developing relationships with others has made it one of the most crucial constructs in leadership, organisational behaviour, and human resource development (Salovey and Mayer, 1990; Mayer et al., 2004; Goleman, 1995). The first models of understanding EI as a competency to perceive, interpret and manage emotions (Salovey and Mayer, 1990), further developed models introduced EI as a competency to self-awareness, self-regulation, motivation, empathy and social skills (Goleman, 1998). A meta-analysis of the EI research indicates that EI has stable associations with positive leadership behaviors including team performance, adaptability, job satisfaction and ethical influence (Cotte and Miners, 2006; O'Boyle et al., 2011). Research on EI continues to be challenged by issues of construct clarity and measurement diversity, despite its widespread acceptance. According to scholars, the conceptualisation of EI is inconsistent as an ability, a trait, or a mixed model, and such conceptual heterogeneity influences not only theoretical consistency but also the practice of leadership assessment (Mayer et al., 2008; Petrides and Furnham, 2000).

Recent research continues to reinforce the link between emotional intelligence and ethical leadership. For example, studies by Smith & Lee (2021) demonstrate that leaders with high emotional self-awareness exhibit stronger ethical decision-making and organisational trust. Nguyen et al. (2022) found that emotional regulation predicts leader integrity and follower moral engagement across diverse cultural contexts. In healthcare settings, Patel and Singh (2023) report that emotionally intelligent leaders reduce workplace conflict and improve ethical outcomes. These studies collectively highlight that emotional intelligence is not simply a performance skill, but a foundation for ethically grounded leadership.

2.2 Emotional Intelligence, Culture, and Context.

Even though, EI is usually sold as a repertoire of universally similar competencies, emotions and their manifestations are mediated culturally as opposed to universal similarity (Hofstede, 2001). Organizational psychological research on cross-cultural studies reveals that emotional regulation norms, interpersonal behavior norms, and norms of moral reasoning differ greatly across different societies and that EI scores derived within a Western society may fail to reflect culturally-constrained emotional repertoires present in non-Western societies (Matsumoto et al., 2008; Mesquita, 2001). As an illustration, collectivist cultures might have social harmony and relationship responsiveness, as compared to individualistic cultures, which affects the implementation of emotional competencies in leadership (Earley and Ang, 2003; De Cremer and Van Knippenberg, 2005).

This cultural contingency implies that the transplantation of EI frameworks is impossible without adaptation; instead, such frameworks have to be culturally contextualised. In turn, recent research on cross-cultural management and HRD has demanded culturally sensitive and pluralistic descriptions of emotional intelligence that incorporate local epistemology and standards (Rockstuhl et al., 2011; Tarique and Schuler, 2018).

Cross-cultural studies have emphasised that emotional intelligence is shaped by cultural norms and values. Zhao et al. (2019) showed that collectivist cultural contexts place greater emphasis on relational empathy and social harmony in EI development, while Okeke & Mensah (2021) found that African leadership models integrate

community responsibility with emotional regulation. Alvarez & Kaur (2023) further demonstrated that South Asian leaders interpret emotional cues through moral frameworks, with higher interpersonal empathy linked to dharma-like values. These studies support the argument that universal models of emotional intelligence are insufficient without cultural grounding.

2.3 Knowledge Systems of the Indigenous, Decolonised Management, and HRD.

Indigenous Knowledge Systems (IKS) are locally based intellectual traditions that combine ethics, psychology, pedagogy, and social organisation into coherent worldviews (Smith, 2012; Dei, 2011). The Indian IKS contains philosophical and ethical concepts like dharma (moral duty), karma (action and consequence), bhakti (relational devotion), and yogic self-discipline, all of which contain implicit conceptions of emotional regulation and moral agency (Radhakrishnan, 1951; Roy, 2013).

The decolonised management scholarship states that the mainstream management knowledge, such as the leadership and emotional intelligence theory, has been biased in favor of the Western epistemologies, but has marginalised the indigenous viewpoints (Alcadipani et al., 2012; Prasad and Prasad, 2019). This Eurocentric bias restricts the conceptual diversity and pragmatic applicability of the leadership development frameworks in diverse cultures. Thus, the incorporation of indigenous knowledge into the leadership frames does not only widen the theoretical perspectives but also facilitates the HRD practices of inclusivity and cultural sensitivity. Recent scholarship on indigenous leadership and decolonised management argues that leadership knowledge must include non-Western epistemologies. Studies from the Global South highlight that leadership is understood as service, moral responsibility, and relational care. These works support the idea that indigenous traditions provide valid theoretical foundations for leadership and emotional intelligence. Several recent contributions expand leadership theory through indigenous and decolonised perspectives. Thomas & Narayan (2018) argue that Western leadership paradigms often overlook relational responsibility and community-centric values present in indigenous traditions. Building on this, Rao & Bhatt (2022) found that indigenous leadership frameworks foreground moral duty and reciprocity as key emotional competencies. Gutiérrez & Singh (2024) extend these insights by linking indigenous philosophies to emotional intelligence, showing that leadership rooted in ethical relationality enhances organisational cohesion. Together, these studies demonstrate the academic momentum toward decentring Western epistemologies in leadership research.

2.4 Indian Epics as An Affective and Leadership Reading.

The classical Indian epics, the Mahabharata and the Ramayana, have served as historic pedagogical instruments to teach the moral, emotional and social lessons (Hiltebeitel, 2001; Narayan, 2006). These are psychologically dense narratives with characters whose emotional situations as well as moral decisions, demonstrate the complicated relations. An example of this would be the moral conflict on the battlefield of Arjuna, in which emotional ambivalence and self-doubt are manifested; the counsel of Krishna, in which emotional empathy relative to the deployment of strategy is manifested; the obedience of Rama, in which emotional restraint is shown; the emotional composure of Sita, in which emotional composure is portrayed; and the devotional action of Hanuman, in which socially intelligent action is displayed.

Although other management education studies have examined Indian epics as a model of leadership or a didactic framework (Chaudhuri, 2017; Chakrabarti, 2020), most studies are normative or anecdotal but not theoretically and methodologically organized. The gap in research is the systematic interpretation of the problem of these epic narratives and the use of the proven constructs of EI and indigenous philosophical frameworks to create a coherent leadership construct that can be applicable in theory and HR practice.

Recent scholarship has also focused on refining how emotional intelligence is measured and applied across contexts. Lee et al. (2020) introduced a culturally adapted EI assessment that incorporates moral and social responsibility items beyond traditional trait scales. Omar & Ruiz (2021) propose an integrated EI model that links emotional competencies with ethical decision-making and organisational citizenship behaviour. Fernandes & Zhang (2025) validate an EI intervention program in multinational teams, showing enhanced empathy and ethical leadership outcomes post-training. These studies highlight the need for expanded measurement frameworks and practical tools that reflect diverse cultural and ethical dimensions of emotional intelligence.

2.5 Integrating EI with IKS: Research Gap and Contribution

There are two gaps identified in the existing literature. To begin with, most mainstream research on emotional intelligence (EI) tends to presume that Western conceptualisations of emotional competence apply to cultural and philosophical diversity, with little consideration of the same. Secondly, even though Indian epics are generally recognised as rich in morals and psychology, they are not yet fully used in such research studies that aim at developing emotional intelligence constructs in a systematic way. The paper handles these gaps by

incorporating the EI theory with the Indian Knowledge Systems through qualitative thematic analysis of the selected characters and episodes of the Mahabharata and the Ramayana. It creates an indigenous emotional intelligence paradigm that decodes emotional abilities in culturally based philosophical ideas, thus contributing the following:

Emotional Intelligence Theory:

The research broadens the EI theory to its Western epistemological origins by inculcating the emotional skills within the Indian philosophical concepts of dharma (ethical duty), karma (action-consequence), and the self-discipline of a yogi. It redefines emotional intelligence as a psychological capability as well as a moral and relational one, which is conditioned by culture values. This makes it a more pluralistic and context-sensitive concept of emotional intelligence. Table 1 presents a comparative analysis of major characters from the Mahabharata and the Ramayana using the five core components of Emotional Intelligence: self-awareness, regulation, empathy, ethical judgment, and social skill. The purpose of the figure is to connect classical Indian literary characters with a modern psychological framework and to show that concepts similar to emotional intelligence were already embedded in traditional narratives. By using simple visual markers (✓ for moderate and ✓✓ for strong), the figure allows quick and clear comparison of each character's emotional and moral strengths. It highlights Krishna as the most balanced and emotionally intelligent character, while also showing the distinct emotional profiles of Arjuna, Rama, Sita, and Hanuman. Overall, the figure serves an analytical and educational purpose, helping readers understand character traits in a structured, visual, and contemporary way.

Table 1: Emotional Intelligence Dimensions in Epic Characters

Character	Self-awareness	Regulation	Empathy	Ethical judgment	Social skill
Krishna	✓✓	✓✓	✓✓	✓✓	✓✓
Arjuna	✓	✓	✓	✓✓	✓
Rama	✓✓	✓✓	✓	✓✓	✓
Sita	✓	✓✓	✓✓	✓	✓
Hanuman	✓	✓	✓✓	✓	✓✓

Leadership Studies:

The study provides a culturally sensitive approach to emotionally intelligent leadership, in which the effectiveness of leadership is based on emotional awareness, moral accountability, and solid commitment. The study has introduced leadership as an emotional-ethical practice and not a performance-driven role by analysing epic leaders who make decisions under moral constraint and under emotional complexity. This adds value to leadership theory because it justifies the use of indigenous values as principles of an effective leader.

