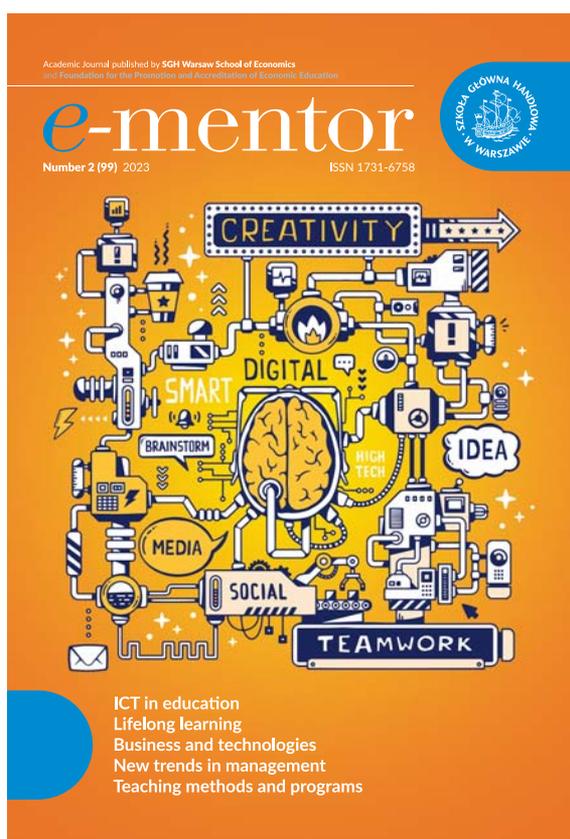


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Artificial Intelligence – an agenda for management sciences

Abstract

Nowadays, the need for digitisation and digitalisation of enterprises, as well as the use of solutions based on Artificial Intelligence (AI), are coming to the fore. The use of intelligent systems in organisations is not a strictly technical issue, and is also important in the management of modern enterprises. The aim of this article is to provide a theoretical analysis of the phenomenon of Artificial Intelligence in management sciences by means of a systematic review of the literature using Scopus database records. Bibliographic analysis of Artificial Intelligence in management sciences in this article points to this topic as something relatively new in the case of management sciences, although rapidly developing. As part of the bibliographic analysis we propose an agenda regarding the issue of AI in management sciences, consisting of thematic clusters related to technologies based on and complementary to AI, the goals of using AI in organisations, human-AI relations and issues related to ethics and sustainable development.

Keywords: Artificial Intelligence, management, literature review, agenda, keywords analysis

Introduction

Companies are currently subject to constant internal changes, as well as changes related to the external environment. Dealing with them requires not only an appropriate response, by adapting to new conditions, but also a pre-emptive, anticipatory response, and even creating changes through innovative processes in the company. Current market characteristics provide innovative companies with a big chance of success by gaining an advantage over their competition, with staff at all levels characterised by a high level of competence, tailored to that required at specific workplaces.

Not only is this topic important today, but the literature analysis shows that the importance of using Artificial Intelligence for management sciences will continue to grow – along with the increasing involvement of such technologies. AI can play a role in management by helping managers make better decisions. For instance, AI algorithms can be used to analyse data and provide managers with insights and recommendations that they might not have come across themselves. AI can also be used to automate certain tasks, such as scheduling and data entry, which can free up managers to focus on more strategic and important work (Walsh, 2017). Additionally, AI can be used to improve the efficiency of a business by streamlining processes or identifying areas for improvement. Overall, the use of AI in management can make business more effective and efficient, and provide managers with the necessary tools to make better decisions (Rathore, 2023). According to predictions of the World Economic Forum (2015), we must be ready to accept that in the future machines with Artificial Intelligence will sit on company boards of directors, and audits will be carried out by artificial intelligence. In addition, researchers predict that by 2050 firing employees through specially programmed robots will become the norm, and managers will be able to spend the time saved on tasks related to strategic and long-term aspects of the business (Walsh, 2017). Research has revealed emerging trends in AI in management science, with an interesting fact being that over time the attention of scientists will shift from technical issues to social issues, such as the ethics of using AI or supporting such technologies in the field of sustainable development.

