The Role of Artificial Intelligence in Modern Information Systems Design: A Systematic Review

Olja Krčadinac[1*], Željko Stanković[2], Dragana Dudić[3], Lazar Stošić[4]

[1] *"Union – Nikola Tesla" University, Faculty of Informatics and Computer science, Belgrade, Serbia, okrcadinac@unionnikolatesla.edu.rs, https://orcid.org/0000-0002-6299-371X*

[2] *Pan-European APEIRON University, Banja Luka, B&H, stanz@medianis.net, https://orcid.org/0000-0002-9893-9088*

[3] *"Union – Nikola Tesla" University, Faculty of Informatics and Computer science, Belgrade, Serbia, ddudic@unionnikolatesla.edu.rs, https://orcid.org/0000-0001-8513-6529*

[3] *"Union – Nikola Tesla" University, Faculty of Informatics and Computer science, Belgrade, Serbia, lstosic@unt.edu.rs, https://orcid.org/0000-0003-0039-7370*

Review paper

https://doi.org/10.7251/JIT2501055K UDC: 007.52:004.738.5

Abstract: The integration of Artificial Intelligence (AI) into Information Systems (IS) design is significantly reshaping traditional development processes, introducing automation, intelligent decision-making, and advanced data analysis capabilities. This systematic review explores the current landscape of AI-driven IS design, focusing on key AI techniques—such as machine learning, natural language processing, and generative models—that are increasingly applied across various stages of system development. The paper examines how these AI technologies are enhancing requirement engineering, system modeling, and process optimization. It also evaluates the benefits of AI in improving system efficiency, decision-making, and user experiences, while addressing challenges such as data quality, technical expertise, and ethical concerns. Finally, the review looks toward the future of AI in IS design, highlighting emerging trends such as low-code platforms and explainable AI. The findings emphasize the need for interdisciplinary collaboration and the development of transparent, responsible AI frameworks to fully realize the potential of intelligent, adaptive, and user-centric information systems.

Keywords: artificial intelligence, information systems design, intelligent system, system architecture

Introduction

The rapid advancements in Artificial Intelligence (AI) technologies have significantly transformed various industries, with Information Systems (IS) being no exception. Traditionally, the design and development of information systems have been human-centric processes, involving manual analysis, design, and decision-making. However, the integration of AI into the design phase of IS development has the potential to revolutionize the way systems are conceptualized, built, and optimized (Hassan et al., 2024).

Artificial Intelligence, through its various techniques such as machine learning, natural language processing, and automation, offers unprecedented opportunities to enhance the efficiency and accuracy of information system design. AI can automate repetitive tasks, assist in the generation of system architectures, and even make intelligent decisions based on large datasets, thus significantly improving the quality of the final product (Crawford et al., 2023; Pattam, 2023).

This paper provides a comprehensive review of the integration of AI in the design of modern information systems. The aim is to explore how AI is being utilized to streamline and enhance various stages of system development, including requirement analysis, system modeling, and process optimization. Additionally, this review discusses the benefits and challenges associated with the adoption of AI in this field, as well as provides insights into future trends and potential research directions (Hassan et al., 2024).

The Role of Artificial Intelligence in Information Systems Design

The integration of Artificial Intelligence (AI) into Information Systems (IS) design has undergone significant evolution in recent years. Traditionally, IS design was a human-centric process, requiring extensive manual intervention at every stage, from requirements gathering to system modeling and decision-making. However, advancements in AI technologies have enabled the automation of many of these tasks, leading to faster and more accurate system design (Safaei et al., 2024).

During the requirements gathering phase, AI tools such as Natural Language Processing (NLP) can analyze large volumes of unstructured data, including user feedback and business documents. This facilitates the automatic extraction of key requirements and identification of patterns that may not be immediately apparent to human analysts. NLP-based techniques also assist in creating user stories and use cases, streamlining the design process (Ofosu-Ampong, 2024).

In the system modeling phase, AI techniques like Machine Learning (ML) and evolutionary algorithms optimize system architectures. These models analyze historical design data to predict efficient architectural components and generate new designs based on predefined criteria. For instance, AI-driven design tools can create scalable and fault-tolerant systems by analyzing existing architectures and recommending improvements (Crawford et al., 2023).

