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A REVIEW OF SCIENTIFIC DEBATES ON ARTIFICIAL INTELLIGENCE AND SUSTAINABLE DEVLOPMENT DURING THE PANDAMIC

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ABSTRACT

The current paper offers a comprehensive review of the more prominent trends that have emerged at the crossroads of AI and sustainable development within the timeframe of the covid-19 outbreak. The review was conducted based on a set of selective scientific publications, which date from the start of the covid-19 pandemic up to 2023, marking the most comprehensive analysis regarding the complex role of AI within the sustainable development goals. The systematic clarification of the prevailing trends of the current scientific studies registered within Web of Science and Scopus using the methodologies of both bibliometric analysis and text analysis sketches the prevailing trends of current studies. To start, descriptive statistics may help unearth the individual contribution of authors, geographical coverage of scientific publications, generalization of all keywords, and other relevant bibliographic factors. The clarification of prevailing trends using a set of chosen keywords therefore uses data reduction methods.

Which are essentially founded upon co-word analysis, more specifically multivariate correspondence analysis. The analysis of scientific publications using the citation metrics complements the analysis with the latent Dirichlet allocation as well as the structural topic analysis of scientific article abstracts, marking the overall perspective of scientific debate surrounding AI and sustainable development.

The interpretation of the data showed a set of prominent themes, which included issues related to social sustainability and health-related issues. AI-based initiatives for the enhancement of energy efficiency and sustainability related to industries and innovation; Internet of Things (IoT) applications related to infrastructural development of smart and sustainable urban spaces; managing urban spaces; and overall implications related to the use of internet technologies within the SDGs. The data also portrays the fact that a positive bias does exist within the literature related to the use of AI within the context of sustainable development. Since they understand the presence of an innate risk, most authors have predicted a possible positive benefit within the sectors of the industries. All of these findings add to the existing knowledge base regarding the present research work related to academic discourse and the prospects of the future with respect to the nexus of AI and sustainable developments. They point out some of the important gaps in the present research work and provide implications for policymakers and practitioners in order to provide a direction for future inquiry and prudent decision-making.

Keywords: *Artificial intelligence, Sustainable development, Bibliometric analysis, Text mining, LDA*

INTRODUCTION

Within the last decade, the term "artificial intelligence," with respect to its development and application, has undergone tremendous change. The interpretation of the term "artificial intelligence" takes a different form depending upon the situation and the standards that are currently set forth on a general understanding. The interpretation of artificial intelligence takes a loose grouping of machines that are capable of handling intellectual tasks that are generally believed to be associated with the term "human intelligence." These include handling tasks such as reaction interpretation simulation regarding human acts such as speech simulation, regarding acts such as vision simulation, regarding acts such as emotions, using the function or process of machine learning, and interacting dynamically regarding the environment associated with problem-solving associated with acts such as creation. The issue of sustainability has, over the past few years, crept into the discussion platforms of academia. When considering artificial intelligence, sustainability can be regarded as a term that focuses entirely on the issue of managing non-renewable physical, social, and cultural resources, ensuring a prosperous life for all kinds of living beings. The sustainable development, in its turn, aims to promote development by providing some economic, environmental, social, or technological improvements that will increase the living standards without depleting the resources available to the following generations.

Two different strands of AI such as AI to sustainability and Sustainable AI are strictly defined in modern literature. The first is about the use of AI technologies: machine learning, predictive analytics, and automation, to promote the Sustainable Development Goals, including clean energy, public health, and inclusive education. The latter questions the sustainability of AI as a whole, questioning the capacity of its algorithms, hardware, and data centers to support the systems that they host without causing the ecological costs that are prohibitive. This negative outlook has led to the development of principles and strategies that are supposed to reduce carbon emissions and increase the energy efficiency throughout the entire AI lifecycle, including the conceptual design and training stages, the deployment and the utilization of AI. Sustainable AI, therefore, is AI systems that are intentionally designed and implemented to meet business practices that are environmentally sound and economic frameworks that are viable. Although most current AI solutions are coupled with the high price of the environment, the integration of sustainability concepts can be beneficial in reducing the negative effects.

The rationale for undertaking this current research work is based on the knowledge that a significant amount of scattered data across a wide range of sources exists on the topic of artificial intelligence in sustainable development. Not as much as the knowledge collected is broad-based; as a matter of fact, these pieces of knowledge are normally incoherent in a way that requires some meaning to be ascribed post facto. The current research work therefore provides a systemized compilation assessment and aggregation of knowledge based on various threads of inquiry that therefore provides a concise holistic summary based on various themes that can be ascertained within the interzone that is related to sustainable development, AI, and so forth at a time when technological innovation is increasingly considered more important within policymaking circles as well as within global sustainable agendas. As artificial intelligence permeates more sectors of the economy, there is a need to critically consider how it could be utilized in the achievement of the SDGs. AI could end up presenting both negative and positive implications within sustainable development. On the negative side, AI could be harmful to the natural environment, particularly from the perspective of heightened power consumption. Sustainable-AI strategies can help solve these issues through focusing on data quality, scale of models, energy efficient infrastructure, supportive policy framework, and nurturing a sustainability culture, through educational efforts.