The aim of this article is a theoretical analysis of the phenomenon of Artificial Intelligence in management sciences, as well as discuss which AI-related topics have

occupied the attention of management researchers in recent years. To achieve this goal, a systematic review of the literature on the issue using Scopus database records was used.

Justification for addressing the topic of trends related to Artificial Intelligence in management sciences

Dynamic changes in technology and society caused by the disruptive consequences of the Fourth Industrial Revolution are causing profound changes in our reality, both socially and economically. One of the most important pillars of technological change is the increasingly common and perfect use of solutions based on Artificial Intelligence (Schwab, 2016). The increasing impact of these solutions is also reflected in the growing interest in the subject of AI on the part of scientists of various fields. Figure 1 shows how the number of scientific publications on Artificial Intelligence in the Scopus database has been developing over the years.

An analysis of the number of publications on Artificial Intelligence over the years leads to a conclusion that this topic has seen a constant, growing interest of scientists, which confirms the importance of this issue and the need to consider this topic when analysing trends, which is the aim of this paper. Also worth emphasising is the huge increase in the number of publications that took place after 2000. This also demonstrates the novel nature of the topic of AI.

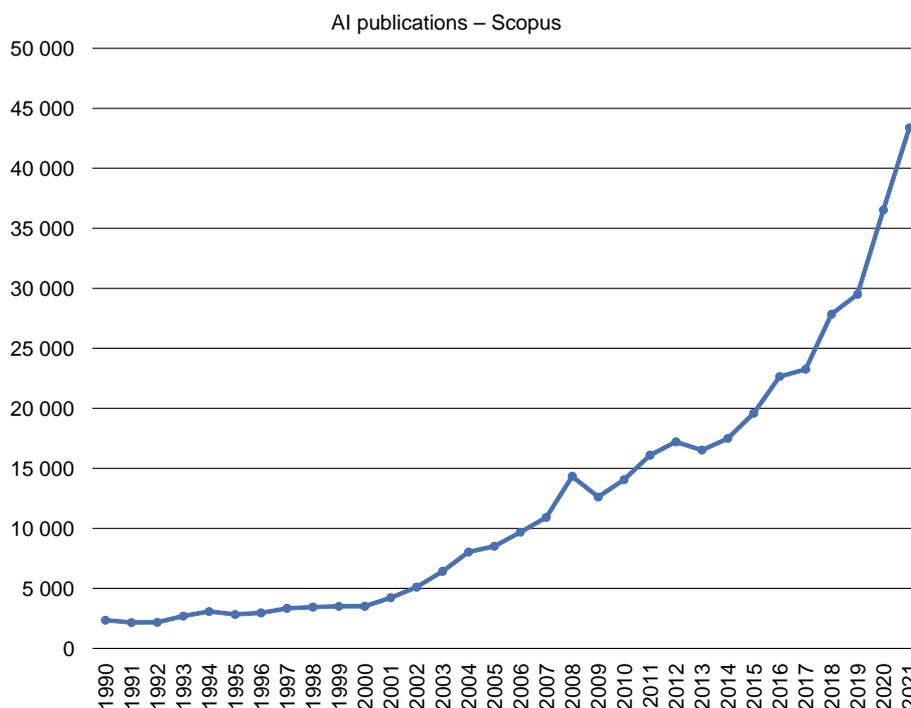
Such conclusions can be reached by analysing the distribution of fields (Figure 2) when it comes to publications on AI.

Technical and mathematical sciences largely dominate in the fields in which papers on Artificial Intelligence are published. *Computer Science* shows over 300,000 publications, while *Engineering* and *Mathematics* over 121,000 papers. Texts assigned to social sciences only account for 22.7 thousand papers, while the equivalent of management sciences, i.e., *Business Management and Accounting*, is covered in only 12.6 thousand publications. Figure 3 shows the development of the number of scientific publications over the years in the field of management in the Scopus database.

