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ADOPTION OF ARTIFICIAL INTELLIGENCE IN INDUSTRIAL PROJECT MANAGEMENT: A BIBLIOMETRIC ANALYSIS OF RESEARCH TRENDS

A.O. Myrzagaliyev[1], G.S. Akybayeva[1*], L.M. Bekenova[2]

[1]Astana IT University Astana, Kazakhstan
[2]Almaty University of Humanities and Economics, Almaty, Kazakhstan

**Corresponding author e-mail: gulvira.akybaeva@astanait.edu.kz*

Abstract. *The rapid adoption of artificial intelligence (AI) across industrial markets is transforming the conventional project management (PM) approaches. However, studies on this emerging field remain scattered across application-focused and industry-specific domains. The purpose of this study is to identify current trends and gaps within the research of AI adoption in industrial PM landscape by conducting a bibliometric analysis of the existing studies. To fulfill this purpose, a sample of 95 journal articles, published between 2019 and March 2026, were collected from Scopus database using corresponding keywords and analyzed on VOSviewer software using its embedded visualization tools and science-mapping technique. The results demonstrate a rapidly expanding research domain with prevailing number of engineering and technology-focused papers with a focus on construction industry as an empirical setting, while lacking contributions from theoretical and evidence-based works on management perspective. This trend reveals the increasing gap between the research in AI advancements and their adoption in managerial landscape, as well as a lack of empirical research addressing their practical implementation in industrial PM. The article contributes to the research by consolidating the scattered knowledge in AI adoption in industrial PM, identifying key research gaps, and highlighting prospects for future research.*

Keywords: *artificial intelligence project management, industrial sector, Industry 4.0, bibliometric analysis, science mapping, VOSviewer.*

Main provisions. The conducted bibliometric analysis confirms that the field of AI adoption in industrial PM is still in the phase of intensive development, featured by knowledge fragmentation and prevalence of technology-focused research over organizational outlook. The visualized map of the field highlights six interconnected technological and socio-technical subject clusters, such as AI-enabled PM, construction-focused applications, organizational determinants, Industry 4.0 infrastructure, education ecosystems, and implementation challenges. The findings show an insufficient incorporation of research on AI-enabled PM into organizational studies, as well as scarcity of works focused on its adoption constraints. It is concluded that further expansion of the field requires a transition to empirically grounded methodologies that ensure enhanced effectiveness of AI adoption in industrial PM environments.

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Introduction. Industrial projects are understood as projects executed with an aim to develop, construct, modernize, or commission industrial facilities, production systems, technological products, and related infrastructure [1]. Over the last decade, the accelerated development of AI technologies has become the main driver of industrial sector's digitalization by optimizing its practices of project planning, execution, and control. Specifically, within the framework of Industry 4.0, AI technologies encompassing machine learning, predictive analytics, and automation systems are widely implemented in production activities, assisting engineers and operators in real-time process monitoring, improving forecasting accuracy, and enhancing operational efficiency [2].

Beyond its technological capabilities, AI is also viewed as a strategic managerial resource capable of improving organizational performance and competitiveness. Within PM functions, AI technologies provide support in optimizing resource allocation, risk assessment, and decision-making processes [3], by automating repetitive activities and providing data-driven insights [4]. These capabilities contribute to the digitalization of management processes and may significantly improve delivery timelines, cost control, and organizational adaptability in rapidly changing industrial markets. Consequently, understanding the conditions of AI adoption represents not only a technological issue but also an important economic and managerial challenge for organizations undergoing digital transformation.

The number of studies on adoption of AI technologies has been rapidly increasing across multiple domains, including engineering, information technology, and, in recent years, in social sciences, indicating the growing acknowledgement that AI is not just a support tool but a stimulator of digital transformation and organizational performance growth [5]. Notwithstanding the expansion, the research on AI adoption within PM discipline remains scattered across various domains. Most of the existing studies are concentrated on AI's specific applications, such as budget estimation [6], risk identification [7], or timeline optimization [8], while offering limited insights on the structure and theoretical development of the field. This research gap is further widened by scarcity of works describing the intersections between AI implementation in PM and industrial segments experiencing digital transition [2, 7, 9]. To address this gap, the study investigates the following research questions:

RQ1: What thematic areas characterize the existing body of knowledge on AI adoption in industrial PM?

RQ2: To what extent does the current literature address managerial and organizational aspects of AI adoption alongside its technological applications?

RQ3: What directions for future research emerge from the current development of the field?

