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SYSTEMATIC REVIEW - INNOVATIVE APPROACHES IN ARTIFICIAL INTELLIGENCE DEVELOPMENT

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Abstract

This study analyses current advances and challenges of artificial intelligence (AI) development through a systematic literature review. The literature search was conducted across major databases including IEEE, ScienceDirect and Scopus. Peer-reviewed articles published between 2016-2023 were included based on relevance to the research topic. Out of 152 initial search results, 48 articles were selected for in-depth review using PRISMA guidelines. The results were analyzed to identify key focus areas, techniques and applications of AI over the selected period. The study found a significant increase in AI-related publications in 2022-2023 (62% of selected articles), indicating growing research interest. Key application areas identified are smart cities, education, image processing and medicine. Machine learning methods like neural networks and deep learning were frequently applied for tasks like classification, prediction and pattern recognition. Along with opportunities, ethical concerns like privacy, security, transparency and bias were major AI challenges discussed. Developing standards, regulations and testing mechanisms to ensure reliability and fairness of AI systems was highlighted. In summary, the systematic review demonstrates the rising significance of AI across industries, while underscoring the need to proactively address risks for its safe and ethical development. Overall, the study confirms that AI has great potential in various industries, but its implementation requires the development of ethical standards and data security to maximise benefits and minimise risks. The practical significance of the study is to deepen knowledge about AI and its impact on modern society.

1.0 INTRODUCTION

Artificial intelligence (AI) is an integral part of the modern technological era, actively penetrating all spheres of life. From medical diagnoses and autonomous cars to financial forecasts and personalised recommendations, innovative AI solutions are becoming a significant driver for the continuous growth of efficiency and empowerment of modern society. The relevance of the chosen topic is due to the powerful impact of AI on various aspects of life. Modern AI technologies are already able to change and simplify many routine tasks, but at the same time, they pose new challenges and questions. Understanding these challenges and finding approaches to AI development is a critical task for technological progress and ensuring the harmonious development of society.

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The research concerns several important aspects. First, the limitations of AI are a relevant topic, as AI systems are not always able to solve different types of tasks efficiently. Anticipating and understanding these limitations can contribute to the further development of the technology. In addition, security and data privacy issues related to the use of AI are critical to ensuring user trust and protecting their rights. Another important research issue is the impact of AI on the labour market and social structures of society. The replacement of human labour with automated systems may lead to an increase in unemployment and the need to adapt to new working conditions. Among the studies that have already been conducted, there are works devoted to the study of specific aspects of AI applications. As Kostenko [1] noted, the areas of AI development include augmented and virtual reality systems, communication networks, cloud computing, cyber-physical systems, cybersecurity, data mining, interaction technologies, and the Internet. The field of AI application is wide and diverse [2]. The authors include machine learning, neural networks, deep learning, computer vision, theorem proving, image recognition, machine translation and language understanding, gaming applications, machine creativity, and expert systems.

Sharov [3] noted that the improvement of AI technologies is inherently associated with certain risks. The researcher draws attention to the consequences of AI use in various spheres of life. Moreover, AI development can also lead to a radical change in the global labour market, the emergence of new professions and a reduction in the number of employees in outdated areas. Busaga et al. [4] emphasise the need to promote research and development of new technologies aimed at protecting children's rights in AI. Artificial intelligence has some limitations, as noted by Bril [5]: AI systems successfully solve only a specific type of problem for which they were originally designed. AI cannot easily switch between different types of tasks as humans do. In addition, when the conditions for which the system was trained change, it needs to be re-trained for the new conditions. These limitations require constant research and development of AI to improve its efficiency and reliability in various applications. Zhyvtsova [6] notes that the use of AI can lead to a desire for total control and restriction of personal freedom. Other problems include environmental risks, lack of versatility in solving various tasks, replacement of human labour, and the possibility of the system getting out of control.

The purpose of this article is to study and analyse the issues related to AI and its impact on modern society. It is aimed at identifying the limitations of AI systems and understanding the challenges that arise in their application. The research also aims to clarify the issues of data security and privacy in the context of AI use, as well as to study the possible impact of AI on the labour market and social structures of society.