A compilation of all this data shows that there is a research gap in the description of the issue of the impact of AI on social sciences, especially on management issues in organisations. A very interesting outcome of the analysis of the total number of publications and the number of publications in the field of management is the fact that the topic of AI reached this area rather late. In the overall ranking, a sharp increase in the number of publications can be observed since 2002, while in *Business Management and Accounting Area* since 2008. This emphasises the importance of the subject of this paper, with the topic of Artificial Intelligence in management sciences proving to be essential, innovative, and novel.

Based on the above considerations, a bibliometric analysis of keywords and abstracts was made, as an introduction to a further deeper analysis of scientific

Figure 1
Number of publications on Artificial Intelligence in the Scopus database (1990–2021)

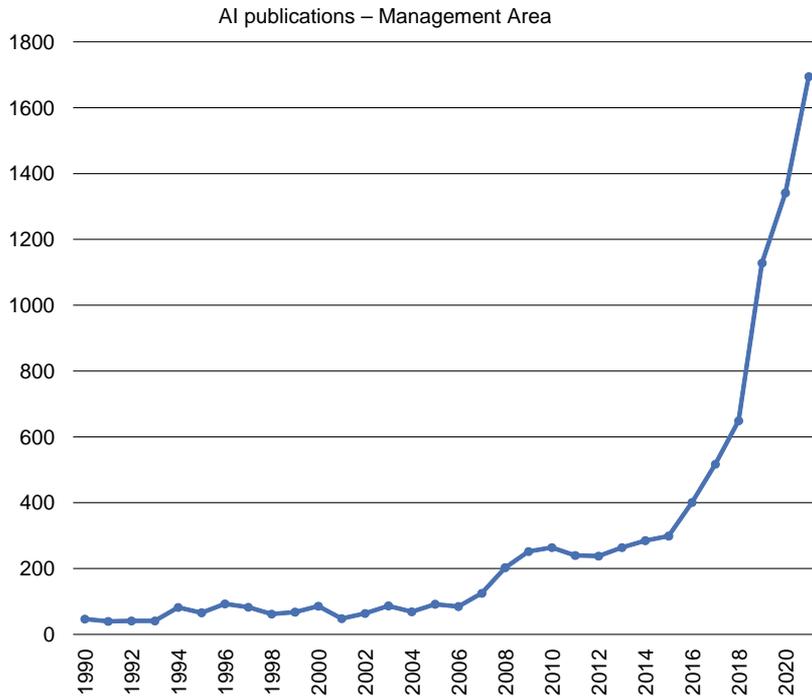


Source: author's own work.

Artificial Intelligence – an agenda for management sciences

Figure 2

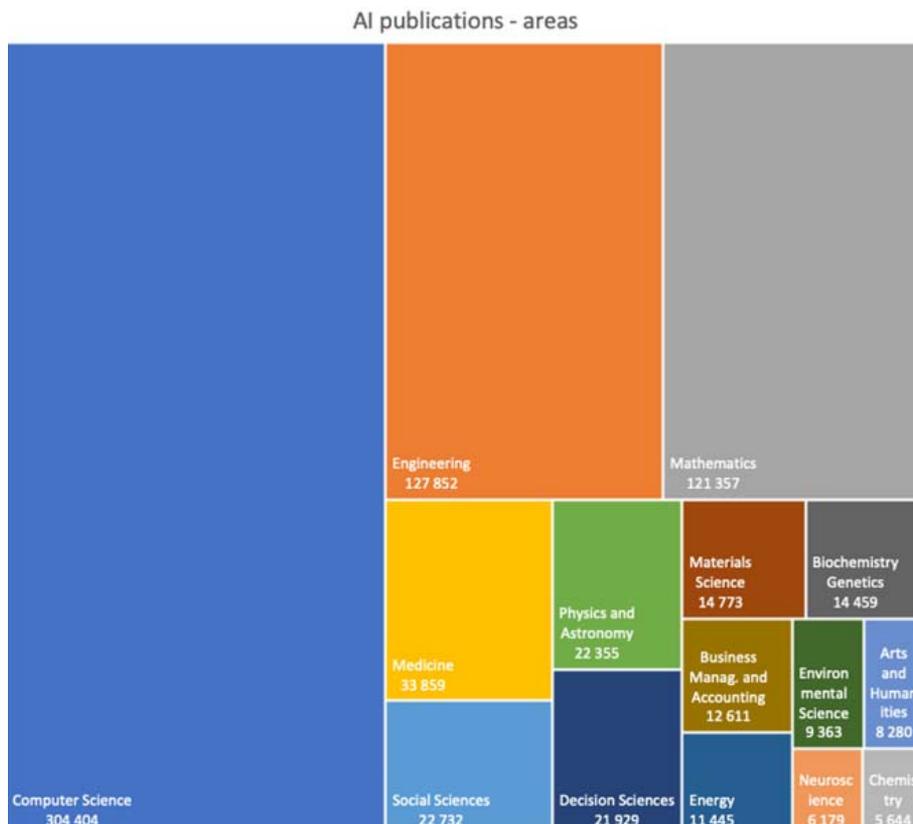
Number of publications on Artificial Intelligence in the Scopus database broken down by areas