HRD Practice:

To human resource development, the study gives a framework that can be used to guide culturally responsive leadership development programs. Learning can be applied through the use of epic stories and IKS principles to cultivate empathy, emotional control, moral judgment and social intelligence. This allows the leadership training to be inclusive, cultural, and relevant within the various organizational contexts.

Methodological Contribution:

This research contributes to the methodological practice by considering epic narratives as analytical data, however, not as inspirational or symbolic literature. It shows how indigenous stories can be rigorously applied to theory-building in leadership studies through systematic thematic analysis as aligned to EI dimensions and the IKS concept.

Non-colonised Knowledge of Management:

Lastly, the research also leads to decolonised management studies as it undermines the Western hegemony of epistemology in leadership and EI theory. It makes Indian Knowledge Systems valid sources of theoretical and practical knowledge, which promote knowledge pluralism and the formulation of leadership models with global relevance.

2.6 Research Gap

The literature confirms that emotional intelligence is important for leadership, but most EI theories are culturally narrow and rooted in Western psychology (Mayer et al., 2008; Prasad & Prasad, 2019). At the same

time, Indian epics and Indigenous Knowledge Systems offer deep emotional and ethical insights but are underused in systematic EI research (Chakrabarti, 2020). There is a clear need for a culturally grounded model of emotional intelligence that integrates emotion with moral duty and relational responsibility. This study addresses this gap by integrating emotional intelligence theory with Indian Knowledge Systems through qualitative analysis of epic narratives, leading to the development of an Indigenous Emotional Intelligence framework for leadership and human resource development.

2.7 Conceptual Framework: Integrating Emotional Intelligence with Indian Knowledge Systems



Figure 1: Conceptual integration of Western Emotional Intelligence constructs with Indian Knowledge Systems to develop an Indigenous Emotional Intelligence Framework.

Figure 1 illustrates the conceptual foundation of this study by showing how the theory of emotional intelligence and Indian Knowledge Systems are integrated to develop an Indigenous Emotional Intelligence framework. On the left side of the figure are the dominant Western emotional intelligence constructs: self-awareness, self-regulation, motivation, empathy, and social skills, which represent the psychological understanding of emotional competence used in leadership and HRD literature. These dimensions describe how individuals perceive, manage, and express emotions in both interpersonal and organisational contexts.

On the right side are core concepts from Indian Knowledge Systems, including *dharma* (ethical responsibility), *karma* (action and consequence), *bhakti* (relational devotion), and yogic self-discipline. These concepts reflect indigenous understandings of emotional life as inseparable from moral duty, relational responsibility, and disciplined self-control. Unlike Western models that focus mainly on individual emotional management, IKS situates emotions within a broader ethical and social order.

At the centre of the figure is the Indigenous Emotional Intelligence Framework, which emerges from the interaction of these two traditions. This framework emphasises culturally grounded emotional competence, ethical and moral awareness, and relational wisdom. It suggests that emotionally intelligent leadership involves not only managing emotions effectively but also aligning emotional behaviour with ethical duty, social responsibility, and cultural values.

3. RESEARCH METHODOLOGY

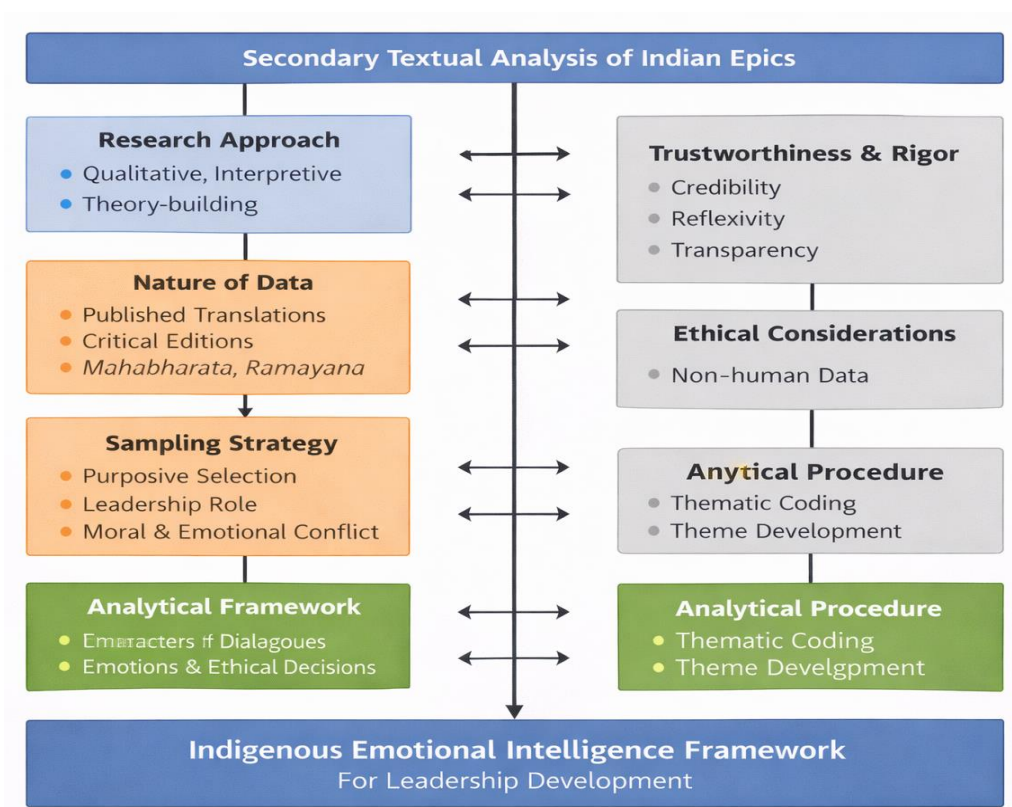


Figure 2: Workflow for Research Methodology

Figure 2 presents the overall research process adopted in this study. It visually explains how the study moves from research design to theoretical output systematically and transparently. At the top, the figure begins with secondary textual analysis of the *Mahabharata* and the *Ramayana*, establishing the nature of the data used in the study.

3.1 Research Design and Approach

The research design chosen in this study is qualitative and interpretative research design using secondary data. The aim is to come up with a local emotional intelligence paradigm through decoding of emotional and moral patterns as found in Indian epics. Given the fact that the study concentrates on meanings, values and emotional processes that the narrative texts depict, a qualitative and interpretative approach will be suitable. The research does not focus on testing the variables but seeks to build up theory by means of systematic interpretation of texts of cultural relevance.

3.2 Data Characteristics: Secondary Textual Sources.

The research is solely based on secondary qualitative data which comes as published translations and critical editions of the *Mahabharata* and the *Ramayana*. These epics are taken as sources of narrative data which hold psychological, emotional and ethical knowledge transmitted in the form of stories. Secondary information is suitable in this study due to the fact that the objective is not to study modern day behavior rather to derive the model of leadership and emotional intelligence out of a classical text that has traditionally served as a moral and emotional instructional resource.

3.3 Unit of Analysis

Characters, their deeds, conversations, emotional reactions, and moral choices are the main units of analysis. Special attention is paid to those characters who exhibit leadership, influence, or moral authority (Krishna, Arjuna, Rama, Sita, Draupadi, and Hanuman, etc.). The episodes that involve emotional struggle, ethical conflict, sacrifice, duty and relational responsibility are being analysed since such situation discloses emotional awareness, regulation, empathy and ethical reasoning.

3.4 Sampling Strategy

Characters and episodes are selected with the help of a purposive sampling strategy. The selection of the characters is based on the three criteria:

- Position of power or leadership over other people,
- Participation in emotional or moral issues, and
- Cultural and narrative meaning.

The episodes are also chosen when characters are in severe emotional struggle, moral judgment or relationship negotiation like the battlefield crisis of Arjuna, Krishna giving him strategic advice, Rama in his exile and during his reign, Sita in her trials, Draupadi in her disgrace, and Hanuman as his servant. This makes sure that the information is full of emotional and ethical information that pertains to emotional intelligence.

3.5 Analytical Framework

The conceptual lenses of the analysis include two:

Dimensions of emotional intelligence (self-awareness, self-regulation, motivation, empathy, and social skills), and

Concepts of Indian Knowledge Systems (dharma, karma, bhakti, and yoga self-discipline).

These lenses are sensitizing concepts that help interpret without necessarily dictating the outcomes. They enable the emotional and ethical patterns to manifest themselves out of the text and be still theoretically based.

3.6 Analytical Procedure

Thematic analysis is also used as the major approach to analysis. The process is divided into four steps. To become familiar with emotional and ethical patterns, first, the selected readings are repeated. Second, the open coding is performed through the identification of emotional, moral struggle, relationship behaviour and leadership action expressions. Third, the other codes are classified according to the concepts of EI dimensions and IKS. Fourth, more general themes that include emotional restraint, moral courage, relational wisdom and ethical leadership are established. Lastly, the themes are combined to form an Indigenous Emotional Intelligence model on leadership.