Answering these questions requires systematic approaches that can consolidate the existing knowledge, identify trends within the field and prospects for future studies. Bibliometric analysis is an internationally accepted scientific practice, based on organizing, visualizing, and analyzing scientific information fragmented across research domains. This approach allows researchers to identify key research correlations, influential contributions and collaborations, as well as subject clusters in a given field [10]. A widely adopted bibliometric technique is science mapping, which focuses on visualizing the intellectual, conceptual, and social subjects of scientific domains through the analysis of relationships among publications, authors, citations, and keywords [10]. Such analyses are facilitated by using VOSviewer software that allows researchers to examine co-occurrence networks, citation maps, and cluster structures, required to identify main research subjects and their relations [11].

Therefore, the present study conducts bibliometric literature analysis, based on internationally recognized methodological approaches [12] with a goal to collect, organize, and analyze the existing research on AI adoption in industrial PM. Using a sample of scientific articles published in Scopus database, science-mapping technique, and visualization functionalities embedded in VOSviewer, the study aims to achieve the following research objectives:

- to analyze publication trends and growth patterns,
- to construct a thematic map through co-occurrence and citation analyses,
- to identify key research clusters, gaps, and emerging directions.

The scientific novelty of the study lies in providing a comprehensive bibliometric mapping of the emerging research field of AI adoption in industrial PM, identifying its thematic composition, managerial knowledge gaps, and future development directions. Unlike existing literature focused on specific applications of AI technologies, the present study examines the field on a broader scale and identifies underexplored organizational and managerial perspectives required for successful AI implementation.

Literature review. The modern literature envisions AI as an optimization catalyst for coordination, forecasting, and information exchange practices across industrial project networks consisting of customers, contractors, and solution providers [13]. Some of the related works in the field associate AI adoption with open innovation and inter-organizational collaboration. For example, the study by Broekhuizen et al. reveals the stimulating effects of AI adoption on initiation, coordination, and governance of innovation processes across organizations through data-driven decision-making and optimized coordination costs [14]. Another empirical analysis of around 400 international organizations by Sahoo et al. confirms the favorable effects of AI capabilities on open innovation practices that subsequently lead to enhanced efficiency of organizational performance [15]. In this context, the application of AI surpasses firm-level adoption and becomes a significant part of industry-level processes of digital transformation, where value is created via enhanced data integration, real-time analytics, and adaptive collaborative mechanisms [16]. However, as it increasingly becomes embedded within industry-wide digital transformation processes, AI adoption becomes challenging due to organizational and ecosystem-level barriers, such as insufficient data standardization, shortages of AI-skilled personnel, substantial investment requirements, and limited coordination among stakeholders [16, 17]. The understanding of these adoption challenges is supported by established technology adoption frameworks, such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) [18, 19]. TAM proposes that adoption behavior is primarily determined by perceived usefulness and perceived ease of use of a technology [18]. UTAUT extends this perspective by incorporating performance expectancy, effort expectancy, social influence, and facilitating conditions as determinants of technology acceptance [19]. Although originally developed at the individual level, these theoretical perspectives have been widely applied to organizational technology adoption studies and provide a useful perspective for understanding the technological and managerial factors influencing AI adoption within industrial environments.

In the context of industrial digital transformation, these theories suggest that successful AI adoption depends not only on the technological capabilities of AI solutions but also on organizations' ability to create favorable conditions for their acceptance and utilization. In project-oriented environments, where execution results are influenced by collaboration among multiple stakeholders, factors such as social influence, organizational

support, and access to relevant resources become especially important affecting adoption decisions.

Thus, while AI demonstrates significant potential for enhancing the effectiveness of industrial PM processes, the literature indicates that its successful adoption depends on the interaction between technological capabilities and organizational conditions. Existing studies acknowledge the importance of factors such as organizational support, stakeholder influence, resource availability, and digital transformation initiatives, yet these insights remain fragmented across technological, managerial, and industry-specific research streams. Consequently, there is limited understanding of how these dimensions collectively shape AI adoption within industrial PM environments. This highlights the need for studies that structure existing knowledge, identify main research themes and gaps, and provide a clearer understanding of the organizational and managerial context in which AI adoption occurs.

Materials and methods. The present study implements bibliometric research methods to analyze the conceptual and thematic map of the literature on AI adoption in industrial PM [12]. The research is based on the analysis of metadata from the retrieved sample of articles using science-mapping techniques.