Source: author's own work.

Figure 3

Number of publications on Artificial Intelligence in the Scopus database in the field of management



Source: author's own work.

texts, which enabled the identification of trends in the description of AI technologies in management sciences.

Methodology of trend research in describing the issue of AI

A systematic literature review was conducted to present research describing the use and impact of AI technology on management sciences. The first phase of the research used bibliometric analysis, a method with a long history of use in business research (Smith, 1977) that can be helpful in assessing trends (Xie et al., 2018). Systematic literature review is a frequently used tool in management and quality science papers (Bramer et al., 2017; Kosch & Szarucki, 2020).

The first step was to run a query in a selected databases, the choice of which is crucial when it comes to the search strategy. This analysis was carried out using the Scopus database, a scientific database maintained by Elsevier, which is one of the most renowned and popular among scientists, and most importantly one of the most extensive databases in the world.

A significant step in systematic literature review and classification methods is the selection of categories that will be used to organise the data, in order to avoid omitting categories or works that are unknown to the researcher or treated as less important (Wawak et al., 2020; Xiao & Watson, 2017). Therefore, on 12 February 2022 the following search was carried out in the Scopus database:

- TITLE-ABS-KEY (artificial AND intelligence) AND (EXCLUDE (PUBYEAR, 2022)) AND (LIMIT-TO (SUBJAREA, "BUSI"))

In the titles, keywords and abstracts, the phrase *Artificial Intelligence* was searched, limited to the field of *Business Management and Accounting*. It should be mentioned here that the year 2022 was excluded, as during the research process it was still not over. The search in the Scopus database came up with 11,576 results.

On the basis of the obtained results and quantitative analysis of keywords, the author developed a proposed agenda as a set of individual thematic clusters in the description of the SI issue. The next step was an in-depth qualitative analysis of selected texts from individual thematic clusters, making it possible to understand in detail which issues are discussed within individual thematic clusters.

Analysis of AI trends in management

A keyword analysis made it possible to determine the trends that prevail among scientists when it comes to the broadly understood concept of Artificial Intelligence in management sciences. The bibliographic analysis of the literature enabled an extraction of 24,038 keywords from the Scopus database, among which we determined the keywords with the highest occurrence rate.

Table 1 shows an aggregate of the most popular keywords along with the number of their occurrences in the years 2000–2020.

Table 1
A collection of the most popular keywords with the number of their occurrences in the years 2000–2020 – Scopus

Keyword	Occurrences
Machine Learning	731
Decision Support Systems	692
Big Data	237
Neural Networks	196
Internet of Things	185
Data Mining	155
Deep Learning	153
Simulation	137
Industry 4.0	129
Expert Systems	125
Knowledge Management	100
Automation	98
Blockchain	96
Optimization	94
Decision Making	88
Sustainability	82
Ethics	80
Digitalization	77
Natural Language Processing	76
Innovation	75
Forecasting	72
Digital Transformation	72
Active Learning	72
Robotics	70
Cloud Computing	65
Supply Chain Management	64
COVID-19	57
Social Media	56
Scheduling	55
Artificial Neural Network	55
Trust	52

Source: author’s own work.