2.0 MATERIALS AND METHODS

A thorough systematic literature review was conducted in this study, focusing on a wide range of available online resources such as IEEE Xplore, ScienceDirect, Google Scholar, Scopus, and Web of Science, to examine the current state of AI-related research in detail and comprehensively. The main objective of this review was to uncover current advances in the field of AI and to identify areas for its further development. To ensure a successful and efficient selection of articles, a query was created based on a wide range of keywords, such as ethical issues, machine learning, data security, applications, social aspects, and AI. This combined query helped to increase the chances of identifying relevant and interesting research from a wide range of academic sources. The combination of keywords and the use of different online resources made it possible to cover a wide range of AI-related topics and explore different aspects of its application. This made the research more holistic and informative.

To ensure high research quality, certain criteria were established when selecting studies. Particular attention was devoted to the selection of peer-reviewed research articles, which guaranteed the reliability of the data obtained. In addition, the date of publication of the studies was considered, and the range of years from 2016 to 2023 was chosen given the rapid development of the AI industry and the need to consider the latest achievements. The results of the literature review were structured according to the years of publication. This analysis allowed to consider the development and trends in the AI industry during the selected period in more detail. Comparing the results for different years, the dynamics of the industry development and changes in research focus can be seen. For example, an increase in the number of articles in 2022 and 2023 may indicate a growing interest in AI among the scientific and applied community, as well as the emergence of new research areas and innovative applications.

The article review process involved a sequential analysis of each selected article to systematically review research on the specific topic of AI. First, the

titles of the articles were checked to determine their relevance to the search criteria. The next step was a careful study of the abstracts and conclusions, which allowed to get a general idea of the content of the research and determine its relevance in the context of AI. In case the articles met the established search criteria, they were analysed in detail. The main part of each study was thoroughly studied with attention to the key theses and conclusions. The collected abstracts were analysed in detail, and key findings were highlighted to help create an objective overview of the research on the selected topic. Highlighting the main research findings contributed to an understanding of the achievements in the industry and the identification of potential challenges and problems.

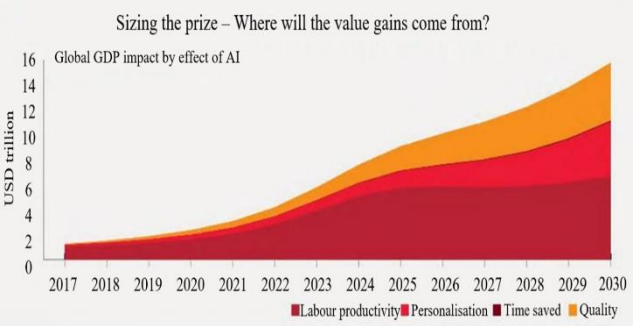

Figure 1: Impact on global gross domestic product (GDP) due to the impact of AI [9]

3.0 RESULTS

AI is a cutting-edge technology that has the potential to dramatically change various industries, such as smart city development, education, image processing, and nuclear medicine [7]. The history of AI dates back to the mid-20th century when researchers began to explore the possibility of creating machines that could mimic human intelligence. Over the decades, significant progress has been made in the field of AI, which has led to its widespread adoption and application in various fields. AI is a cutting-edge technology that has the potential to significantly impact various industries and contribute to the global economy [8]. AI usage statistics underline its growing116importance and influence. For example, according to "Top AI statistics and trends in 2023" [9], the global AI market size was estimated at $136.55 billion in 2022 and is expected to grow exponentially in the coming years due to the increase in investment in AI technology, digital disruption, and competitive advantage in this fast-growing global economy. The global AI market is expected to grow at a CAGR of 37.3% from 2023 to 2030, reaching USD 1811.8 billion by 2030. AI has the potential to make a significant contribution to the global economy. By 2030, AI is projected to contribute more than the current output of India and China combined. This forecast shows that AI will contribute $15.7 trillion to the global economy by 2030 (Figure 1).

The potential economic benefits of AI will be most pronounced in China, where GDP is expected to grow by 26% in 2030, followed by North America with a 14.5% increase, totalling USD 10.7 trillion, accounting for almost 70% of the global economic impact. This data demonstrates the great potential of AI and its significant contribution to global development and the economy (Figure 2).