AI also plays a pivotal role in process optimization. It automates tasks such as testing, debugging, and deployment, reducing the time and cost associated with these activities. Additionally, AI algorithms monitor system performance in real-time, making adjustments to optimize resource allocation and improve system efficiency (Pattam, 2023).

The integration of AI into IS design not only enhances development efficiency but also contributes to creating more intelligent, adaptable, and user-centric systems. As AI continues to evolve, its role in modern information systems design is expected to expand, enabling more innovative and automated approaches to system development (Safaei et al., 2024).

Key AI Techniques in Information Systems Design

The integration of artificial intelligence (AI) into information systems (IS) design goes far beyond simple automation; it represents a deeper transformation in how systems are conceptualized, built, and improved. Rather than relying solely on static logic and predefined rules, modern systems increasingly adopt adaptive, data-driven techniques to enhance both functionality and flexibility (Weisz et al., 2023).

One of the most influential developments in this space has been the rise of machine learning (ML). By analyzing large volumes of data, ML algorithms uncover patterns and trends that are often too subtle or complex for rule-based systems to detect. In IS design, this means that decisions regarding user behavior, resource allocation, or system architecture can be guided by empirical evidence rather than assumptions. ML enables predictive capabilities—such as anticipating user needs or detecting performance bottlenecks—making systems not only reactive but also proactively intelligent (Xu et al., 2023).

Natural language processing (NLP) represents another major advance, particularly in bridging the gap between human communication and machine logic. Because IS design often relies on interpreting complex user requirements, NLP tools are used to process unstructured inputs such as customer feedback, support tickets, and documentation. These tools can extract actionable insights that streamline requirement analysis and reduce the risk of misinterpretation. NLP also enhances user interfaces by powering intelligent assistants and context-aware search tools (Zhang & Müller, 2024).

More recently, generative models have introduced powerful new capabilities for automating and accelerating system design. Built on transformer-based architectures, these models are capable of generating code, user interface components, or even complete workflows from natural language prompts. This dramatically shortens the prototyping phase and supports rapid design iterations. Tasks that previously required days of manual work can now be executed in minutes with remarkable consistency (Majchrzak & Thies, 2023).

Taken together, these AI techniques do not replace human designers and engineers—they augment

their abilities. By automating repetitive tasks and delivering intelligent suggestions, they enable design teams to focus on strategic and creative aspects of IS development. As these tools continue to mature and become more widely accessible, they are expected to become a standard part of the IS design process, supporting the creation of smarter, more adaptable systems that align with the evolving needs of businesses and users (Weisz et al., 2023).

Research Methodology

The research presented in this paper is based on a systematic literature review focused on recent developments in the application of artificial intelligence in the design of modern information systems. The selection of relevant sources was guided by the goal of identifying prevailing AI techniques, domains of application, and observed benefits and challenges.

The literature search was conducted using academic databases such as IEEE Xplore, ScienceDirect, and Google Scholar, targeting publications from 2018 onward. Keywords were selected to reflect the core concepts of the research, including combinations of terms like *artificial intelligence*, *information systems*, *system design*, and *AI methods*. The inclusion process prioritized peer-reviewed articles published in English, while works not directly addressing the intersection of AI and IS were excluded.

After filtering and reviewing the material, approximately thirty publications were selected as the basis for analysis. These works were examined with respect to their thematic focus, proposed approaches, and reported outcomes. Rather than following a strictly quantitative synthesis, the review aims to offer a structured yet flexible overview that highlights key patterns and relevant examples. Although the research provides a current snapshot of the field, it is limited by the scope of databases used and the exclusion of non-English or non-peer-reviewed material.

Case Studies and Applications

The practical integration of artificial intelligence (AI) into information systems is no longer a matter of theory or experimentation—it is actively shaping the architecture and functionality of real-world systems across industries. Several high-impact case studies illustrate how organizations are leveraging AI to enhance their information systems, demonstrating both the capabilities of current technologies and the diverse contexts in which they can be applied.