3.7 Trustworthiness and Rigour

Several readings and constant comparisons of interpretations are done to make sure that it has credibility. To ensure transparency, the decisions concerning coding are recorded. The process of reflexivity is upheld by critically evaluating the effect of the cultural context of the researcher and his/her theoretical assumptions on the interpretation. Reliability is also created by the explicit recording of the steps used in the analysis to ensure that the process can be repeated. The study is interpretive but has systematic procedures that guarantee analytical rigour.

3.8 Sample Coding and Theme Development

To enhance methodological transparency and meet high-impact journal standards, this study provides sample coding trails illustrating how epic narratives were systematically transformed into analytical themes. Tables 2 and 3 demonstrate the analytical progression from narrative episode to open code, emotional intelligence dimension, Indian Knowledge System lens, and final theme. These examples show how thematic analysis was operationalised in practice rather than remaining only conceptually described. By presenting this audit trail, the study ensures analytical rigour, transparency, and replicability, allowing readers to clearly trace how interpretations emerged from the data.

Table 2: Sample Coding – Mahabharata

Episode	Text / Action	Open Code	EI Dimension	IKS Lens	Final Theme
Arjuna's battlefield crisis	Arjuna drops his bow, expresses grief and moral confusion	Moral distress, emotional awareness	Self-awareness	Dharma conflict	Emotional Self-Awareness under Ethical Dilemma
Krishna's counsel to Arjuna	Krishna adapts his teaching to Arjuna's emotional state	Strategic empathy	Empathy	Karma–Dharma integration	Empathy as Moral Guidance

Table 3: Sample Coding – Ramayana

Episode	Text / Action	Open Code	EI Dimension	IKS Lens	Final Theme
Rama accepts exile	Calm acceptance despite injustice	Emotional discipline	Regulation	Dharma	Regulation through Ethical Duty
Sita in captivity	Endures suffering with moral strength	Emotional resilience	Regulation, Empathy	Bhakti, Dharma	Compassionate Endurance
Hanuman serving Rama	Selfless service to Rama and Sita	Devotional action	Social skill, Empathy	Bhakti	Relational Intelligence through Devotion

3.9 Ethical Considerations

The research uses classical readings that can be found publicly and does not require the involvement of human participants. Thus, no direct ethical risk comes into play. Nevertheless, there is cultural and philosophical discretion in the interpretation of religious stories. The interpretations are provided in a respectful way, which does not involve theological judgment but dwells on emotional, ethical, and leadership-related meanings of significance to organisational and HRD studies.

This approach offers a stringent basis on which secondary qualitative information on Indian epics is employed to come up with a native emotional intelligence model of leadership and human resource development.

4. FINDINGS

The following section shows the key themes that have been identified as a result of the thematic analysis of the picked episodes and characters of the Mahabharata and the Ramayana. The results demonstrate the use of emotional intelligence through the emotion awareness, regulation, empathy, ethical judgment and relational competence and the approach of embedding the dimensions of emotional intelligence within the Indian Knowledge Systems.

4.1 Epic Leadership Emotional Self-awareness (ESA).

One of the main themes in all the epics is a strong emotional self-awareness by the main characters. The crisis of Arjuna on the battlefield shows that a person is incredibly aware of internal conflict, fear, grief, and confusion with morality. Arjuna does not suppress his feelings; instead, he openly admits his emotional breakdown, thus, it becomes the beginning of transformation. On the same note, Rama is always conscious of his emotional condition when confronted with exile, separation and loss. He is aware of his sorrow and his attachment, though he deliberately puts personal feeling behind the ethical obligation. Krishna, on the contrary, demonstrates reflective consciousness not only towards his feelings but also the feelings of other people, especially Arjuna, and modifies his teachings accordingly. These stories demonstrate that emotional intelligence is initiated by becoming aware of emotional states instead of repressing them.

4.2 Emotional Control and Regulation.

Emotional control becomes one of the main peculiarities of leadership in the epics. Rama is an example of controlled emotional restraint as he takes exile with himself without anger or revolt though the process was not fair. His reply shows yogic self-control - restraint of impulse and emotion on ethical grounds. The fact that Sita managed to survive in captivity is an expression of emotional strength, and not an emotional repression; she is the one who suffers but, at the same time, has inner stability and moral orientation. Arjuna does not have a proper regulation of his emotions initially as he is immersed in his fears and attachment, but over time slowly learns to control his emotions through reflection and Krishna. Those instances reflect emotional intelligence as the ability to control the emotion without refusing to be emotional.

4.3 Empathy and Relational Intelligence

Empathy is not only described as having an emotional sensitivity but a relational responsibility. The advice that Krishna gives to Arjuna is strategic empathy; he knows how Arjuna feels, how confused and fearful he is, and how his moral pain is, and tailors his message to these needs. He does not ignore the feelings of Arjuna and lets him stay in the state of emotional paralysis. Hanuman is described as empathetic by use of devotion, whereby he serves Rama and Sita selflessly. His emotional intelligence is manifested in loyalty, compassion, and willingness to selflessly do something on behalf of others. It is the case that Draupadi displays relational awareness of humiliating and unjust situations, in which she appeals to the moral conscience of all and not just her own feelings. These are cases that involve empathy as an active moral participation, but not an emotional sympathy.

4.4 Moral Decision-making and Dharma-directed Leadership.

Emotional intelligence cannot be separated from the epics without ethical reasoning. It is not the personal feeling upon which the matters are decided, but rather dharma-ethical responsibility. Rama, on several occasions, prefers duty to desire even though this entails personal pain. The manner in which Arjuna overcomes his emotional crisis is brought about not by emotional comfort but by reorienting his emotions by moral responsibility. Krishna connects feeling, doing and result using the logic of karma, whereby an emotionally intelligent action should take into consideration the effects of that action in the long run in terms of ethical outcomes. These stories indicate that emotional intelligence in Indian epics cannot be separated from moral consciousness.

4.5 Indigenous Emotional Intelligence Dimensions.

Based on thematic analysis, there are five native dimensions of emotional intelligence, which are emotional awareness, emotional regulation, relational empathy, ethical judgment, and disciplined action. These dimensions are consistent with current EI constructs but are well grounded in IKS principles of dharma, karma, bhakti, and yogic self-control. The distribution of these dimensions among the main characters is shown in Table 2 as emotional strengths vary but complement each other. The combination of these dimensions creates an Indigenous Emotional Intelligence model where emotional competence is not only described by interpersonal effectiveness but also by moral accountability and cultural sense.

4.6 Operational Meaning of Indigenous Emotional Intelligence Dimensions

Indigenous Emotional Intelligence is operationalised through five interrelated dimensions. Emotional awareness refers to a leader's ability to recognise and reflect on personal emotions, especially during situations of moral or relational conflict. Emotional regulation is the capacity to manage emotional reactions through inner discipline and ethical reflection rather than impulse. Relational empathy involves understanding the emotions of others and responding with responsibility, care, and social sensitivity. Ethical judgment refers to the ability to make decisions guided by moral duty and social responsibility instead of personal benefit. Disciplined action is the ability to translate emotional understanding and ethical awareness into responsible, purposeful action in real leadership situations



Figure 3: Thematic dimensions of Indigenous Emotional Intelligence derived from epic analysis

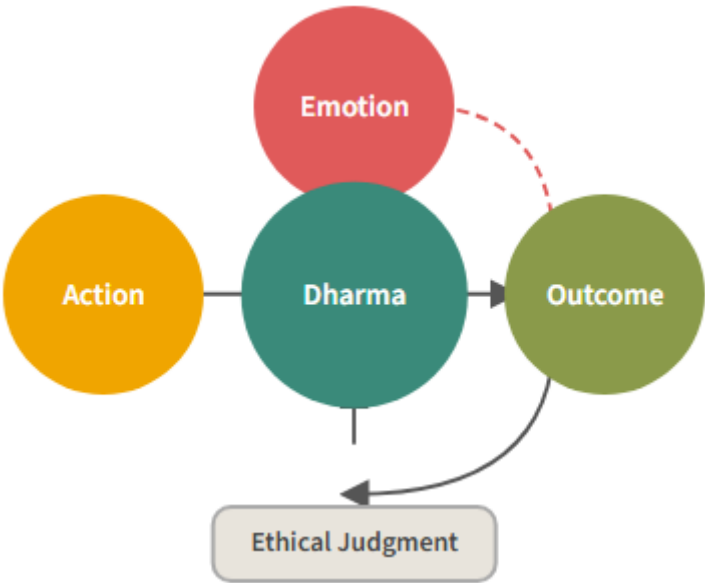


Figure 4: Emotional decision-making through dharma and karma.