"Scopus" journals database was selected as the sole source of bibliometric data due to its broad multidisciplinary coverage, standardized indexing procedures, and compatibility with bibliometric software tools, including VOSviewer [20]. Compared with other scientific databases, Scopus provides extensive representation of engineering, management, and information systems journals. Nevertheless, the exclusion of publications indexed only in Web of Science or Google Scholar from the analysis may have resulted in underrepresentation of contributions from specific research areas. This limitation should be considered when interpreting the findings and represents an opportunity for future comparative bibliometric investigations.

The sample's extraction and analysis were conducted in March 2026. To ensure compliance of the selected sample with the core subject requirements and exclude irrelevant content, the search of articles was conducted within the "Article title, Abstract, Keywords" category. The search strategy was designed to capture publications that simultaneously address AI technologies, industrial digitalization, and PM context. The search query, therefore, combined the keywords "artificial intelligence", "Industry 4.0", and "project management" using Boolean operators, as demonstrated in Table 1.

Table 1 – Search query structure used in the bibliometric analysis

Concept	Purpose	Keywords
Block 1: AI	Core AI technologies adopted in PM	"Artificial intelligence"
Block 2: Digital industry	Digitalization of industrial sectors	"Industry 4.0"
Block 3: PM context	Affected PM knowledge areas	"Project management"

The resulting dataset was subsequently filtered according to predefined inclusion criteria, that required publications to: (1) explicitly address AI, industrial digitalization, and PM; (2) be published in the last 10 years; (3) be published in English language; and (4) be journal articles. Documents were excluded when they represented conference papers, editorials, book chapters, notes, duplicate records, or studies unrelated to PM context. The filtering process was conducted sequentially to ensure thematic relevance and methodological consistency of the final sample. This screening process resulted in a final dataset comprising 95 scientific journal articles. Figure 1 demonstrates the flowchart of articles screening process in Scopus database.

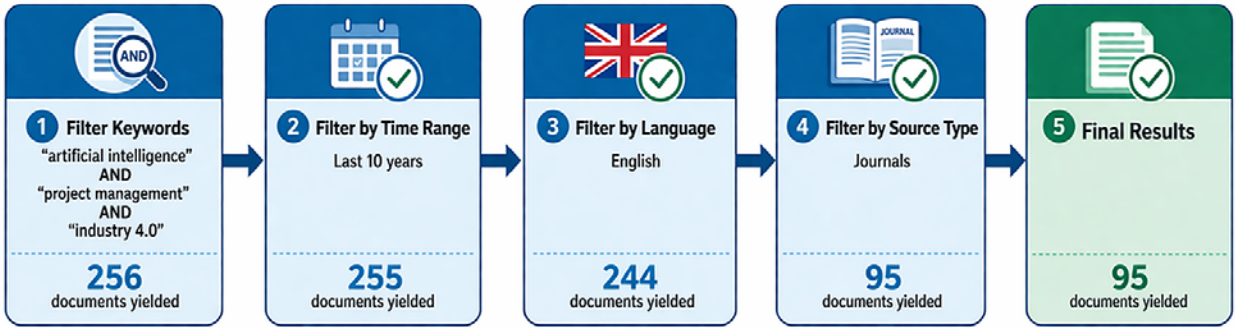

Figure 1 – Scopus-based literature screening for the bibliometric analysis

Note: prepared by the authors based on Scopus data

Using the built-in "analyze results" functionality of Scopus, a descriptive assessment of the yielded dataset was conducted. The analysis included visual presentations of publication trends, distributions across timeline and subject areas, as well as rankings of the most cited publications and leading publishing countries.

The dataset was then exported in CSV file format, including such metadata fields as citation data, bibliometric information, abstracts and keywords, and references.

The dataset was inserted into VOSviewer software to construct a thematic map, based on the analysis of authors' keywords co-occurrences. The thematic mapping allowed to identify keywords' co-occurrence patterns, research clusters reflecting main study areas, their interconnections, and development of new research trends.

Results and discussion. The chronological distribution of the publications illustrated in Figure 2 indicates the relatively recent appearance and rapid growth of the research on adoption and implementation of AI in industrial PM domain. According to the graph, all of the sampled articles have been published in the last decade. This suggests that the research field is at its start of rapid theoretical expansion, leading to an increasing need for additional empirical studies.

