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Artificial Intelligence and Sustainable Development in Business Management Context – Bibliometric Review

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Abstract

Artificial Intelligence (AI) has emerged as an innovative technology with significant potential to transform industries and societies worldwide. In the context of Sustainable Development (SD), AI presents a unique opportunity to address the managerial challenges related to sustainability. This study explores the relationship between AI and SD in the management context, highlighting the potential of AI to contribute to SD through various applications. The research presents a bibliometric literature review of scientific publications on AI and SD, identifying key areas where AI can make a significant contribution to achieving sustainability in business management. These areas include sustainable agriculture, computer sciences, economy and business management, and decision-making processes. The challenges and ethical considerations associated with the use of AI in business management literature in the context of SD were also discussed. In addition, the paper presents the implications of AI for decision-making and management practices, particularly in terms of the development of AI strategies and the adoption of AI-based solutions in environmental performance. The integration of AI into management practices can facilitate SD and help organizations achieve their strategic goals, which has been proposed and discussed in this article. Moreover, the research contributes to the ongoing discourse on the role of AI and SD in management. The study concludes by calling for further research and collaboration among various stakeholders to maximize the potential of AI in SD.

Keywords: computer sciences, decision-making, green management

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1. Introduction

Artificial Intelligence (AI) is generally considered to be an engineering discipline that seeks to create machines that can mimic human intelligence and behavior [1,2]. One of the current research directions in this field of management is the development of work models that incorporate AI solutions in place of human labor [3,4], making them easier and less burdensome [5,6]. The AI can be defined as any software technology with at least one of the following capabilities: perception - including audio, visual, textual, and tactile (face recognition) [7,8], decision-making (especially in medical diagnosis systems) [9,10], prediction (weather forecast) [11,12], automatic knowledge extraction and pattern recognition from data (discovery of fake news circles in social media), interactive communication (social robots or chatbots), and logical reasoning (theory development from premises) [6,13]. This view encompasses a large variety of subfields, including machine learning [13,14]. The recent researches dealing with AI and SD in the business management context are related to the multiple management fields, such as environmental risk management and human resource management [15,16]. This perspective reflects various processes involved in managing an organization in a broad sense.

The application of AI in management raises diversified possibilities and concerns the various stages of the management process, where AI can assist in generating benefits or solving managerial problems [17]. AI has emerged as a transformative technology with the potential to reshape industries and societies [18]. The rapid advancements in AI have led to the development of sophisticated algorithms and intelligent systems that can learn and adapt to complex data sets [19], making AI an attractive option for many industries seeking to improve their operations and bottom line [19,20]. The complexity of challenges in the business environment is growing [21,22]. With them, the data growth rate is increasing, forcing faster reactions on the part of companies and optimizing decision paths. The increase in the use of digital tools in management has made digitization and AI necessary [23]. Management uses AI embedded in advanced technological tools, where it serves one of three purposes: automation, optimization, and expansion of the capabilities of a solution. Artificial intelligence influences automation by enabling task optimization and replacing repetitive human tasks with more efficient technology in globalizing world [24]. This process does not contribute to redundancy of employees, but rather an optimization of tasks that lead to better quality jobs, improved performance, resource management, effective customer analysis, and improved competence in personalizing offerings [18,25]. Currently, the most crucial significance of AI concerns the use of generative artificial intelligence algorithms, and their impact on cost efficiency. The use of AI-embedded tools in management is diverse and not limited to advanced analytics and big data; it also supports simpler processes and operations. Organizations have a wide range of choices for using AI: they can do their research and development, develop new tools and processes, or buy solutions that can be implemented immediately.

This paper aims to explore the relationship between AI and the SD in the management context, highlighting the potential of AI to contribute to sustainable development through various applications. The research aims to address two following Research Questions (RQs):

RQ1: What is the current direction of research on applying AI in management to improve SD?

RQ2: In which fields AI supports goals established by management to achieve SD?