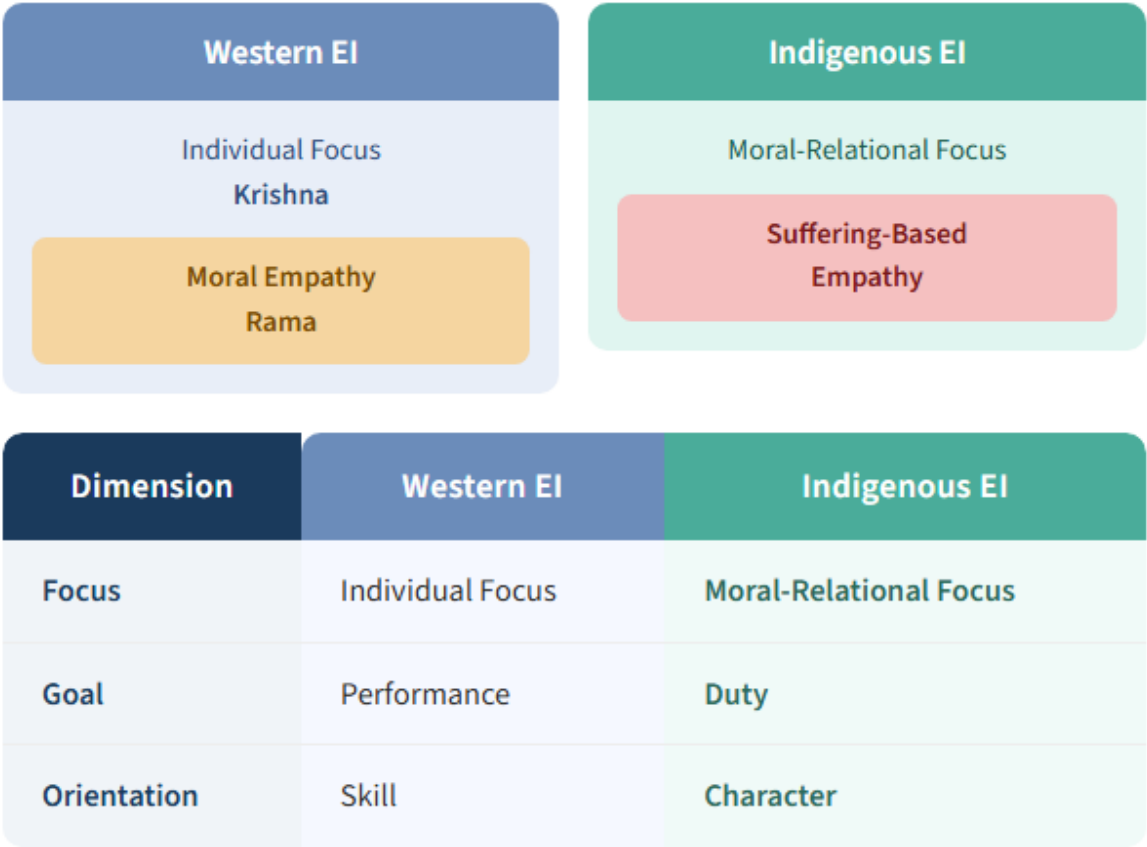


Figure 5: Forms of empathy in epic leadership.

The combination of these characters creates a holistic idea of how Indigenous Emotional Intelligence works, relying on characters and values that are present in Indian myths like the Mahabharata and the Ramayana. This framework puts emotional intelligence not only as a psychological ability, but as a moral, relational, and cultural system.

Figure 3 describes the inner framework of Indigenous Emotional Intelligence. It reveals that emotional self-awareness, emotional control and ethical judgment are not discrete skills but are in a process. An individual should know his or her emotions, manage them and lastly analyse his or her actions through moral judgment. The three of them combined create a culturally oriented concept of emotional intelligence, which is influenced by dharma and moral accountability.

This structure is applied in Figure 4 to such epic characters as Krishna, Rama, Arjuna, Sita, and Hanuman. It uses a visual profile in comparing the emotional awareness, discipline, ethical judgment, and action of each of the characters. This indicates that emotional intelligence is not universal, as all the characters have a different emotional style. Krishna is seen as the most balanced prototype, Rama as a person who was aligned to his duty, Arjuna as an emotional and moral character in conflict, Sita as an emotional and socially resilient woman, and Hanuman as a devoted, sentient, and social powerhouse.

Figure 5 emphasises the way decisions are made based on emotions. It demonstrates that feelings control action and actions cause consequences, but this is controlled by dharma and moral compass. This model does not suppress emotions but instead leads them through the morality reasoning process. This is a manifestation of the Indian philosophical concept that right action is not merely founded on feeling or logic, but it is founded on karma and dharma.

Figure 6 compares Western Emotional Intelligence with the Indigenous Emotional Intelligence. Western EI is demonstrated to be individualistic, performance-based, and skills-based. Indigenous EI, on the other hand, is moral-relational, duty-based, and character-based. This is where the difference lies because Western EI is more about personal achievement and efficacy, whereas Indigenous EI is more about social responsibility, interpersonal agreement, and inner being.

The combination of these figures describes that Indigenous Emotional Intelligence is a comprehensive system. It is a mixture of emotion, morals, activity and social justice. This model conceptualises emotional intelligence not as being emotionally intelligent, but as being morally upright, socially responsible, and dharma adhering. This is what has rendered emotional intelligence not just a personal skill, but a cultural and ethical lifestyle.

4.6 Summary of Findings

According to the findings, the Indian epics have a holistic picture of emotional intelligence where emotional awareness, emotional regulation, empathy, and ethical judgment work as a unity. Leadership in these stories is not impassive, but it must be emotionally disciplined based on moral values and responsibility to others. Emotional intelligence is therefore presented as an inbuilt ability in culture that incorporates the concept of emotion, ethics and action. This forms the basis of the creation of an indigenous emotional intelligence framework applicable in the field of leadership and human resource development.

5. RESEARCH OBJECTIVES

General Objective

To develop an indigenous emotional intelligence framework for leadership by integrating Emotional Intelligence theory with Indian Knowledge Systems through the analysis of Indian epics.

Specific Objectives

1. To identify emotional intelligence dimensions reflected in selected characters from the *Mahabharata* and the *Ramayana*.
2. To analyse how emotional awareness, regulation, empathy, and ethical judgment are represented through epic narratives.
3. To examine the relationship between emotional competence and ethical responsibility (*dharma*) in epic leadership.
4. To develop an Indigenous Emotional Intelligence model grounded in Indian Knowledge Systems.
5. To explore the relevance of the indigenous EI framework for leadership development and HRD practices.

6. RESEARCH HYPOTHESES

H1: Leadership characters in Indian epics demonstrate core dimensions of emotional intelligence, including self-awareness, emotional regulation, empathy, and social competence.

H2: Emotional intelligence in Indian epics is significantly shaped by ethical responsibility (*dharma*) and moral consciousness.

H3: Indigenous Emotional Intelligence differs conceptually from dominant Western EI models by integrating emotional competence with moral duty and relational responsibility.

H4: Leaders who display higher emotional awareness and regulation in epic narratives also demonstrate stronger ethical judgment.

H5: An indigenous emotional intelligence framework derived from Indian Knowledge Systems can provide a culturally responsive model for leadership development.

7. DISCUSSION

The findings of this study align with recent research showing that emotional intelligence is culturally shaped and morally grounded in non-Western societies. While recent studies emphasise cultural sensitivity in leadership models, this study extends that work by providing a structured Indigenous Emotional Intelligence framework rooted in Indian Knowledge Systems. This section synthesises the findings and interprets them in relation to emotional intelligence theory, leadership studies, and Indian Knowledge Systems, while highlighting the broader theoretical and practical significance of the study.

7.1 Emotional Intelligence as a Culturally Situated Construct

The results are quite clear and point to the fact that emotional intelligence cannot be perceived as a culturally neutral or universally homogeneous phenomenon. Although the models of EI in the West are mostly based on cognitive and behavioural psychology, the epic-based model evidences that emotional competence in the context of the Indian Knowledge System is closely interwoven with moral, social, and spiritual factors. It does not regard emotional awareness, regulation and empathy as value-free skills, but as abilities that acquire their own meaning only when they are pursued in accordance with dharma (ethical duty) and karma (action-consequence). This leads to the argument that emotional intelligence has to be culturally framed and construed in the traditions of philosophical action that can define ethical action. In this way, the study will take the EI theory beyond the psychological functionality to the sphere of moral and cultural accountability.

7.2 Leadership as Moral–Emotional Practice

The results indicate that Indian epics' leadership is not only a strategic or performance-oriented leadership model. Rama and Krishna are leaders who make morally sound choices that are informed by emotions. They do not dissociate emotion with responsibility; on the contrary, they combine emotional knowledge and moral obligation. Compassion, restraint, sacrifice, and relational accountability are their leadership principles. This is a challenge to instrumental leadership models that are primarily concerned with efficiency and results. Rather, leadership is moralised as an emotive practice in which power is justified through ethical action and emotional accountability. Such interpretation reinforces ethical and value-based theories of leadership as they are based on indigenous philosophy.