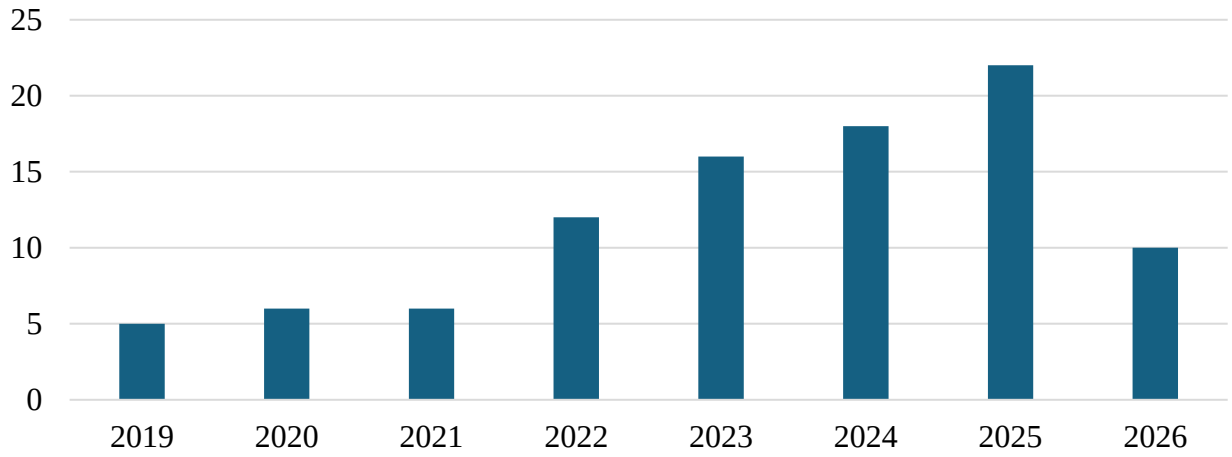

Figure 2 – Chronological distribution of publications in the bibliometric dataset (2019 – March 2026)

Note: prepared by the authors based on Scopus data

The prevailing number of English-language publications corresponds with the geographical locations of the top publishing countries demonstrated in Figure 3, where a significant portion of the leading countries are English speaking or operate within English-centric academic ecosystems. Taken together, these insights emphasize the accelerated integration of AI integration research with global scientific discourse.

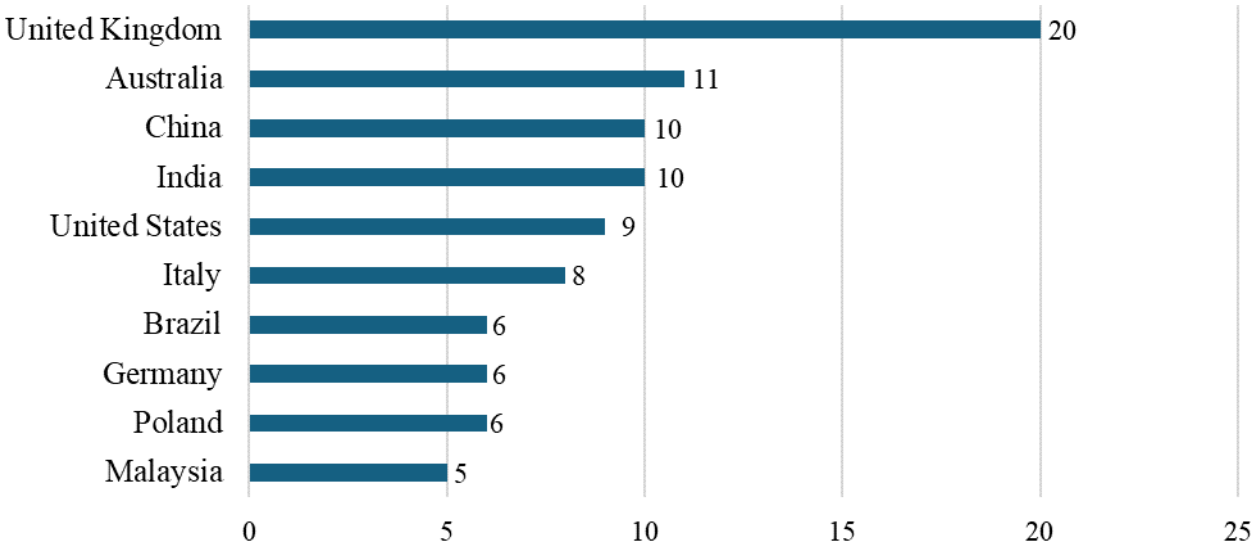

Figure 3 – Top ten countries by publication output

Note: prepared by the authors based on Scopus data

The publication distribution by subject area reflected in Figure 4 highlights the notable concentration of scientific studies within Engineering and Computer Science fields, accounting for 45% of total publications, whereas the share of the "Business, Management, and Accounting" subject area remains comparatively smaller, accounting for only 12% of the sample. This disproportion suggests that the current research trend is primarily directed by technical and system-oriented perspectives, with a lack of exploration of managerial and organizational outlooks on AI adoption.