Artificial intelligence, on the one hand, provides strong benefits to sustainable development. AI systems can be used to optimize energy use, reduce waste, reduce greenhouse-gas emissions, and promote sustainable industrial activities, and at the same time, they can be applied in the creation of new sustainable materials. Additionally, such systems allow identifying diseases early because of the detection of symptoms and tracking epidemics because of AI-supported protocols. In the agricultural industry, AI provides decision-support systems that can optimize the process of planting, harvesting, fertilizing, and meteorological predictions, which improves the efficiency of agriculture in general. They also include increased operational efficiency in both storage, manufacturing and distribution channels.

However, simultaneously, the literature also recognizes the range of negative effects of AI technologies. These are massive energy use to build and implement AI models, the possibility of adding to the existing environmental problems, ethical issues related to environmental regulation, the creation of electronic waste, and the further displacement of natural resources like water. Moreover, the occupational roles and activities can become obsolete or transformed with the help of the automaton affordances of AI, and widespread use of data creates more issues regarding cyber-security and social inequalities. These types of algorithmic effects can eventually erode larger goals of social sustainability.

Despite this recognition of such negative effects a large part of the literature especially empirical research on the subject based on perceptions of individuals has a strong positivity bias the overall picture therefore about the state of survey-based research among academics and students and ai users shows that ai is perceived to apply a mostly positive impact on the sustainable development of its social economic and environmental aspects other researchers reiterate the same finding by indicating that around 79 per cent of SDGA’s are positively influenced by ai as opposed to 35 per cent who are adversely affected this trend is oriented towards very deterministic and optimistic vision for ai technologies Current research thus critiques such a story by suggesting a set of gaps and imbalances in the available literature that should be addressed by other researchers.

There is a great deal of literature on the implications of artificial intelligence on sustainable development, which usually concentrates on a specific research area or aspect of sustainability, for instance, health, agriculture, or production. For instance, Mhlanga, Kulkov, Thamik, and others, such as Goralski and Tan, have analyzed the implications of AI on socio-economic topics and the environment for sustainable development separately. In view of the discontinuity between these studies, it is the aim of this research to synthesize these diverse approaches to provide a detailed consideration of how AI can be applied to all three parts of sustainable development. Methodologically existing studies are primarily based on a review of literature surveys, case studies, and content analyses, with most authors using either systematic reviews, bibliometric studies, or a combination of both, yet the number of studies using text mining and topic modeling algorithms for investigating the linkages between AI and sustainable developments is relatively small in number. Even in recent studies there is a beginning in using such algorithms, but most of these studies are not exhaustive in their approach. the current study proposes an extension in methodology by combining both a bibliometric study and text mining. Particularly, there is the use of Latent Dirichlet Allocation (LDA) and structural topic modelling, which detect, label, and dynamically cluster themes in research, thus making it possible to understand emergent topics and changes in the direction of research through time in a more refined manner.

The Sustainable Development Goals are 17 interconnected goals that can give a global roadmap towards ensuring peace and prosperity to the human and the planet today and in the future. These objectives are usually categorized into three pillars namely social, economic and environmental sustainability.

Goals 1, 3, 4, 5, 11, and 16 are included in social pillar. Goal 1 will focus on ending extreme poverty; however, long-term constraints and recent world crises indicate that the levels of poverty can increase. The analysis conducted by Scheyvens and Hughes was on whether tourism could help in reducing poverty. Goal 3 is focused on the enhancement of health and well-being, which was an even more important priority during the COVID-19 pandemic. Goal 4 aims at quality education, and the analysis by Morales et al. is done using a proposed physical education model. Goal 5 enhances gender equality and empowerment of women, and Eden and Wagstaff emphasize the need to implement policy changes on evidence-based intervention. Goal 11 seeks to develop inclusive, safe, resilient and sustainable cities and Goal 16 seeks to ensure peace, justice and effective institutions with quality education to be one of the enabling factors.

In the development agenda of the economic aspect, we target Goals 8, 9, 10, and 17. Goal Little 8 envisages goal-based and sustainable development, with decent workplaces, but the modern crises still put much pressure on the world economies. Researchers, in turn, have been developing new theoretical frameworks and questioning the concept of sustainability as practiced, in particular, in SMEs. Goal 9 is an advocate of resilient infrastructure, sustainable industrialisation, and innovation, and embodied by emerging paradigms like Industry 4.0 and Society 5.0, which are starting to draw more scholarly attention. Goal 10 targets the reduction of inequalities, and digitalization is critical to this (it becomes a catalyst). Lastly, Goal 17 is focused on strengthening global partnership, and research has evaluated development of these high-aspirational partner expectations.