In this article it is assumed, that AI should create new opportunities to support management focused on realizing SD. In this study, investigated are methods and conditions for realizing SD through integration between AI and management described in the scientific literature. In this context, AI presents a unique opportunity to accelerate progress towards the SD through its potential to enhance speed, efficiency, productivity, and innovation across a range of sectors [26,27]. Given the limited results that companies are achieving in the realization of SD, the potential of AI may prove to be a new technology that will significantly facilitate the realization of SD. Therefore, new perspectives in management are linked to the high potential of AI, which is an initiating factor for great challenges [28]. Achieving sustainable growth based on AI requires implementing new solutions based on competitive algorithms [14,19]. AI is a new tool already playing a key role in the competition between companies, and from the perspective, it may represent an opportunity for SD implementation [22].

The paper presents a bibliometric literature review of the scientific publications on AI and SD, with a particular focus on the potential of AI to contribute to the achievement of the SD in business management. The review identifies key areas where AI can make a significant contribution, including resources allocation in sustainable agriculture, economy and management field, computer science and decision-making processes important for production and environmental performance. Therefore, this paper contributions are identification patterns and trends in the literature, identification of research gaps and recommendation of new research areas. Moreover, the paper discusses the

challenges and ethical considerations associated with the use of AI in the context of SD. The paper also examines the implications of AI for management practices, particularly in terms of the SD of AI strategies and the adoption of AI-based solutions. In conclusion, this paper contributes to the ongoing discourse on the role of AI in SD, highlighting the potential of AI to facilitate progress towards the SD in the management context. The paper concludes by calling for further research and collaboration among various stakeholders to maximize the potential of AI in SD.

The structure of the article is subordinated to the aim and two research questions formulated above. The article is organized as follows. In the introduction of this study, the aim of this work and research questions are presented. There is a justification of the undertaken research problem. The second section describes the research methods used in this study. In the third part, the bibliometric literature review results are presented in form of bibliometric maps and their descriptions. Next, there is a discussion of the presented results together with new research areas identification.

2. Method

The main method used in this research is bibliometric literature review [11,29]. This method employs queries to explore the Scopus scientific database [30] by the queries syntax and identify keywords-specified areas around which the topics of AI and SD in business management context revolve [31]. In this study, the bibliometric review method is used as a tool for identification of knowledge gaps [30] and indication of directions of the research based on the data collected in bibliographic databases [25,29,32]. In this paper the whole Scopus database was researched with limitations to specific years 1995-2022, as presented in Figure 1, and specific subject area (Table 1). The subject of this study is metadata of scientific literature collected in the Scopus database [11,33]. This database was selected due to its broad scientific recognition and wider collection of content than other databases. The information related to the bibliometric records of the Scopus database were explored by the bibliometric visualization tool software. The results of this method are presented in form of bibliometric maps with the use of the VOSviewer program (version 1.6.18). Therefore, the method used in this research is to perform bibliometric analysis to produce a network visualization of keywords for the queries [34]. In this method, there are two queries formulated and presented in Table 1. The queries have a syntax that corresponds with the database on which they are used and there are different numbers of query results [35], depending on formulated conditions (Table 1). First, on the Scopus website option “analyze search results” was selected to analyze the results of Q1 online [35].

Table 1. Syntaxes used in Queries after calibration for the Scopus scientific database exploration of AI and SD concepts.

Symbol	Query syntax	No. Results
Q1	TITLE-ABS-KEY ("artificial intelligence" AND "sustainable development")	3301
Q2	TITLE-ABS-KEY ("artificial intelligence" AND "sustainable development") AND (EXCLUDE (PUBYEAR , 2023)) AND (LIMIT-TO (SUBJAREA , "BUSI")	391

Source: Authors’ elaboration.

Presented queries do not differ in the publication type, years or category, because such filters were not used to explore the Scopus database [11]. The results obtained from queries were downloaded each time as a set of files in .csv format and during the export procedure, all fields on the publication were marked. Further analyses were carried out on the collected data in the VOSviewer program and the results are shown in bibliometric maps [36]. The presented queries were proposed to answer two RQs formulated in the Introduction, to indicate the current direction of research on applying AI in management to improve SD, and to define fields where AI supports process of achieving sustainability goals established by organization managers, respectively.

The research has its own limitations because the choice of the number of co-occurrences determines the result obtained in its graphical presentation and bibliometric map clarity [4]. Therefore, a minimum number of 10 keyword co-occurrences was set for each figure with the bibliometric map. The VOSviewer program allowed in this study to indicate the directions of scientific development for analyzed subject of AI and SD connections.