The largest number of occurrences is related to keywords related to the technological aspects of Artificial Intelligence and other related technologies, e.g., *Machine Learning, Big Data, Neural Networks, Deep Learning, Blockchain, Natural Language Processing, Cloud Computing*. This further suggests that much of the work stems from the technological aspects of the operation or implementation of AI, while soft aspects, e.g., the impact of AI on employees, competence preparation or sustainability, are less often undertaken.

Keywords appearing in the general overview such as: Decision Support Systems, Data Mining, Simulation, Automation, Digitization, Innovation, Scheduling, and Forecasting indicate in which areas organisations can use AI-based solutions, the most popular being a decision support system based on the analysis of large amounts of data that can be processed based on AI technologies. AI can also support an organisation's innovation and efficiency by automating processes. In addition, the collection and analysis of a large amount of data can be used to forecast, as well as predict, trends in the economy, which with the current level of volatility is crucial for an organisation to adapt and actively take advantage of a market situation.

In the general overview you can also find (less common) keywords that indicate the trend of describing AI technologies and the changes caused by them from the “soft” side. Words such as Sustainability, Ethics or Trust prove that such breakthrough technologies as AI should be considered from the technical, technological, and (equally important) social perspective.

The occurrence of keywords in particular years is not homogeneous, as there are similar keywords occurring in certain years, but you can see that the trends in the description of AI in management sciences are progressing and changing over time – trends are not homogeneous.

An analysis of the most popular keywords in particular years shows throughout the years the key topics related to AI were the issue of machine learning or a decision support system, with strictly technical trends dominating in the earlier years. It was only in the subsequent years that the emergence of the social side of the changes caused by artificial intelligence was observed.

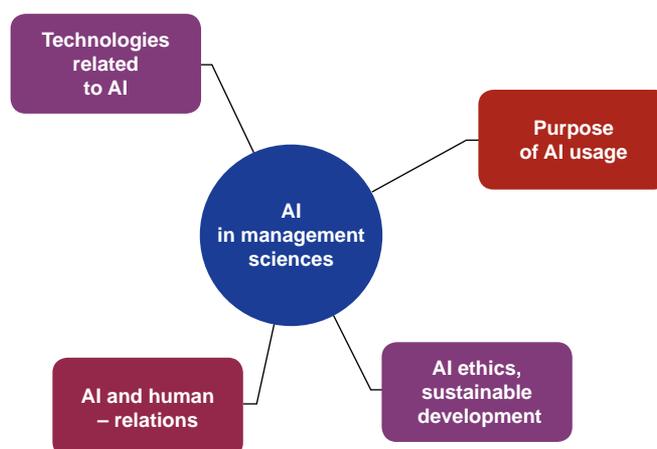
The next stage of the literature analysis was the author's clustering of individual trends into similar thematic classes, and then an in-depth analysis of selected texts included in individual clusters. The individual thematic clusters are presented in Figure 4.

Analysis and description of thematic clusters from literature research

When discussing technologies based on or related to Artificial Intelligence that are used in organisations (**cluster 1 – technologies**), mention should be made of *Machine Learning*, which is a branch of Artificial Intelligence technology that describes techniques and mathematical formulas that enable a system (machine) to independently generate knowledge from experience (Bell, 2014). Machine learning algorithms detect patterns in input, learn from mistakes, and can correct themselves (Canhoto & Clear, 2020).