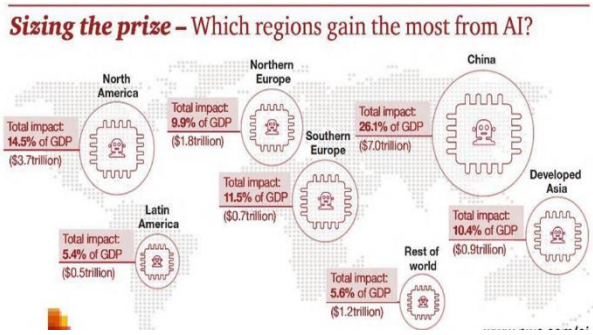

Figure 2: Regions that benefit the most from AI [9]

In the context of smart cities, an intelligent lighting control system has been developed and tested, demonstrating the practical application of AI to optimise energy consumption. In addition, AI methods such as artificial neural networks and the EM algorithm are used to predict consumption and cost, ensuring the system's innovation in terms of intelligent prediction [7]. AI is already being integrated into high school and college curricula, and preschool children have access to AI-based devices [10]. Furthermore, AI has been successfully applied in image processing, in particular in handwriting recognition, where neural networks have proven to be efficient and eliable [11]. In nuclear medicine, AI models have been used to optimise image-processing workflows [12]. The development and use of AI are accompanied by certain challenges (Table 1).

Table 1: Issues in Development and Use of AI

Issue	Description
Ethical issues	Collection and use of personal data, moral responsibility of AI decisions, fair and non-discriminatory algorithms
Privacy Concerns	Violation of rights and privacy through data collection and use, face recognition systems
Discrimination and Inequality	Incorrect algorithms leading to discrimination based on race, gender, or other characteristics
Security Concerns	Insufficient reliability and accuracy in AI decisions, risk of data misuse
Data Misuse	Potential misuse of large amounts of data required for AI training
Insufficient Security	Insufficient security measures to protect data and AI systems

Unpredictable Consequences	AI decisions can lead to unpredictable and unintended consequences
Responsibility for Mistakes	Determining who is responsible for AI decisions, especially in critical applications like autonomous vehicles
Employment Impact	AI's impact on jobs and employment, potential job losses due to automation

Ethical issues are raised in the context of AI systems, as well as requirements for privacy and social justice [13]. In addition, the introduction of AI in education creates both opportunities and challenges for students, teachers, and parents, which requires adaptation of the entire educational community [10]. One of the main AI security issues is the ethical issues related to the collection and use of personal data of citizens, which may violate privacy and confidentiality [14-16]. The use of AI, in particular machine learning and deep learning methods, requires access to large amounts of data to train models [15]. This can pose a risk of insufficient security and the possibility of misuse of this data [16].

One of the ethical issues is the problem of privacy. The collection and use of personal data can violate the rights and privacy of citizens. For example, the use of AI in face monitoring and recognition systems can pose a threat to privacy and the possibility of malicious use of this data. Another ethical issue is the responsibility for mistakes that may be made by AI. AI can make decisions that have major consequences, and the question arises as to who is responsible for these decisions. For example, if AI is used in autonomous vehicle systems, there may be situations where important choices need to be made between different dangerous scenarios. This raises questions about the moral responsibility of AI and the need to create ethical standards for such cases. In addition, ethical issues also include issues of discrimination and inequality. AI may use incorrect algorithms that lead to discrimination based on race, gender, or other characteristics. For example, facial recognition systems may incorrectly identify a person from a certain race or gender, which can lead to negative consequences for those individuals. This raises the question of the need to develop algorithms that are fair and non-discriminatory [13].

To address the ethical issues of AI security, it is necessary to develop ethical standards and legal frameworks. As such, it is important to develop laws and policies that regulate the use of AI in various fields, such as medicine, transport, and marketing. It is also necessary to protect the privacy and confidentiality of personal data by developing and using appropriate encryption and anonymization technologies. Furthermore, it is important to conduct research and develop new methods of testing and verification of AI to ensure its reliability and security [15; 17]. Another problem is the insufficient reliability and unpredictability of AI algorithms. AI may show insufficient accuracy and reliability in its decisions, which can lead to unpredictable consequences. For example, the use of AI in marketing can lead to incorrect content distribution settings [18; 19]. AI can also affect employment and jobs, which puts workers at risk. To address AI security issues, attention should be paid to the development of ethical standards and legal frameworks. For example, it is important to develop laws and policies that regulate the use of AI in various areas, including autonomous vehicles and public administration. It is also necessary to ensure the reliability and security of AI algorithms by developing and using appropriate testing and verification methods [20]. The development of AI encompasses various approaches and applications in different industries (Table 2).