One prominent example is IBM Watson, a cognitive computing platform that combines machine learning, natural language processing, and data analytics to support decision-making in complex environments. Originally developed for open-domain question answering, Watson has since been deployed in domains such as healthcare, where it assists doctors in diagnosing conditions based on large datasets of clinical records. The system's ability to interpret medical literature and cross-reference patient data highlights how AI can be used to augment human expertise and improve information accessibility within a specialized IS (Devarakonda & Tsou, 2015, Shwedeh et al., 2023).

In the field of software development, tools such as Google's AutoML represent a shift toward automating parts of the AI design process itself. AutoML allows users to train machine learning models with minimal human intervention, making advanced AI more accessible to non-experts. Within information systems, this has enabled the creation of intelligent modules that adapt to changing data without requiring frequent manual updates. AutoML has been used to optimize logistics systems, personalize customer experiences, and automate fraud detection in financial services (Zhang et al., 2023).

Beyond individual platforms, entire industries are embracing AI-driven information systems. In banking, AI models are integrated into fraud monitoring systems that analyze transaction patterns in real time and flag suspicious activities. In education, adaptive learning platforms use student data to tailor content delivery, while institutions employ predictive analytics to anticipate dropout risks and improve retention. In healthcare, AI enhances electronic health records by enabling natural language input and decision support, streamlining both administrative and clinical workflows (Kabudi, 2023, Gopalakrishnan, 2023).

These applications illustrate that AI is not a one-size-fits-all solution but a versatile set of tools that can be tailored to specific organizational needs. What unites these cases is the strategic embedding of AI into the core of the system's architecture—moving from isolated features to intelligent systems that continuously learn and evolve. This trend is likely to continue as AI tools become more powerful, more trans-

parent, and easier to integrate into existing information infrastructures (Poulain et al., 2024).

To better understand the practical impact of artificial intelligence in the design of information systems, we categorized the reviewed studies based on their primary application domains. This classification helps identify where AI is currently making the most significant contributions and highlights emerging areas of interest.

Table 1 provides a summary of the main domains, the number of papers identified in each, and representative examples from the reviewed literature.

Table 1 *Categorization of reviewed papers by application area*

Application Area	Number of Papers	Authors / Papers
Software Engineering	6	Crawford et al. (2023), Hassan et al. (2024), Pattam (2023)
Healthcare & Medical Systems	3	Devarakonda & Tsou (2015), Poulain et al. (2024), Shwedeh et al. (2023)
Transparency & Ethics	3	Brown et al. (2024), Kumar & Srinivasan (2023), Nguyen et al. (2023)
Business Information Systems	3	Smith & Jones (2024), Li et al. (2023), Gopalakrishnan (2023)
Digital Platforms	2	Majchrzak & Thies (2023), Tan & Lee (2025)
Natural Language Processing	3	IBM (n.d.), Springer (2024), Cambridge Advance Online (2024)
Regulatory & Socio-Technical	2	Safaei et al. (2024), Ofosu-Ampong (2024)
Generative AI	3	Gartner (n.d.), Weisz et al. (2023), Zhang et al. (2023)
Other	4	Kabudi (2023), Ahmed et al. (2024), Zhang & Müller (2024), Xu et al. (2023)

In addition to the tabular summary, the following chart (Figure 1) visualizes the distribution of reviewed papers across the identified application domains.

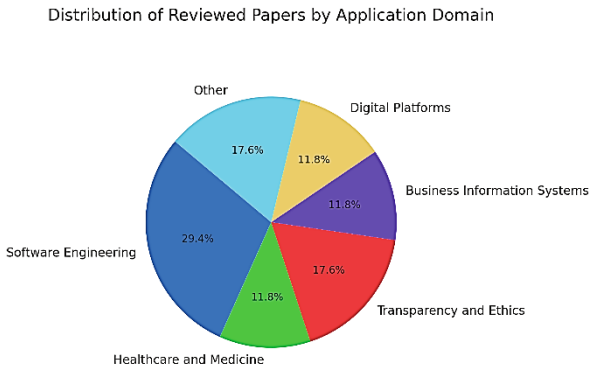

Figure 1 *Distribution of reviewed papers by application area*

Challenges, Opportunities, and Future Directions of AI in IS Design

The growing integration of artificial intelligence (AI) into the design of information systems presents a dynamic interplay between technological promise and practical complexity. As organizations increasingly embrace AI to enhance decision-making, optimize workflows, and deliver intelligent functionalities, it becomes essential to evaluate not only the benefits of this integration but also the limitations and future pathways.