The disciplinary imbalance is further expanded by observation of the top cited works in the area. As shown in Table 2, among the ten most cited studies, only two articles (№6 and №10) are published in journals categorized in business management domain, whereas the remaining nine are published in engineering and industry-oriented journals. This pattern highlights the lack of management-oriented research representation within the scholarly structure of the field.

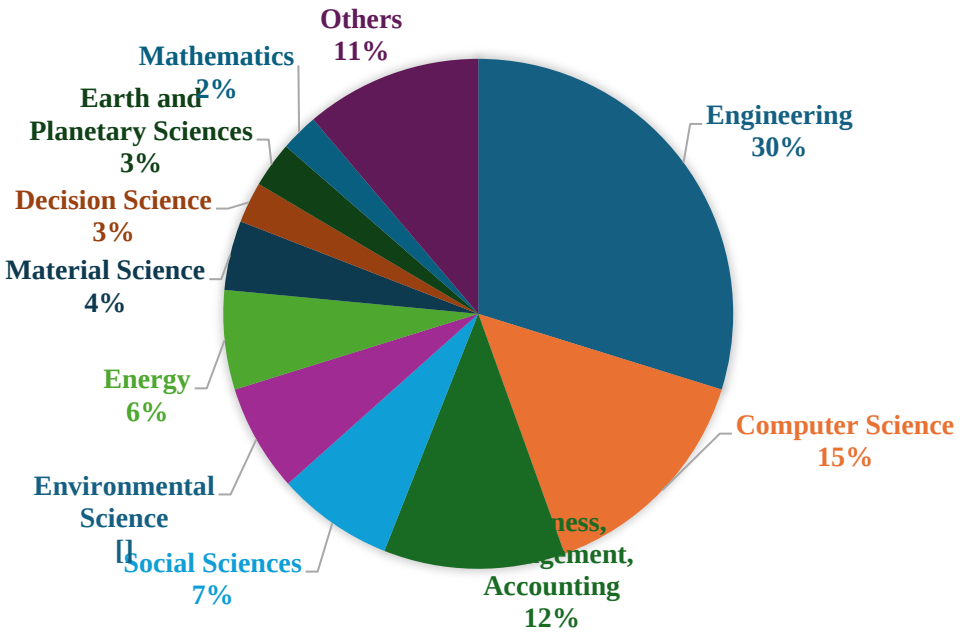

Figure 4 – Distribution of publications by science area

Note: prepared by the authors based on Scopus data

Table 2 – Top ten most cited articles

№	Article title	Journal	Year	Citations
1	Artificial intelligence in the AEC industry: Scientometric analysis and visualization of research activities	Automation in construction	2020	508
2	On Predictive Maintenance in Industry 4.0: Overview, Models, and Challenges	Applied sciences	2022	411
3	Digitalization and intelligent robotics in value chain of circular economy oriented waste management – A review	Waste management	2019	388
4	Utilizing Industry 4.0 on the Construction Site: Challenges and Opportunities	IEEE transactions and industrial informatics	2021	261
5	Natural language processing for smart construction: Current status and future directions	Automation in construction	2022	211
6	Artificial intelligence in supply chain and operations management: a multiple case study research	International journal of production research	2024	151
7	A Modern Approach towards an Industry 4.0 Model: From Driving Technologies to Management	Journal of sensors	2022	135
8	Current status and future trends in the operation and maintenance of offshore wind turbines: A review	Energies	2021	106
9	An Internet of Things-enabled decision support system for circular economy business model	Software practice and experience	2022	90
10	Developing a smart port architecture and essential elements in the era of Industry 4.0	Maritime Economics and Logistics	2022	89

The detailed analysis of Table 2 also reveals that a significant part of the top cited studies consists of review articles, containing the existing knowledge on industry-specific applications of AI technologies. While review papers are critical in strengthening a domain

knowledge base, their dominance also highlights a shortage of empirical and theory-based examinations. This observation reveals a significant gap, represented by a lack of theoretical studies addressing the implementation and influences of AI adoption within industrial PM.