3. Results

In this study, 3301 articles and publications from the query Q1 and 391 articles and publications from the query Q2, respectively, between 1995 and 2022 were examined. Due to the results that could be analyzed in more detail,

only full bibliometric analysis of the 391 results from Q2 was undertaken. The year 2023 was discarded in the analysis due to new ongoing publications. The articles and publications from the above queries were selected from the Scopus database.

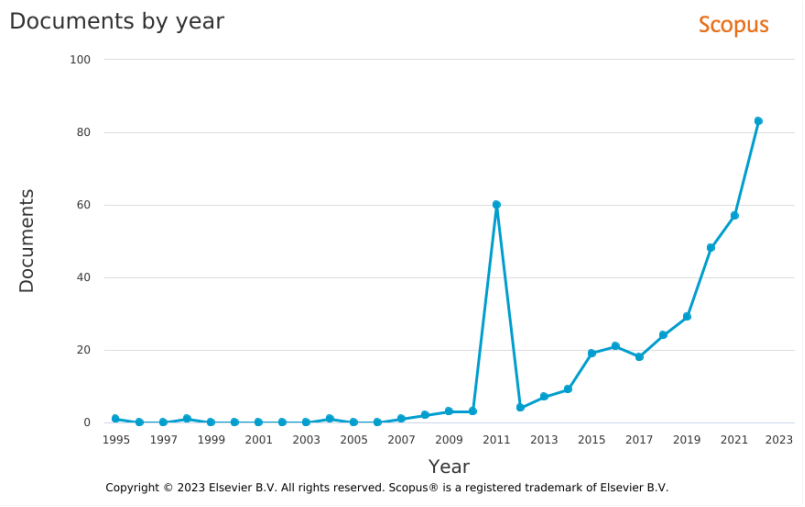

Fig. 1. Publication graph from Query Q2 showing number of publications in given years. Source Authors elaboration in Scopus.

Figure 1 shows the number of publications per year that were correlated with SD and AI. The publication dates show an increasing trend since 2011. This is when publications related to SD and AI peaked. A possible reason for the spike in publications in 2011 was the start of the introduction of the Sustainable Development Goals (SDGs) to replace the Millennial Development Goals (MDGs). Additionally, the reason for the observed peak in 2011 was the number of the conferences dedicated relations between AI and SD, the materials of the single conference were responsible for the observed change in graph (Figure 1). Subsequently, since the pandemic period [37], the number of publications started to increase significantly. The world, looking for automation, turned its attention to the use of AI to achieve the SDGs [38].

In order to explore the links between the keywords “artificial intelligence” and “sustainable development”, VOSviewer software was used to map the network of links, based on keywords and indexed terms in the Scopus database [36]. Based on the results of Q2, after applying a factor of 10 common links, 45 keywords were analyzed respectively. The results were automatically colored and converted into 5 clusters in VOSviewer. Figure 2 presents the keywords most frequently used in scientific publications on “artificial intelligence” and “sustainable development”.

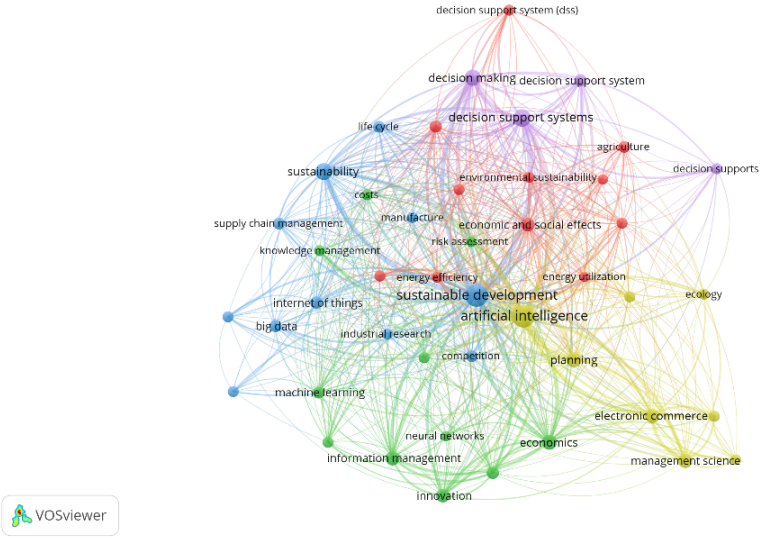

Fig. 2. Indexed keyword co-occurrences in the full counting method of Q2 results. Source: Authors' elaboration.