7.3 Emotional Control as Self-Mastery.

The epic narratives bring out the idea that emotional control is not emotional repression or emotional withdrawal. Rama and Sita are some of the characters who face grief and loss, and injustice, but they do not have their emotional drives to override their moral sense. The discipline of engagement with emotion, rather than emotion denial, is depicted by regulation. This redefines emotional intelligence as self-mastery as opposed to emotional control, to be efficient. The epic model provides that emotionally intelligent leadership needs inner discipline mediated by values, which is contrary to the contemporary managerial styles that frequently focus on emotional management as a means of productivity.

7.4 Ethical Responsibility Empathy.

It has found that there are various types of empathy, such as strategic (Krishna), devotional (Hanuman), moral (Rama) and suffering-based (Sita). These differences demonstrate that empathy is not a one-dimensional phenomenon but a practice that takes place in relationships and ethics. Not only are leaders supposed to comprehend the feelings of others, but they are supposed to do something about this knowledge. Empathy is thus a moral responsibility and not necessarily a social or psychological ability. This expands mainstream EI theory by introducing morality to the phenomenon of empathy.

7.5 Indigenous Emotional Intelligence as the Hologram.

The Indigenous Emotional Intelligence model incorporates emotion, ethics, action and consequence. Emotional awareness brings about reflection, reflection is governed by dharma, and action gives rise to karma. This cyclical model is contrasted with the Western models of EI that tend to distinguish between emotion and morality as two different directions. Indigenous model comes out with emotional intelligence as being holistic, relational and ethically based. It demonstrates that emotional competence cannot be detached from character and moral responsibility.

7.6 Conclusions about Leadership Theory.

These results indicate that the theory of leadership should shift its focus from a performance-based model to one based on ethical and cultural aspects of emotional life. The epic model of leadership is not dominance and control; rather involves service, responsibility and moral courage. It reinforces the theories of leadership that

focus on servant leadership, ethical leadership and authentic leadership, but introduces indigenous philosophical grounding that makes the above concepts culturally diverse and globally applicable.

7.7 Addition to Decolonised Knowledge of Management.

This research will surpass the supremacy of Western epistemologies in the studies of leadership and EI by employing Indian epics as sources of analysis and not symbols. It shows that indigenous traditions can produce systematic, transferable and theoretically meaningful leadership models. This is in keeping with the decolonised management scholarship that triggers plural systems of knowledge and epistemic diversity.

7.8 Implication to HRD and Leadership Development.

The Indigenous Emotional Intelligence framework has the ability to guide culturally responsive leadership development programs. Emotional awareness, ethical reasoning, and relational responsibility can be built through the use of epic narratives, reflection, and dialogue as a part of training. This will render leadership learning more purposeful in culturally varied and non-Western situations, as well as apply to the global organisations.

7.9 Theoretical Synthesis

Generally, it can be concluded that emotional intelligence, when interpreted in the light of Indian Knowledge systems, can be seen as a moral-emotional ability that informs leadership behaviour. Leadership is depicted to be emotionally aware, ethically based and socially responsible. This supports the main argument of the paper that indigenous epistemologies can make significant contributions to the emotional intelligence theory, leadership research, and the development of human resources.

8. IMPLICATIONS

8.1 Theoretical Implications

This paper adds to the emotional intelligence theory in terms of broadening their cultural and epistemological frames. It demonstrates that EI is not a culturally neutral phenomenon, instead, emotional competence is conditioned by philosophical, ethical, and social traditions. The incorporation of emotional intelligence as a moral-emotional ability and not a mere psychological skill through incorporation of EI and Indian Knowledge Systems into the study reformulates the perception of emotional intelligence. This suggests that future EI studies should not rely on Western-based models but instead base them on culturally based models. It further creates room to make comparative analysis of the indigenous and dominant models of EI which adds depth to global theory of leadership.

8.2 Implications for Leadership Practice

Applying this to leadership practice, the results indicate that successful leadership should not be influenced or performed by just using emotional skills. Leaders should be able to build emotional consciousness that is informed by moral responsibility and interpersonal accountability. The native EI model demonstrates that the emotional, reflective, ethical responsibility and social responsibility should be incorporated in leadership decisions. In practice, it implies that leaders ought to receive training on how their emotional reactions impact outcomes as well as moral legitimacy and trust. Value-driven emotional responsibility can be enforced in leadership practice instead of performance-driven emotional management.

8.3 Recommendations to Human Resource Development.

In the case of HRD, the research gives a culturally sensitive model of leadership development. Epic narratives, storytelling, reflective conversation and analysis of ethical cases can be introduced into the training programs to build emotional awareness, empathy, self-regulation, and moral judgment. HR practitioners should not stick to Western case studies but instead employ indigenous narratives in a way that appeals to the cultural background of the learners. The strategy could enhance participation, enhance moral awareness, and create emotionally intelligent leaders sensitive to cultural and moral aspects of organizational reality.

8.4 Management Education Implication.

Indigenous knowledge can be utilised in management and leadership courses. An additional way of including the Indian epics and IKS ideas in leadership classes is assisting the students in realising that leadership is a moral-emotional process and not just a technical one. This is backed by decolonised and pluralistic models of education that do not assume only one knowledge tradition as the legitimate source of theory. This kind of practice equips future leaders to become ethical and emotionally intelligent in culturally diverse settings.

8.5 Policy and Organisation Implications.

The indigenous EI can be applied by organisations and policymakers who are dealing with the training of leadership to formulate development policies that are sensitive to culture. Some core competencies in the

leadership competency framework can be emotional discipline, ethical responsibility and relational sensitivity. This has the potential to reinforce organisational cultures that embrace integrity, empathy and social responsibility in addition to performance.

9. LIMITATIONS OF THE STUDY

This study is based only on secondary textual analysis of the *Mahabharata* and the *Ramayana*. No primary data from contemporary leaders or organisations has been used. Therefore, the Indigenous Emotional Intelligence framework has not yet been empirically tested in real organisational settings. Interpretations may also vary because different translations and versions of the epics exist. As the analysis is qualitative and interpretive, the researcher's perspective may influence theme development. These limitations suggest that the findings should be seen as theory-building rather than final conclusions.

10. DIRECTIONS FOR FUTURE RESEARCH

Future studies can test the Indigenous Emotional Intelligence framework in real organisational contexts using surveys, interviews, and experiments. Researchers can develop a measurement scale based on the five indigenous EI dimensions and validate it statistically. Comparative studies between Western EI models and Indigenous EI models can also be conducted across different cultures. Further research may also include other Indian texts, such as the Upanishads and Puranas, to expand the indigenous leadership framework.

11. RESEARCH CONTRIBUTION

This study makes three major contributions. First, it extends emotional intelligence theory by integrating moral duty, relational responsibility, and cultural values through Indian Knowledge Systems, moving EI beyond a purely psychological skill. Second, it contributes to leadership studies by presenting leadership as a moral-emotional practice rather than only a performance-driven role. Third, it supports decolonised management scholarship by positioning Indian epics as valid sources of theoretical knowledge, not merely cultural or religious texts. Together, these contributions offer a culturally grounded and globally relevant model of emotionally intelligent leadership.

12. CONCLUSION

- The Indian epics' emotional intelligence is both psychological and moral-emotional ability, based on dharma, karma, bhakti, and self-control.
- Leadership in the Mahabharata and Ramayana is also emotionally sensitive, ethical, and socially accountable instead of being performance-based.
- The Indigenous Emotional Intelligence framework takes the EI theory further than the Western epistemological frameworks and brings up culturally-based emotional competence.
- Narrative conflict and duty situations are examples of epic characters who exhibit major EI dimensions of self-awareness, regulation, empathy, and ethical judgment.
- The paper establishes Indian Knowledge Systems as valid sources of leadership and emotional intelligence theory.
- The framework offers culturally sensitive leadership development and HRD courses guidelines.
- Effective pedagogical tools to be used in achieving emotional and ethical leadership training can be applied in the form of epic narratives.
- The study embraces decolonised and pluralistic management education.
- The study is conceptual but provides a firm foundation for further empirical studies in organisational contexts.
- Blending ancient wisdom with contemporary leadership requirements produces leaders who are emotionally intelligent, ethical and culturally intelligent.

This study demonstrates that emotional intelligence, when viewed through Indian Knowledge Systems, becomes a moral emotional capability grounded in duty, responsibility, and relational care. Leadership in the epics is not based on power or performance alone but on emotional awareness guided by ethical commitment. The Indigenous Emotional Intelligence framework offers a culturally rooted yet globally meaningful model of leadership. By blending ancient wisdom with contemporary leadership needs, this research opens new paths for theory, practice, and education in emotionally and ethically grounded leadership.