Goals 2, 7, 12, 13, and 15 make up the green pillar. Goal 2 aims at ending hunger before 2030 and theorists like Viana et al. have developed systematic strategies to food security. Goal 7 will facilitate access to affordable, clean energy; the recent works are focused on energy sustainability in the post-pandemic period. Goal 12 enhances sustainable production and consumption trends, with the material-footprint analysis standing out as one of the main measures. Goal 13 prefigures climate action, which includes policy-interventions that end increased global temperatures. Lastly, Goal 15 dwells on the conservation of the terrestrial ecosystem and studies have suggested measures like not letting people harvest grass in areas that are ecologically disadvantageous.

THEORY

A literature suggests a number of theoretical models to describe the manner in which new technologies are embraced, accepted, and diffused, which include artificial intelligence (AI). One of the most influential is the Diffusion of innovation (DOI) theory introduced by Rogers that focuses on the nature of innovations that affect their adoption. Important characteristics that enable adoption are relative advantage, compatibility with its

current values and experiences, and needs of the users, low complexity, trialability, or how much an innovation can be tried, and observability of its results.

The Theory of Planned Behavior (TPB) based on the Theory of Reasoned Action is another extensive technology-adoption study framework used in the literature. TPB assumes behavior is determined by three major determinants, which include attitudes about the behavior, subjective norms, and perceived control over behavior. The better these factors are the more the intention of an individual to act in a given behavior.

One of the most widespread theories regarding the prediction of the uptake of AI technologies in a range of industries is the Technology Acceptance Model (TAM). As Davis, founding father of TAM, argues, a technology has greater chances of being adopted as long as the users find it useful and easy to operate. TAM extensions are the Unified Theory of Acceptance and Use of Technology (UTAUT) and the UTAUT2, which followed the first one. These theories assume that behavior intention comes before the actual use of the technology and that the intentions are influenced by performance expectancy- degree to which technology is believed to improve task performance-of the system, effort expectancy (perceived ease of use), social influence and facilitating conditions like organizational support, technological compatibility, and perceived control. Actual usage behavior, in its turn, depends on behavioral intention. Other variables, such as socio-demographic factors (e.g., age and gender), previous encounter with technology, and the freewill of usage are other factors contributing to the adoption of technology. UTAUT2 also expands the model to also include hedonic motivation, habit, and price value as other forecasts.

Although TAM and its modifications provide useful data on the topic of technology acceptance and usage, they do not provide the complete picture of the broader societal consequences of new technologies, especially when it comes to the sustainable development. To overcome this shortcoming, Al-Emran proposed the Technology-Environmental, Economic, and Social Sustainability Theory (T -EESST). This model offers a holistic evaluation approach of assessing the technology impacts within the three pillars of sustainable development, which are the environmental, economic, and social sustainability. It is in contrast to the traditional models of acceptance that T-EESST goes beyond user intention and adoption, to evaluate both positive and negative outcomes of technology implementation on sustainable development outcomes.

Over the past few years, the interest of scholars in the issue of artificial intelligence and sustainability has increased, with more and more sources devoted to the matter being released. To fill this growing interest, the current article will seek to make a contribution towards this emerging area of artificial intelligence and sustainable development by providing on the interface of the two worlds to the modern scientific discourse.

MATERIALS AND METHODS

In our current investigation, we apply two major approaches to methodology in questioning the scientific discourse of artificial intelligence (AI) and sustainable development during the epoch of the pandemic. The former is a bibliometric analysis, which examines the trends in scientific output. The second method is a text-mining model based on topic models with the use of Latent Dirichlet Allocation (LDA) and followed by the methods of structural topic models. The bibliometric method is focused on general publication aspects including author keywords and title words, but the text -mining process relies on the information obtained in the abstracts of the articles. The general purpose of this undertaking is to evaluate the role of AI technologies in sustainable development and outline the main AI methods and techniques and applications which have been prefigured in the context of sustainability-oriented studies.

3.1. Bibliometric Analysis

Bibliometric analysis is a powerful tool of assessment of scientific practices and the influence of major participants in the field of academic output. It allows mapping the scientific structure, evaluation of thematic and cognitive patterns within a field of research and finding co-citation relationships. It is a performance-based methodology in that it is able to quantitatively measure the output of publications and the impact of citation and thus makes it possible to quantify individual scholars, institutions, and even nations. Science mapping or bibliometric mapping highlights collaboration networks, as well as conceptual and intellectual interrelations, which permeate a scientific area. These methods of bibliometrics have widely been used in a vast range of fields, such as business and economics, sociology, psychology, education, public health, and sustainability studies. In the context of sustainability research, these analyses have brought light to topics of climate change

and waste management, corporate social responsibility, sustainable tourism and endless other concerns of the environment.

CONCLUSION

This study provides a comprehensive and systematic overview of the evolving scholarly discourse on artificial intelligence (AI) and sustainable development during the COVID-19 pandemic period. By integrating bibliometric techniques with advanced text-mining approaches, including Latent Dirichlet Allocation and structural topic 161odelling, the paper offers a multidimensional understanding of how AI has been conceptualized, debated, and positioned within the framework of the Sustainable Development Goals (SDGs). The combined methodological approach enables not only the identification of dominant research trends and thematic clusters but also a deeper exploration of latent patterns and shifts in academic focus over time.

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