In the modern economy, organisations, thanks to solutions such as the Internet of Things, have access to an infinite amount of data in real time. An example of how machine learning works is AlphaGo Zero, which mastered the Go board game by repeating the game against itself and learning from its mistakes (Silver et al., 2017). It is worth noting that nearly 90% of the developed patents of intelligent technologies use *machine learning* (WIPO, 2019), and machine learning technologies are driving the automation of business processes in an increasing number of areas (**cluster 2 – purpose of use**). The literature gives applications ranging from, for example, the calculation of optimal transport loads to a quick assessment of the applications of people applying for a loan. The popularity of machine learning technology is rooted in a much lower cost intensity than in the case of using human labour (Castelli et al., 2016). Research among senior managers shows that the areas in which machine learning is most often used are *optimisation* and automation of business processes, core business activities, improvement of business models and *forecasting* (Paschek et al., 2017). AI algorithms can be used to analyse data and provide managers with insights and recommendations that they might not have been able to see on their own. AI can also be used to automate certain tasks, such as scheduling and data entry, which can free up managers to focus on more strategic and important work (Hoffman, 2016).

Figure 4
AI in management sciences – thematic clusters



Source: author's own work.

Deep learning is a special type of machine learning technique that can learn from unlabeled data (LeCun et al., 2015). Many companies base their data management on *Deep Learning* technology. Apple, Google, Facebook and Microsoft collect a large amount of data every day through applications such as Siri, Google Translate, or Bing voice search and use this technology to analyse them to provide a number of other services, such as reminders, weather forecasts, personalised recommendations or advertisements (Munappy, 2019).

The use of machine learning, i.e., learning from a huge amount of data, is related to the concept of *Big Data*, which has also been a frequent topic of consideration for scientists, given the conducted keyword analysis and the work of other scientists (Sheng et al., 2017). *Big Data* is a huge amount of data generated in real time from an increasing number of sources, including, for example: online clicks, mobile transactions, user-generated content, and social media, as well as intentionally generated content through a network of sensors (e.g., real-time production data from factory 4.0 devices) or business transactions, such as sales inquiries and purchase transactions (George et al., 2014). *Big Data* resources are characterised by (McAfee & Brynjolfsson, 2012):

- *Variety* – resulting from the fact that the company generates huge amounts of data from various sources, in sensors, systems, applications, machines and devices and communication processes between them.
- *Velocity* – data is delivered and analysed in real time.
- *Veracity* – information generated from real data facilitates making the right decisions.

Big Data is crucial when it comes to management (Sheng et al., 2017), and collecting and properly analysing data (using technologies supported by AI) is necessary with regards to proper optimisation of processes in an organisation (**cluster 2 – purpose of use**). For example, *Big Data* can be used to analyse employee behaviour, using sensors or badges to track people while they work, move around the workspace, or spend time interacting with others or assigned to specific tasks (George et al., 2014). In marketing activities, *Big Data* analytics can help track and predict customer behaviour and needs, while in the context of management accounting or management, the data obtained, and the information processed through AI, can help generate relevant and useful information to support decision making (*Decision Support System, Decision Making*) (Gärtner & Hiebl, 2018; Gupta et al., 2022).

A significant volume of communication between sensors and devices gave rise to the *Internet of Things*. The Internet of Things is the contact between objects and people, which is “a dynamic global network of physical objects, systems, platforms and applications” (Furmanek, 2018, p. 58). The detectors and sensors installed in production equipment make it possible to predict a failure or possible manufacturing defects in advance. Data (*Big Data*) obtained through Internet of Things (IoT) solutions plays a key role in all kinds of

technologies such as, for example: public safety, *smart houses*, logistics and traffic control, protection and prevention of environmental degradation, intelligent fire control, the monitoring and control industry, etc. (Li et al., 2017). The great emphasis on data analytics and their use is also confirmed by the frequent occurrence of *data mining* as a keyword in publications, which means looking for relationships, patterns, or dependencies in the acquired data, for which solutions based on Artificial Intelligence can be used.