Among the most evident advantages is the significant boost in system efficiency. AI-driven systems are capable of automating routine operations, processing vast volumes of data in real time, and continuously adapting to new information without human intervention. This adaptability translates into more agile and responsive information systems that can meet evolving business and user demands. Moreover, AI reduces the incidence of human error by providing consistent outputs based on data-driven models, particularly in areas such as diagnostics, risk analysis, and demand forecasting. In decision-making contexts, intelligent systems can synthesize complex data inputs, offering recommendations that are both timely and analytically robust (Smith & Jones, 2024, Li et al., 2023).

However, alongside these opportunities lie notable challenges. One of the foremost technical obstacles is the quality and availability of training data. AI models require extensive datasets to perform effectively, and the presence of biased or incomplete data can lead to skewed outcomes, undermining system reliability. Additionally, the integration of AI often demands specialized expertise in machine learning, data science,

and system architecture—skill sets that may not always be present within traditional IS development teams. This creates a need for multidisciplinary collaboration, bringing together domain experts, engineers, and data professionals to co-design effective solutions (Garcia et al., 2023, Ahmed et al., 2024).

Ethical concerns also feature prominently in discussions about AI integration. Questions related to transparency, accountability, and data privacy are critical, especially in systems that make autonomous decisions or process sensitive personal information. There is an increasing demand for explainable AI, where the logic behind system outputs can be interpreted and audited by human stakeholders. Without such mechanisms, users may be reluctant to trust or adopt AI-enhanced systems, regardless of their technical sophistication. These concerns have spurred significant research into designing interpretable AI models, ensuring that decision-making processes are understandable and justifiable (Brown et al., 2024, Kumar & Srinivasan, 2023).

Looking ahead, the future of AI in information systems design appears both promising and complex. Advances in generative AI, federated learning, and reinforcement learning are likely to unlock new possibilities in how systems learn, evolve, and collaborate. In particular, low-code and no-code platforms powered by AI could democratize access to intelligent system design, allowing non-technical users to participate more actively in shaping digital solutions. At the same time, we can expect increased regulatory oversight and demand for ethical standards, prompting a more responsible and transparent approach to AI development (Tan & Lee, 2025, Nguyen et al., 2023).

To fully realize the potential of AI in IS design, future research should focus on developing hybrid methodologies that combine human expertise with machine intelligence in a balanced and explainable way. Additionally, fostering interdisciplinary education and practice will be essential to ensure that teams are equipped to address both the technical and human-centered dimensions of AI integration. As AI evolves, its transformative potential will require continuous adaptation, ensuring that these systems remain both ethically aligned and pragmatically efficient.

Ultimately, the road forward will require a careful blend of innovation and reflection. By acknowledging both the opportunities and the limitations, designers and organizations can build information systems that are not only more intelligent but also more aligned with the ethical, practical, and societal contexts in which they operate. This dual focus on progress and responsibility will guide the integration of AI in the coming years, enabling smarter, more effective, and ethically sound systems.

Conclusion

The integration of artificial intelligence (AI) into information systems design represents a fundamental shift in how these systems are conceived, developed, and maintained. Through the application of advanced AI techniques, such as machine learning, natural language processing, and generative models, organizations are achieving enhanced efficiency, data-driven decision-making, and more personalized user experiences. AI is enabling systems to evolve beyond static structures, becoming adaptive, intelligent, and capable of learning from data to address new challenges and opportunities.