Table 2: AI applications

Field	Applications
Smart cities	Intelligent lighting control systems, prediction of consumption and cost using neural networks and EM algorithm
Education	Integration in curricula, AI-based devices for preschool children. Intelligent learning systems, decision-support systems, access control based on face recognition
Image processing	Handwriting recognition using neural networks
Nuclear medicine	Optimizing image-processing workflows
Medicine	Deep learning for disease detection, early diagnostic tools for neurodegenerative diseases
Cybersecurity	Intrusion detection models, network anomaly detection
Construction	Optimizing processes, improving energy efficiency, automatic building services management

In medicine, AI is used to diagnose and treat various diseases. For example, research shows that deep learning can be used to detect COVID-19 based on chest X-ray images [21]. AI can also be used to predict changes in the brain of patients with neurodegenerative diseases. This allows the development of early diagnostic tools and effective treatments for patients with these diseases [22]. In education, AI is used to develop intelligent learning and decision-support systems. For example, content visualisation systems can use deep learning and genetic algorithms to automatically generate visually enhanced content for digital use [23]. AI can also be used to develop intelligent control systems in educational institutions, such as access control systems based on face recognition [24]. In the field of cybersecurity, AI is used to detect and prevent cyberattacks. For example, AI can be used to develop intrusion detection models that can detect unusual activity and anomalies in a

network [25]. This helps improve cybersecurity in higher education institutions and other organisations. In construction, AI is used to optimise processes and improve energy efficiency. For example, AI can be used to develop automatic building services management systems that ensure efficient energy use and comfort for residents. Also, AI can be used to optimise construction processes and plan the location of buildings [26].

Further development of AI includes various opportunities and directions. Research shows that AI has significant potential in the healthcare sector. The use of AI in medicine can improve treatment outcomes and diagnosis of diseases. For example, the use of AI in medical image analysis can help detect signs of disease and improve diagnostic accuracy. Furthermore, AI can be used to develop intelligent learning and decision-support systems in medicine [27]. Another area of development is the use of AI in information management and knowledge. AI can be used to manage personal knowledge and information, which contributes to sustainable learning and improved organisational performance. For example, AI can be used to develop intelligent knowledge management systems and automatic data classification. AI can also be used to support decision-making and data analysis in organisations [28]. Another area of development is the use of AI in the development of specialised chips. AI requires a lot of computing power, so the development of specialised chips for AI is becoming increasingly relevant. These chips can be optimised to perform AI tasks such as image processing and neural networks [29; 30]. The use of specialised chips can improve the performance and energy efficiency of AI systems. AI can also be used to develop early warning and forecasting systems. For example, AI can be used to develop early warning systems for emergencies on university campuses. This helps to identify potential threats and ensure the safety of students and staff. AI can also be used to develop early warning systems in the ideological and political spheres. This allows identifying and analysing potential crises and ensuring the stability and development of universities [31; 32].

AI is based on the use of computer algorithms and machine learning methods to analyse and interpret data. AI can use different approaches, such as computer vision, natural language processing, and machine learning, to solve problems and achieve goals. One of the key stages of AI is training models based on a large amount of data. AI uses machine learning techniques, such as supervised or unsupervised learning, to analyse and identify patterns in the input data [33; 34]. This allows the AI model to perform tasks such as classification, prediction, and pattern recognition. AI can also use computer vision to analyse images and videos. The use of computer vision techniques allows AI to recognise objects, faces, movements, and other important details in images [35]. This can be used in various fields, including medicine, security, and autonomous systems. In addition, AI can use natural language processing techniques to analyse and understand human speech. This allows AI to recognise and interpret textual information, including structured text, chatbots, and other forms of communication [36]. The use of natural language processing can be useful in areas such as automated customer support, text document analysis, and machine translation. The way AI works also involves the continuous improvement and optimisation of models. AI can use performance enhancement techniques, such as algorithm optimisation and the use of specialised chips, to improve the speed and efficiency of systems [37]. This allows AI to work faster and with less resource consumption.