An interesting observation is the frequent occurrence of the keyword *blockchain* in connection with AI. *Blockchain* is a decentralised, public, explicit, and distributed ledger, located in a distributed network infrastructure, a kind of electronic letter on which all transactions between many users are chronologically recorded (Swan, 2015). The use of *blockchain* technology means that Artificial Intelligence will be able to process data obtained in real time and in huge amounts from various organisations cooperating with each other. The significant costs of preparing and submitting documentation (GATF, 2021) will reduce the blockchain-based digital identity of exchange participants, goods, and places in supply chains, which will make it possible to verify the origin of products and track their path. Digital representations of real assets would make it possible for relevant data to reach stakeholders without the need to store it in the data warehouses of individual companies, while supplementing the blockchain-based system with Artificial Intelligence would improve the exchange of data and information. For example, if algorithms detected a high probability of bad weather conditions, they would recommend changing a ship’s route. Another example is the transport and storage of refrigerated goods or fast-moving consumer goods (FCMG), where if a sharp increase in air temperature is detected in a specific place, refrigerated vehicles or refrigerators in warehouses would be instructed to turn on additional cooling (Treat et al., 2018).

An important element of management researchers’ reflections on AI is the relationship between Artificial Intelligence and humans (**cluster 3 – relationships**). A literature review confirms that the Fourth Industrial Revolution brings with it profound changes in the characteristics of work and the requirements for individual employees (Jarosz et al., 2020). The new digital reality requires us to quickly adapt to the ever-changing technological reality and gain “*digital trust*”. Digital trust can be referred to the level of confidence that people have in the security, reliability, and integrity of digital systems and technologies (in this paper this would be Artificial Intelligence). Digital trust is crucial when it comes to implementation of AI technologies, because it helps people feel secure when using technology, which is increasingly prevalent not only in the workplace but also in our daily lives (Sołtysik et al., 2022).

The challenges faced, especially in Poland, are considerable. Despite the increase in the “digital engagement” of the public during the COVID-19 pandemic, general digital skills regarding computer and Internet use (searching for information on the web, digital

communication using online mail or instant messaging) remain at a low level in Poland compared to other European Union countries. In 2021, the proportion of people who had at least basic digital skills was 79% in the Netherlands and Finland (which were the highest rates), which the lowest scores were recorded for the citizens of Romania (28%), Bulgaria (31%) and Poland (43%) (Eurostat, 2021).

The need to improve their digital competences was also noticed by the employees themselves. According to a TOP CDR report – Digitally Responsible Company Survey (2019), 40% of respondents consider an organisation that conducts training in the field of increasing digital competences to be a digitally responsible company – not downsizing because of automation. One in three respondents are of the opinion that work automation with the use of robots will force them to retrain or change jobs in the next 10 years, while the same number of people indicate that in the last 3 years the implementation of modern technologies has led to a reduction in employment. In the U.S., the level of fear of automation is even greater, and according to a *PewResearch* study (2022) as many as 72% of respondents are afraid of automation, with the vast majority more concerned than excited about the increased use of Artificial Intelligence in everyday life (Rainie et al., 2022). Those more concerned than excited cite their concerns about potential job loss, privacy risk considerations, and the prospect that the development of Artificial Intelligence could make it surpass human abilities. Some also argue that AI will lead to the loss of interpersonal ties. Those who are “more excited than anxious” point to aspects such as the time savings that AI can bring to everyday life. Respondents also pointed to the fact that Artificial Intelligence systems can be helpful in the workplace: they will automate routine activities and improve cyber security (Rainie et al., 2022). Interestingly, the approach to AI differs depending on the level of education. A higher percentage of people with secondary education or lower say they are more anxious than excited (40%), compared with those with a university degree (32%). This shows how important it is to properly educate people about Artificial Intelligence when it comes to approaching such technology.

The last separate thematic cluster is the trend related to sustainable development (**cluster 4 – sustainable development**). Companies operating in the current economic and social conditions face not only increasingly extensive legal regulations related to environmental protection or ensuring employee rights, but also the expectations of consumers and other stakeholders in the field of sustainable *development*.