However, as AI continues to transform the landscape of information systems, several challenges persist. The availability and quality of data, alongside the need for specialized expertise, remain significant barriers to realizing the full potential of AI. Additionally, ethical concerns, particularly regarding transparency, accountability, and privacy, must be carefully managed as AI systems become increasingly embedded in critical business and societal functions. Addressing these challenges will require interdisciplinary collaboration and the establishment of robust guidelines and standards for the responsible development and deployment of AI technologies.

Looking to the future, the role of AI in information systems design is poised to expand further with the advent of technologies like low-code platforms, federated learning, and explainable AI. These innovations will make AI more accessible and inclusive, allowing organizations to create systems that are not only more intelligent but also more human-centered and adaptable to evolving needs. As AI technologies continue to mature, they will empower organizations to build smarter, more efficient, and ethically aligned systems that contribute to both business success and societal progress.

In conclusion, while the integration of AI into in-

formation systems presents both exciting opportunities and inherent challenges, it is clear that AI will remain a transformative force in this field. By embracing its potential and addressing its challenges responsibly, organizations can harness AI to create systems that better align with the needs of users and society, paving the way for a more innovative and inclusive future.

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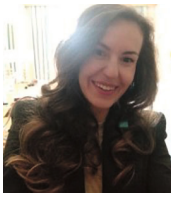
Received: April 25, 2025
Accepted: May 23, 2025

About the authors

Olja Krčadinac (Latinovic, maiden name) is assistant professor at "Union – Nikola Tesla" University - Faculty of Informatics and Computer Science. She earned her Ph.D. in biometric field from University of Belgrade – Faculty of Organizational science, where she conducted groundbreaking research on speaker recognition. In addition to her teaching responsibilities, Olja has authored numerous impactful publications in peer-reviewed journals, contributing valuable insights to the scientific community. Her research focuses on biometric, sensors, IoT and AI, addressing critical issues in AI and making significant contributions to the academic community.

Željko Stanković received his higher education in Cleveland, Ohio, USA, where he graduated in 1981. The topic of the thesis was "Reversible sound in halls". He defended his master's thesis ("Learning control system (LMS) based on ADL SCORM specifications") in 2006 at the University of Novi Sad, Faculty of Science, Department of Informatics. He defended his doctoral dissertation (Laser perception of defined objects and encapsulation of control and logic elements for an autonomous robotic teaching tool) at Singidunum University, Belgrade, in 2010. He has been programming since 1984, creating programs for his first Commodore 64 computer. She works as a full-time professor at Pan-European University "APEIRON". Robotics and bioengineering have been a field of work and interest for many years. He is the holder of the patent right for the teaching tool CD ROBI.



Dragana Dudić obtained BSc and MSc degree in Computer Science at the Faculty of Mathematics, University of Belgrade, and PhD degree in Computer Science at the Faculty of Information Technology, Pan – European University Apeiron Banja Luka. She is an assistant professor at Faculty of Computer Science and Informatics, University Union Nikola Tesla. Dragana is author of more than 20 scientific papers published in peer-reviewed journals, with research focus on bioinformatics, digital literacy and technology integration in education.

Lazar Stošić is a university professor at the Faculty of Informatics and Computer Science, University Union—Nikola Tesla, Belgrade, Serbia and the President of the Association for the Development of Science, Engineering and Education, in Serbia. He is also a leading researcher at the Center for Scientific Competence of DSTU, Department of Scientific and Technical Information and Scientific Publications Don State Technical University, Russia. His expertise includes computer science, IKT, editorial workflow management, conference organization, web technologies, web design, indexing, XML production, SEO, digital marketing, and new media technologies.

For citation

Olja Krčadinac, Željko Stanković, Dragana Dudić, Lazar Stošić, The Role of Artificial Intelligence in Modern Information Systems Design: A Systematic Review, *JITA – Journal of Information Technology and Applications, Banja Luka*, Pan-Europien University APEIRON, Banja Luka, Republika Srpska, Bosna i Hercegovina, JITA 15(2025)1:55-61, (UDC: 007.52:004.738.5), (DOI: 10.7251/JIT2501055K), Volume 15, Number 1, Banja Luka, June (1-80), ISSN 2232-9625 (print), ISSN 2233-0194 (online), UDC 004