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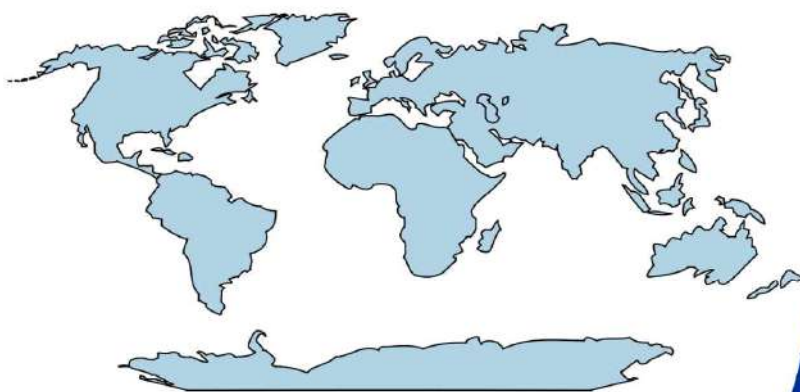
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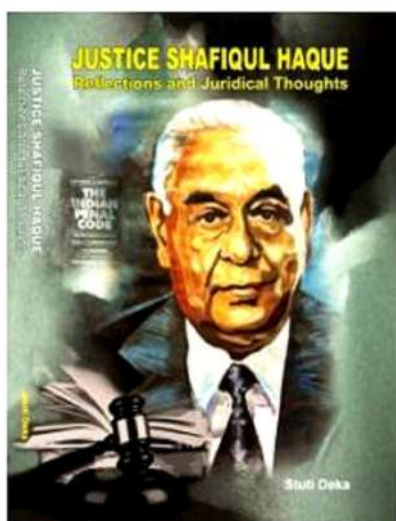


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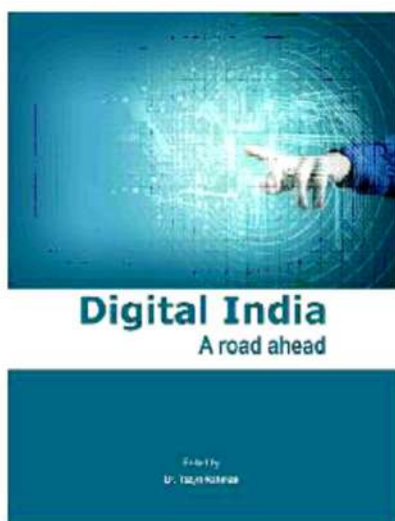
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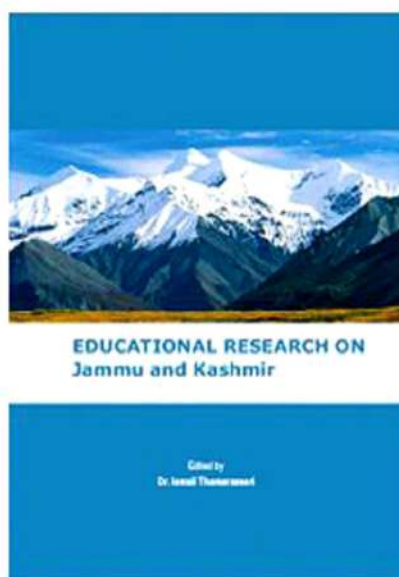
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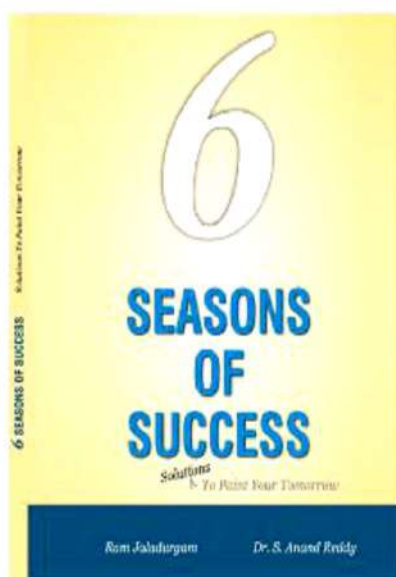
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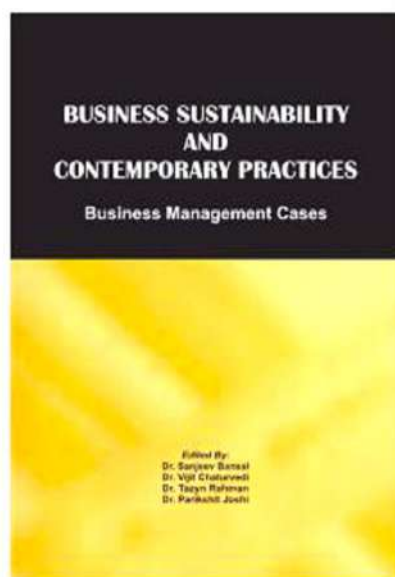
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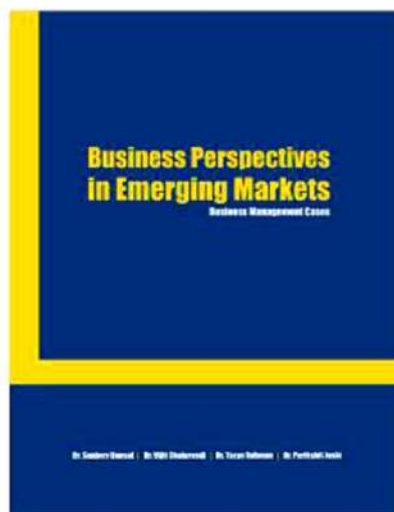
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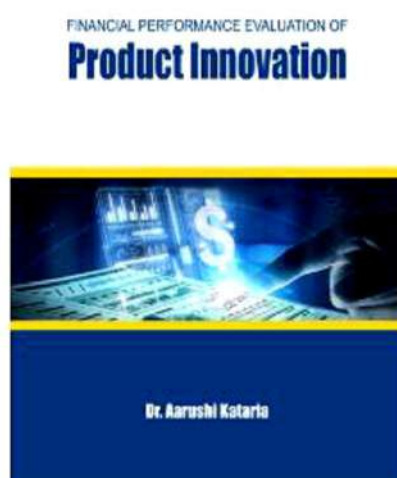
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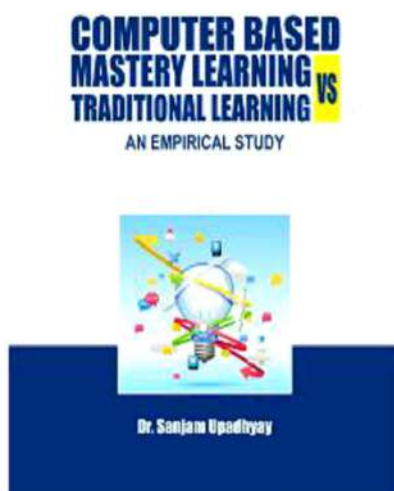
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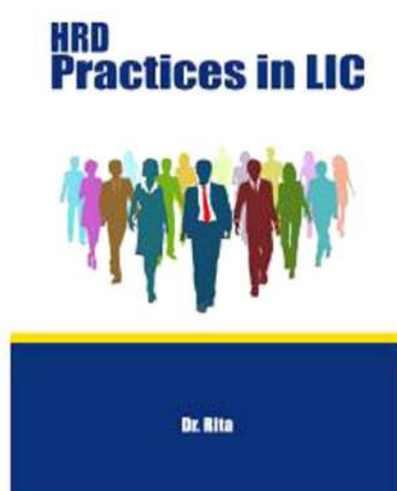
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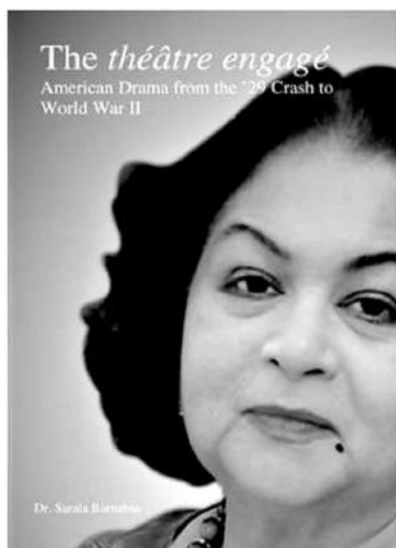
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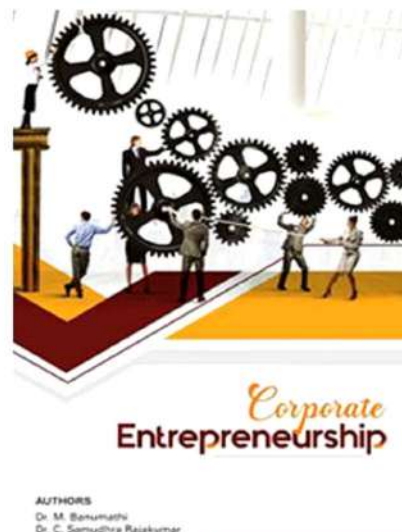
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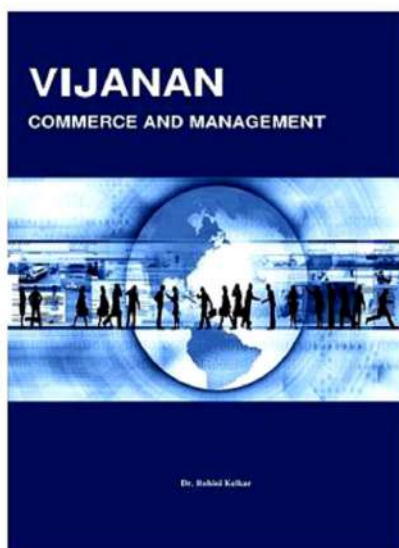
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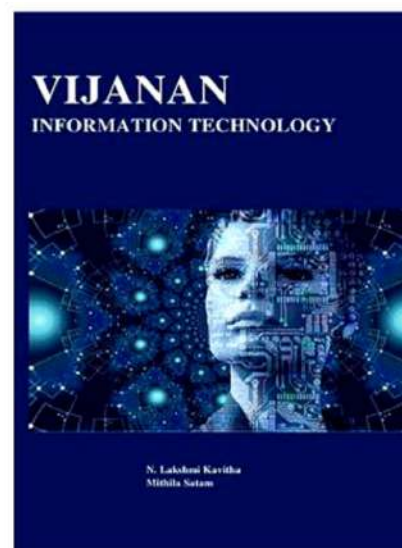
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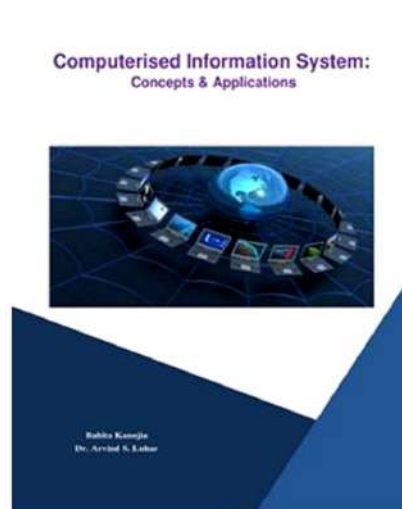
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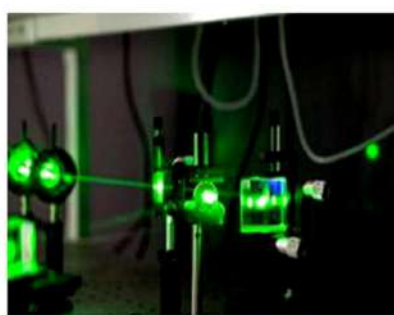