In Figure 2, five linked networks of bibliometric maps have been created to show the connections and co-occurrence of the topic of AI and SD. Lines extend between the keywords, indicating connections and publications related to the co-occurrence of the keywords [36]. Larger lines represent more co-occurrences. The most numerous connections include: "artificial intelligence", "sustainable development", "sustainability", "decision support systems" and "decision making". The largest co-occurring sets are in the center of the Figure 2 and are arranged in clusters. Heading outwards to the keywords, weaker links can be observed. The keywords from the common disciplines were automatically divided into five clusters. It can be observed that electromobility [39], a trend of the last few years , does not appear directly and specifically among the keywords studied [40,41]. Instead, general keywords such as "innovation", "ecology" or "sustainability", which can be identified with many specific aspects of the market, dominate.

The three most numerous clusters are red, green and blue. Each has 11 elements (keywords). The red cluster shows environmental and social aspects. green indicates innovation and management. Blue is modern technology and development. Yellow is applications of AI. The last purple one focuses on decision-making. The fourth, blue cluster contains eight and the least numerous fifth, purple cluster contains five items (Table 2). The network nodes in the study are represented by terms or keywords. Between the keywords there are links or connections represented by edges [30]. Edges "are co-occurrence links between terms" [36]. Each type of map consists of only one type of links.

Table 2. Clusters automatically presented by the VOSviewer and presented in Figure 2.

Cluster	Color	Keywords
1	red	agricultural robots (10), agriculture (16), climate change (15), decision support system (dss) (14), developing countries (12), economic and social effects (32), energy efficiency (15), energy utilization (11), environmental sustainability (15), environmental technology (15), supply chains (20)
2	green	costs (13), economics (50), forecasting (13), information management (37), innovation (30), knowledge management (14), learning systems (14), machine learning (18), neural networks (10), regional planning (23), risk assessment (10)
3	blue	big data (20), competition (17), industrial research (10), industry 4.0 (13), internet of things (22), life cycle (17), manufacture (12), supply chain management (16), sustainability (81), sustainable development (286), sustainable development goals (12)
4	yellow	artificial intelligence (300), ecology (13), electronic commerce (43), environmental management (12), industry (15), management science (36), planning (51), research and development management (10)
5	purple	decision making (65), decision support system (23), decision support systems (100), decision supports (13)

Source: Authors' elaboration.

The above collections are the result of automatic calculations made by the VOSviewer software. The collections are arranged in relation to the number of elements. The order of the keywords is in alphabetical order. The number of occurrences of a keyword is indicated in brackets.

Based on Figure 2 and the results from the Q2 query, Figures 3 and 4 are proposed. Figure 3 is an overlay of keywords from 2012 to 2018, which is a limited time frame due to the 2011 peak shown earlier in this section. The colour bar in the bottom right corner of the visualisation indicates how the scores are mapped to colours [42,43]. The overlay visualisation is identical [36] to the network visualisation (Figure 2). This is the result of using VOSviewer software and the full count method for indexed keywords that met the threshold of ten co-occurrences [11]. This overlay analysis shows, in darker colours, the oldest keywords related to the evolution of the topic of linking artificial intelligence and sustainable development, while the lighter colours present relatively new and fresh keywords. The changing trends of the side studies in relation to the core skeleton of the two main keywords can be observed. The items shown in Figure 4 are scored and the colour of each item depends on its score [36], where by default the colours range from blue (lowest score) to green and yellow (highest score) [4]. Keywords highlighted in yellow are located in the margins of the overlay map (Figure 3). This indicates relatively low correlations over the period analysed, with the possibility of seeing new research directions, otherwise trends. Yellow keywords include "learning systems", "knowledge management", "life cycle", "industry 4.0", "manufacturing" and "industrial research", among others. The darker colours are in the centre. They point towards the underlying research themes from the beginning of the analysed period and present a change over time combined with the presentation of new sectors. This indicates a strong link between the sustainable development sector and artificial intelligence. Point attributes are included in the visualisation generated by the VOSviewer software (Figure 3). Point attributes are not included in the network visualisation (Figure 2) and the density visualisation (Figure 4).