In addition, in a world struggling with climate and energy crises, sustainable development is posed as a response to global challenges (Jarosz et al., 2022, Zakrzewska et al., 2022) caused by degrading human activity in both developed and developing countries (Bombiak & Marciniuk-Kluska, 2018). Furthermore, the growing popularity of the concept of sustainable development is also preceded by the growing aware-

ness of societies in the field of ecology and economic processes consistent with the principles of *ethics* and corporate social responsibility (Jerónimo et al., 2020). The basic motivation of companies regarding sustainable development is the desire to reduce the negative impact of the organisation on the environment and increase social involvement (e.g. activities for the benefit of local communities) while improving (or at least not affecting) the company’s financial results (Baumgartner & Rauter, 2016). Researchers suggest that such environmental intelligence can be a powerful tool supporting global efforts to promote sustainable economic development, while at the same time sustainably counteracting the negative impact of production and consumption on societies, management systems and the environment (Goralski & Tan, 2020). For example, optimisation methods using Artificial Intelligence can be used to better manage water resources (Goralski & Tan, 2020) or renewable energy resources (Vinueza et al., 2020), reducing the impact of noise from various sources, such as road and rail transport, construction, and operations. etc. (Mrówczyńska et al., 2019).

The trend towards sustainable and ethical use of AI technologies is being promoted by scientists as one of the most important current and upcoming developments in such technology. Interviewing experts in the field of AI, Velarde (2021) argues that among the “ideal” SI trends are the following aspects: ethics, data use, human-machine interaction, learning along with a deep understanding of Artificial Intelligence in theory and practice, its regulation, explainability, reproducibility, trust, and security. It should be essential for organisations to both be and stay up to date on the latest security technologies and best practices, and to be transparent and responsive in their handling of, for instance, security issues related to Artificial Intelligence (Dhingra et al., 2016).

Conclusions

Artificial Intelligence already significantly impacts virtually every area of our lives, and its importance, especially in the context of the development of modern enterprises, will be growing.

The current characteristics of a highly-digitised market are forcing enterprises to constantly implement new technologies, with innovative companies having a greater chance of success and gaining an advantage over the competition, due to their staff showing a high level of competence, tailored to the profile required in each case.

This article contributes to the understanding and discussion around the incorporation of Artificial Intelligence in management, and also organises the knowledge and topics dealt with by scientists with regards to artificial intelligence in management. A bibliographic analysis of AI in management sciences for this paper has shown that this topic is relatively new for management sciences, but is developing at a rapid pace, with an agenda for the issue of AI in management sciences proposed, consisting of thematic clusters related to

technology based and complementary to AI, goals of using AI in organisations, human-AI relations and issues related to ethics and sustainable development.

Summarising the above considerations and research on trends with regards to AI in management sciences, it should be stated that analysis on this topic is characterised by a large thematic range and variability over time.

Initially, experts' efforts focused on the technical aspects of AI, but over time the issues of using such technology to improve decision-making or optimise processes in organisations came to the fore. The latest trends in Artificial Intelligence are topics related to the social consequences of AI technology, its impact on and relation with humans, the ethics of use or the impact on sustainable development. AI can help with sustainability in several ways (Goralski & Tan, 2020). For example, AI algorithms can be used to analyse data and identify patterns and trends that can help to identify areas where a business or organisation is not sustainable, where such information is then used to make changes that can help to reduce waste and improve efficiency. Additionally, AI can be used to automate certain tasks, such as monitoring and controlling energy use, which can help to reduce a business's carbon footprint. Furthermore, it can be used to develop new technologies and solutions aimed at addressing environmental challenges, such as renewable energy sources and sustainable transportation. Overall, the use of AI in sustainability efforts can help businesses and organisations operate in a more sustainable way and help protect the environment. Future considerations of scientists should focus on empirical solutions regarding the impact of Artificial Intelligence on the development of sustainable organisations and the attitude of employees working with intelligent systems in organisations towards these technologies.

To summarise, Artificial Intelligence is a very important issue for management sciences, both in terms of technology (implementation of systems) and the attitude and belief of employees in the changes and transformations taking place in enterprises.

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