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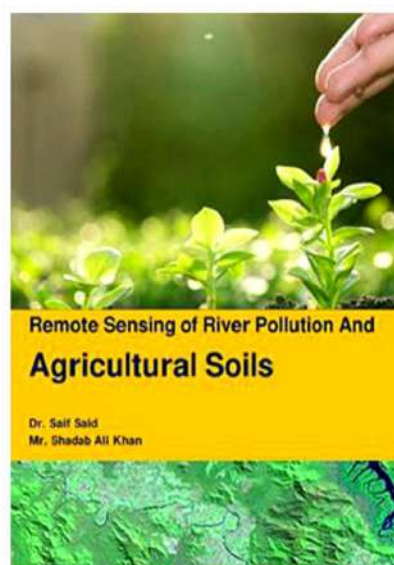
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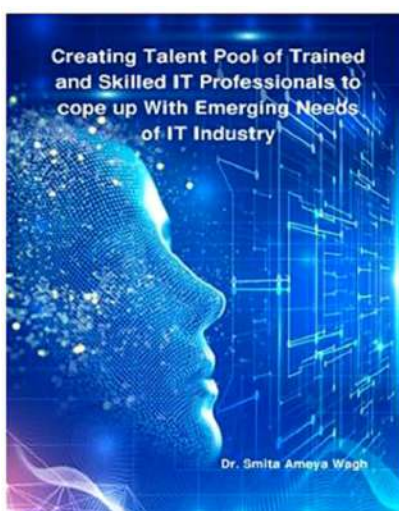
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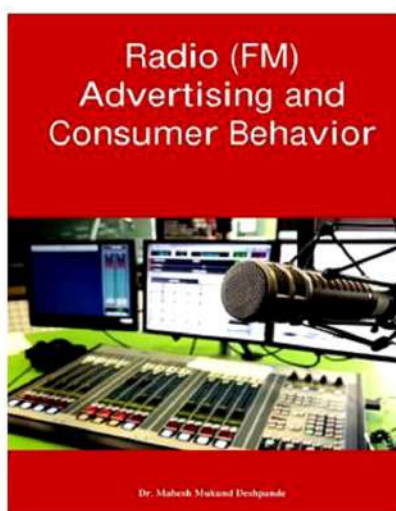
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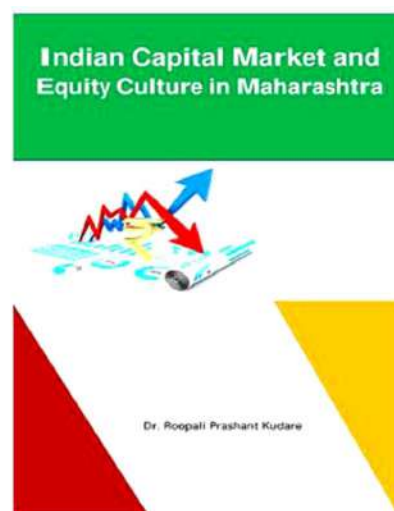
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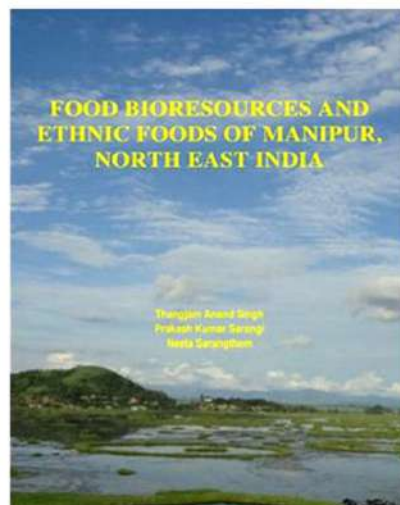
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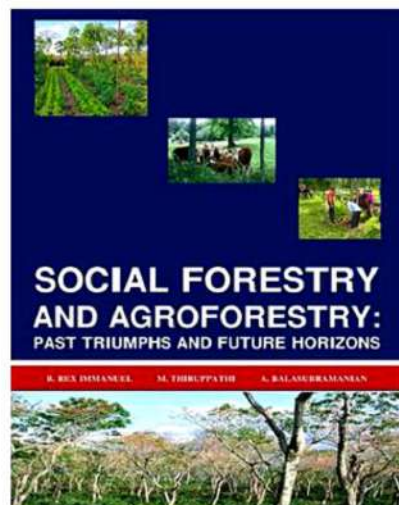
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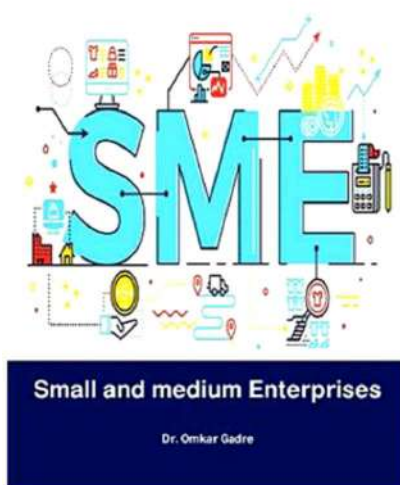
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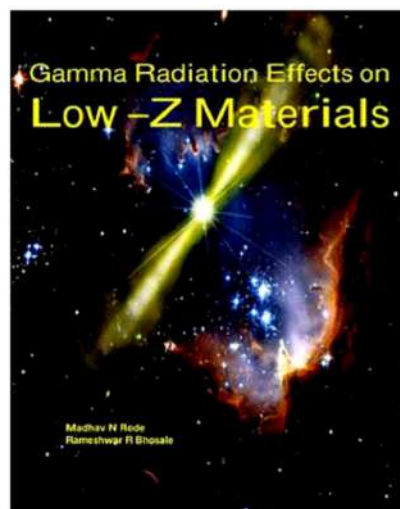
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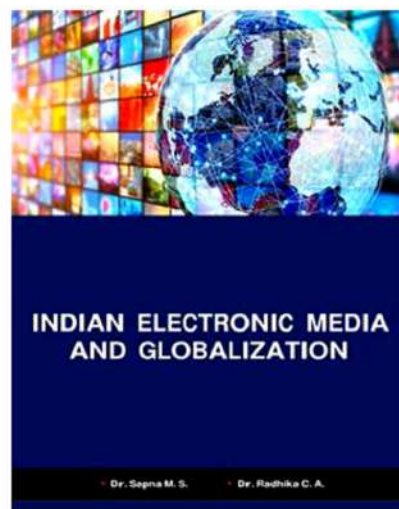
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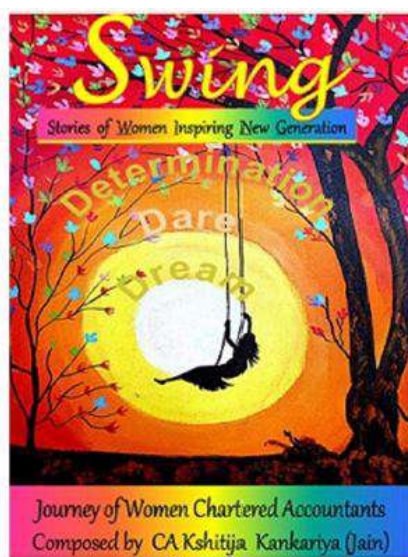
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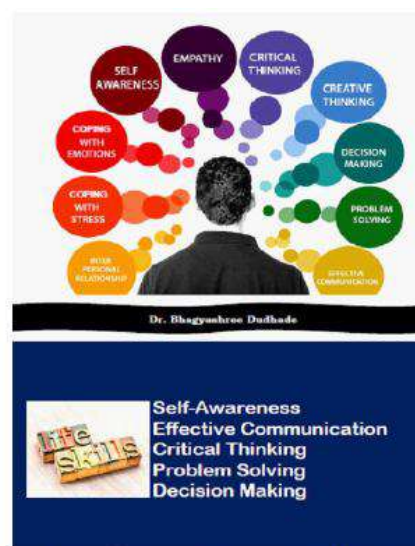
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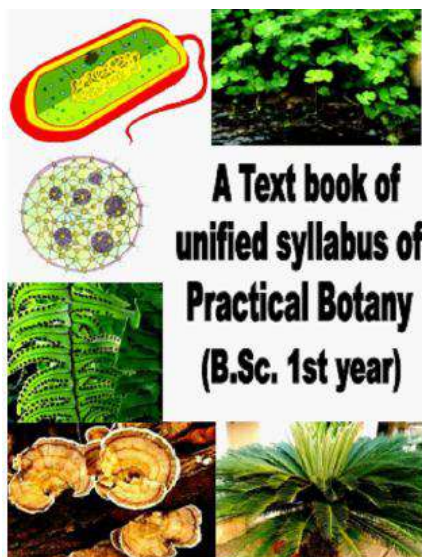
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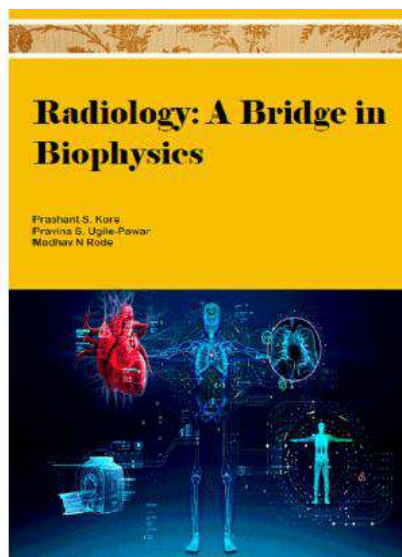
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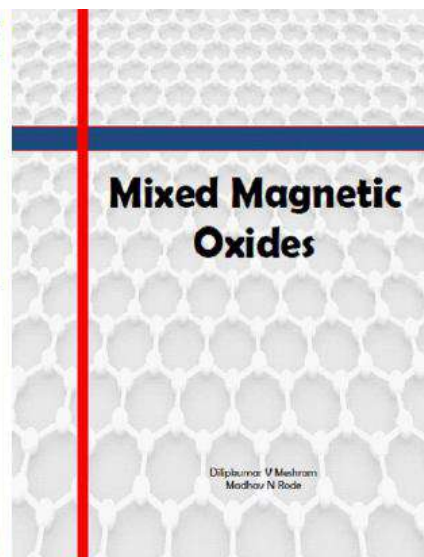
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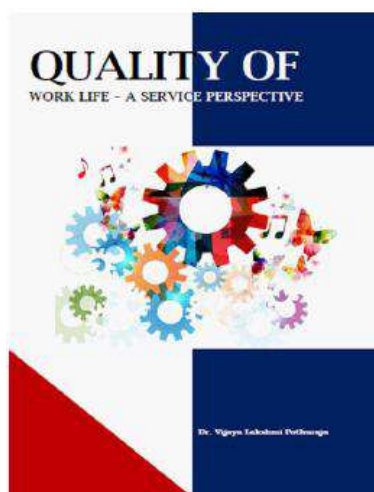