In order to test the power of the keywords presented in Figure 2, a density visualisation is proposed in Figure 4. The three most frequently used keywords (100 or more occurrences in Table 1) are shown in yellow in Figure 4. These words form a central triangle and are artificial intelligence (300 occurrences), sustainable development (286) and decision support systems (100). There are also other keywords with a significant number of occurrences; however, they are strongly related to the indicated three clusters and leading keywords. Therefore, the weight of the keyword indicates its importance. In the visualization of the map presented in Figure 4, keywords with a higher weight are shown more prominently than items with a lower weight [4]. The Figure 3 has automatically generated legend for years 2012-2018, which allowed to distinguish the older (darker) and the newest co-occurring keywords in the explored literature.

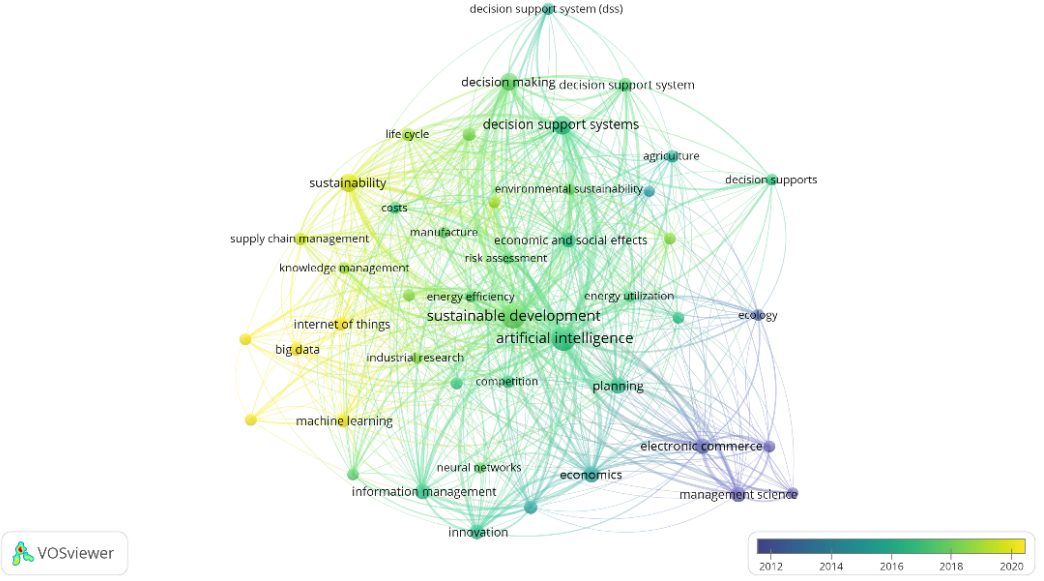

Fig. 3. Overlay map of the indexed keyword co-occurrences. Source: Authors' elaboration

Density visualisation can be performed in two variants as: position density visualisation and cluster density visualisation. In Figure 4, shown above, an item density – position density visualisation was performed [30]. The keyword density visualisation was generated from within VOSviewer via the radio button on the right in the options panel. In the item density visualisation (Figure 4), keywords are represented by their labels in a similar way to the network visualisation. Each point in Figure 4 has a colour which, through its saturation, represents the density of the keywords at that point. By default, the colours take values from blue through green to yellow [25]. The higher the number of elements in the neighbourhood of a point, the higher the weights of the neighbouring elements [30]. The closer the colour of the point is to yellow, the higher the weights of the neighbouring keywords [36]. In the centre of Figure 4 there is a cluster of keywords with a higher density.