AI has significant potential in various fields, such as medicine, transport, marketing, cybersecurity, and construction. However, its development is also accompanied by various ethical and security challenges. The development of ethical standards and legislation governing the use of AI in various industries is of particular importance [38-40]. It is important to ensure the protection of privacy and confidentiality of personal data, as well as the reliability and security of AI algorithms. Insufficient reliability and unpredictability of AI algorithms can lead to unpredictable consequences, which highlights the need for research and development of new testing and verification methods. The development of AI covers various opportunities and areas, including applications in medicine, information management, development of specialised chips and early warning and forecasting systems.

4.0 DISCUSSION

In the modern world, the development of AI is becoming increasingly important, and research in this area is being actively conducted in many countries. The results of other authors' studies help to understand a wide range of AI applications, as well as identify common aspects and differences with the research. Comparing the results of this study with the works of other authors is an important and valuable part of scientific activity, as it allows one to better understand the context and significance of one's research in the global context of AI development. Analysing the

scientific works of other researchers expands the horizons of knowledge, helps to identify common aspects and finds new ways to further improve this technology. Ukrainian researchers such as Tarasiyk et al. [38] and Azmuk [41], also focus on studying the application of AI, but in different fields, such as economics and the digital economy. This demonstrates the wide range of interests and relevance of AI in various fields. At the same time, different researchers may focus on different aspects of the technology, which creates opportunities for collaboration and knowledge sharing between research groups. One of the areas of research in the field of AI is the development of AI quality models.

Stanislavyk and Zamlynskyi [42] emphasize the strategic significance of artificial intelligence in corporate sustainability and strategic management. They argue that AI can enhance CSR programs, improve risk management, and offer a competitive edge. They also address privacy concerns, ethical considerations, and the need for open and responsible AI methods. The research also examines AI integration into business processes, emphasizing a methodical approach aligning technology advancements with sustainable development objectives. Kharchenko et al. [37] proposed basic models and characteristics for assessing the quality of AI. These results are a tool for further improvement and development of AI systems, which is important for ensuring the reliability and efficiency of its application in various fields. The use of AI finds its application in various industries, including agriculture, telecommunications, organisational management, and astronomy [43]. The study by Tarasiyk et al. [38] investigates the creation of intelligent management systems for agricultural enterprises, which can help improve the efficiency and productivity of agricultural enterprises. This is just one example of how AI can influence the improvement of various areas of activity and ensure the development of innovative solutions.

Medicine is another area where AI has great potential. Gogayeva et al. [39] focused on the analysis of the perioperative period in patients with cardiovascular diseases. The use of AI can greatly improve the detection of pathologies and the development of effective treatment methods, which will contribute to positive treatment outcomes and improve the quality of life of patients. The use of AI in medicine is of particular interest, and the authors' study emphasises the importance of this area. AI can help to identify pathologies and develop effective treatment methods, which can improve treatment outcomes and quality of life for patients. However, it should be remembered that the introduction of AI is accompanied by challenges and risks, such as high energy consumption and risk perception on the part of users. However, these challenges should not slow down the development of this technology but require a careful approach to the development of systems and algorithms, as well as the introduction of ethical principles in the use of AI [41]. Comparing the results of this study with the works of foreign authors, several similar and different aspects of AI applications can be identified. For example, Boillat et al. [44] found that there is no significant difference in familiarity with AI between medical doctors and students, which is consistent with the results of this study. Both studies emphasise the importance of AI in medicine, in particular for decision support and improving treatment outcomes. In addition, AI is also showing promise in the field of drug design. The study by Hessler and Baringhaus [45] emphasises the power of AI in generating new biologically active molecules with desirable properties. This is in line with the findings of this study, which emphasises the possibility of automating the drug discovery process using AI and synthesis planning.