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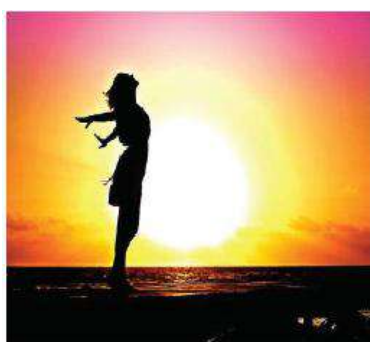
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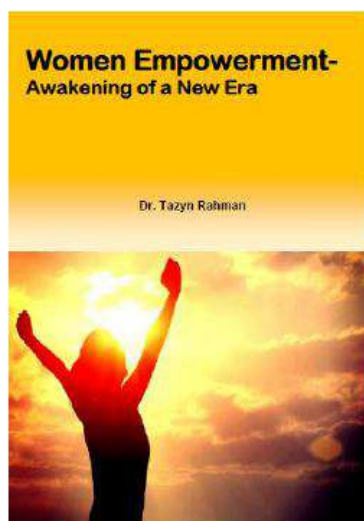


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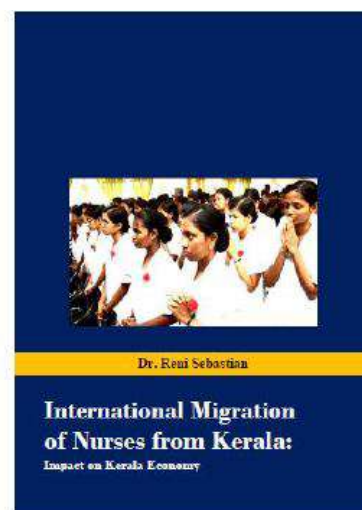


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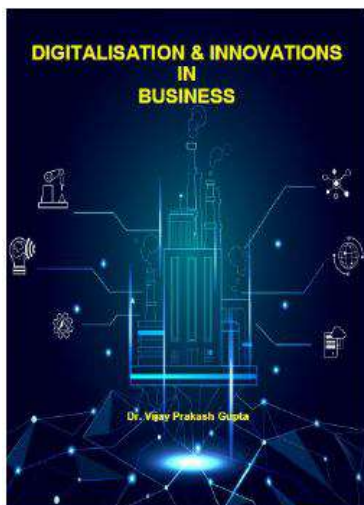


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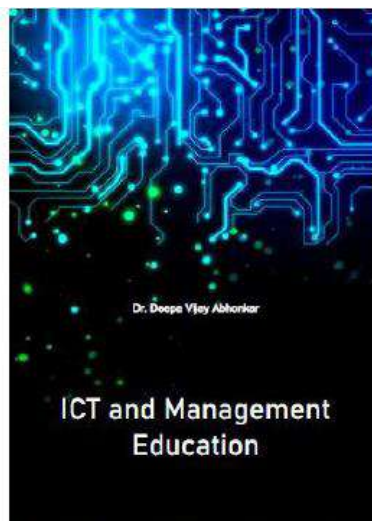
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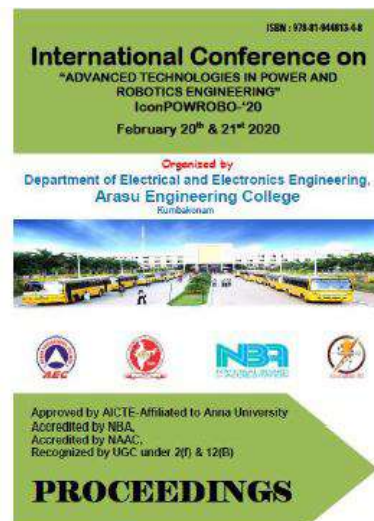
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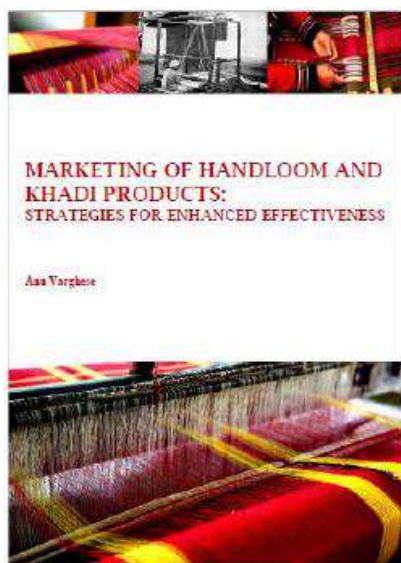
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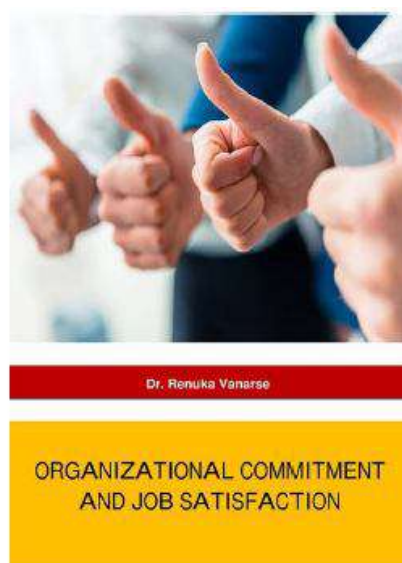
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