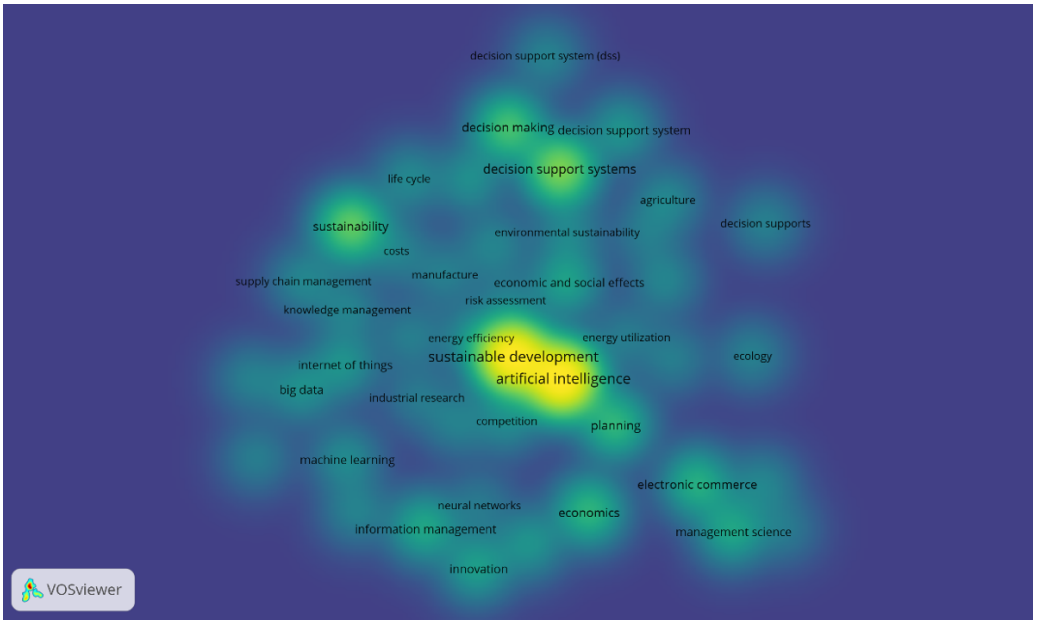

Fig. 4. Item density visualization. Source: Authors' elaboration

In the study carried out, it can be seen that the most significant keywords do not necessarily belong to the most numerous clusters. As in Figure 2, decision support systems and decision-making have a noticeably higher density. In contrast, the term "sustainability" shows a low density.

4. Discussion and Conclusions

This article aimed to identify keyword-specified areas around which the topics of AI and SD in business management context revolve in the literature. To address this research problem two RQs were stated in the introduction section and related to the directly queries were proposed in the methods section. In this paper 3301 (Q1 in Table 1) and 391 (Q2 in Table 1) peer-reviewed academic publications associated with AI and SD using Scopus were identified. The performed analyses are not fully comprehensive; however, they present the most popular keywords, associated with AI and SD in business management literature indexed in Scopus scientific database. The presented results show that the use of terms related to the explored in bibliometric maps and reveal the context of their use. Analysis of the results proved that AI support goals established by management to achieve SD in the following areas: sustainable agriculture, computer sciences, economy and business management, and decision-making processes.

Emerging new concepts make it difficult to carry out a comprehensive analysis of the concepts. Therefore, the analysis undertaken focuses on commonly occurring synonyms. The analysis undertaken is devoid of the mantle of linguistic research or semantic analysis of words. At the same time, it may be an interesting new direction for future

research, which may show the different perceptions of researchers regarding AI and SD, as intertwined ideas. Such different nomenclature forces researchers on the subject, to analyze the content of individual articles quite meticulously at the stage of selection for analysis, which is carried out using programs such as VOSviewer. Researchers should especially pay attention to keywords with no reference to sustainability issues. This forces researchers to perform an in-depth qualitative analysis of the surveyed publications when qualifying them for analysis using VOSviewer. Only after such a qualitative analysis that leads to the exclusion of articles not related to the combined topics of AI and SD the analysis procedure in VOSviewer software can be applied. The researchers, therefore, drew attention to the need to implement SD and AI into economic practice. This explains the growing interest in SDGs, not only from a scientific but also from a practical point of view.

A limitation of this study is the lack of detailed dynamic analysis performed in VOSviewer which addresses the strength of the connections between individual keywords. Such a dynamic analysis is only possible when using the VOSviewer program and its graphical representation is impossible due to a large number of identified connections. This type of analysis can be explored in the future extended studies. Those future studies can be supported by the collaboration of various stakeholders to maximize the potential of AI in SD, especially in field of self-employment or green jobs creation.

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