Al-Shoteri [46] focused on the role of AI tools in the diagnosis and detection of various diseases. The study discusses the need to develop systems and algorithms for the full use of AI in medicine. This coincides with the conclusions of this study, which emphasises the importance of introducing AI into medicine to improve diagnostics and prognostic accuracy. In addition, both studies note that the introduction of AI is also accompanied by certain challenges and risks. In their work, Boillat et al. [44] note that medical students perceive higher risks associated with AI in medicine. Özdemir et al. [47] discussed potential problems, such as high energy consumption in the application of AI. These are important aspects to consider when developing and using AI. It is also worth noting that both studies used different methods and approaches to study AI. In the research by Boillat et al. conducted a systematic literature search using the PRISMA methodology to identify relevant articles on the impact of AI on sustainable development goals. The research by Martyniuk et al. [48] focuses on enhancing the server-side integration of web applications with AI, particularly using ChatGPT. The study details improvements in user experience and request processing speed through advanced integration techniques. It also discusses the use of technologies like Web-API, Entity Framework, and JWT Tokens to secure and optimize the server

application, ensuring efficient data handling and AI functionality.

This study has confirmed the notion that AI development is an extremely relevant and promising area of research in the modern world. Many researchers are studying various aspects of this technology, which helps to understand its wide range of applications and potential. One of the most important research areas is the development of AI quality models to ensure the reliability and efficiency of its application in various fields. Research in this area is important for the further improvement and development of AI systems. AI applications are considered in various industries, such as agriculture, telecommunications, and organisational management. Studies in these areas, such as those by Tarasiyk et al. [38], show the potential of AI to solve specific problems and improve various aspects of business. In general, comparing the results of this study with other scientific works, the growing interest and activity in AI research can be identified, which finds its application in various fields and has the potential to change many aspects of human life. Research in this area is of great importance for the development of society, technology, and the improvement of the quality of life.

Collaboration and knowledge exchange between research groups from different countries will help accelerate progress in this area and reach new heights in AI development. This can stimulate further cooperation and exchange of research ideas between Ukrainian and foreign authors. In general, these comparisons of foreign studies with the results of this research complement and emphasise the relevance, prospects, and potential of AI in various fields, including medicine, as well as the need to carefully consider possible challenges and risks for the effective implementation and development of this technology.
All research in this area shows the significant potential of AI to solve various problems and achieve positive results in various industries. AI helps to automate processes and improves the accuracy of forecasts and decision-making, which creates prospects for more efficient functioning of many areas of human activity. Thus, the study and development of AI is an important task that has great potential to improve the quality of life and ensure progress in various areas of society.

5.0 CONCLUSIONS

This study analyses and examines various aspects of AI application in the modern world. The development of AI is becoming increasingly important in modern society, and its potential to influence various areas of human activity is significant. The main goal of the study was to identify the possibilities and prospects of AI application in various industries and the opportunities for its development. First of all, the study showed that AI is widely used in various fields of activity, such as medicine, agriculture, telecommunications, and organisational management. In medicine, for example, AI can help identify pathologies and develop effective treatments, which can have a positive impact on treatment outcomes and improve the quality of life of patients. In agriculture, intelligent systems can support the management of agricultural enterprises and increase their efficiency. The study also found that the development of AI quality models is an important component in ensuring the reliability and effectiveness of its application. Comparing the results of this study with other research papers, several similar and different aspects of AI applications have been identified. This indicates the relevance of the topic and the great interest of researchers in the development and application of AI. In addition, the study found that the introduction of AI is accompanied by certain challenges and risks, such as the possibility of algorithmic and social injustice, as well as high energy consumption. These aspects need to be carefully considered when developing and using AI.

To summarise, the study confirms the importance and potential of AI applications in various spheres of life. Its impact on medicine, agriculture, telecommunications, and organisational management is promising and can positively change modern society. Further research in the field of AI can be aimed at improving the quality of AI systems, applying it in medicine for diagnostics and personalised treatment, developing autonomous systems, analysing large amounts of data quickly and efficiently, considering ethical and security aspects, integrating AI with humans, and promoting its application in new industries. Following the set directions, researchers will be able to expand the capabilities of AI and contribute to new achievements in the implementation of intelligent technologies in various spheres of life and activity. The practical significance of the study is to unlock the potential and application of AI in various industries.

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