Figure 5 depicts the bibliometric map of the sample dataset constructed on VOSviewer. The analysis of keyword co-occurrences uncovers fairly centralized structure of the research field divided into six interdependent subject clusters covering technological, organizational, and application-oriented research directions.

The network topology highlights three highly interconnected nodes, specifically "construction 4.0", "Industry 4.0", and "digital transformation", acting as conceptual links between the scattered clusters. This observation suggests that research on AI adoption within industrial PM is not addressed as an isolated technology-oriented field, but as an essential part of industrial digitalization processes, especially those related to Industry 4.0 solutions implemented in construction industry.

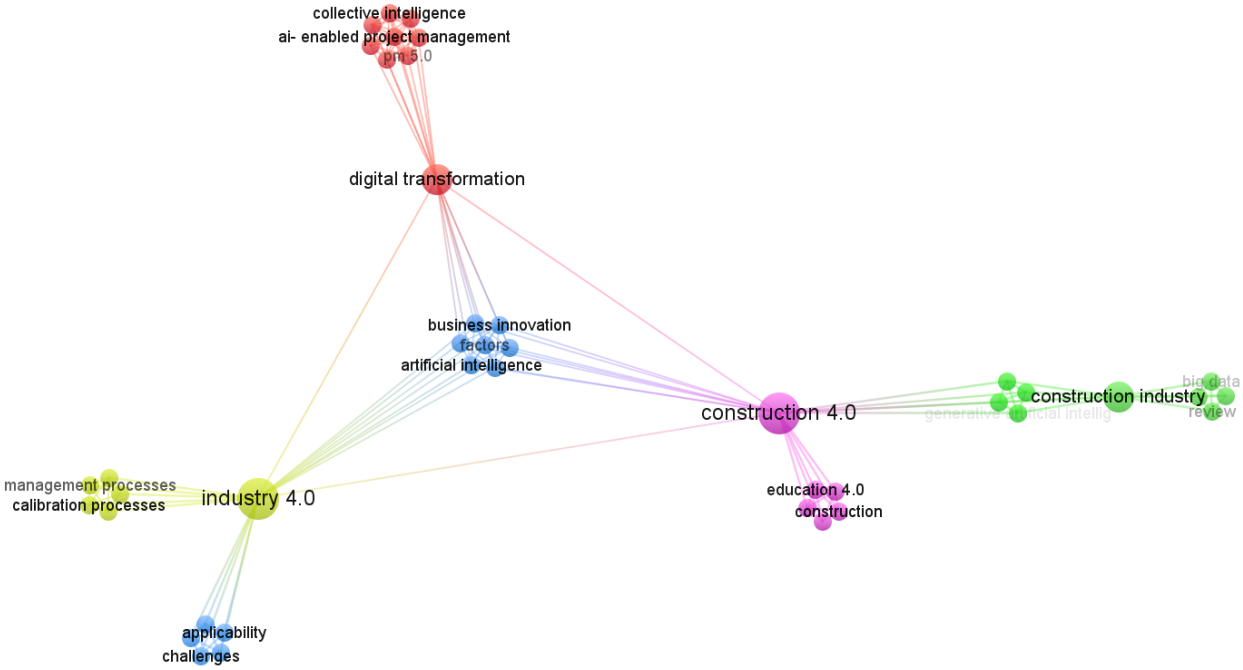

Figure 5 – Bibliometric map of publications in the field

Note: prepared by the authors based on Scopus data using VOSviewer software

The nodes can be categorized into two distinct research directions:

– technological–operational axis, represents Industry 4.0, measurement systems, and digital metrology directions;

– managerial–socio-technical axis, represents AI-enabled PM and PM 5.0 directions.

This separation reflects the ongoing shift from technology-focused perspective to socio-technical one, where the success of AI adoption is not only determined by technical capabilities but also by organizational, managerial, and cultural factors.

In addition to the composition analysis, a density analysis was conducted to assess the distribution of research intensity across subject areas. As visualized in Figure 6, the map

depicts a rough knowledge terrain, marked by remotely developed research areas (yellow zones) with pronounced epicenters.

The identified research concentration areas are:

– “Project Management 5.0”,“AI-enabled project management”, and “collective intelligence” represent the highest research concentration zone, reflecting a rapidly expanding interest in integration of AI technologies in project networks.

– “Construction 4.0”, “industry”, and “construction” form another major collection, indicating a significant role of construction industry as an empirical setting.

– “Factors”, “artificial intelligence”, and “business innovation” form a third concentration of nodes representing a growing attention to factors and constraints influencing AI adoption in business management.

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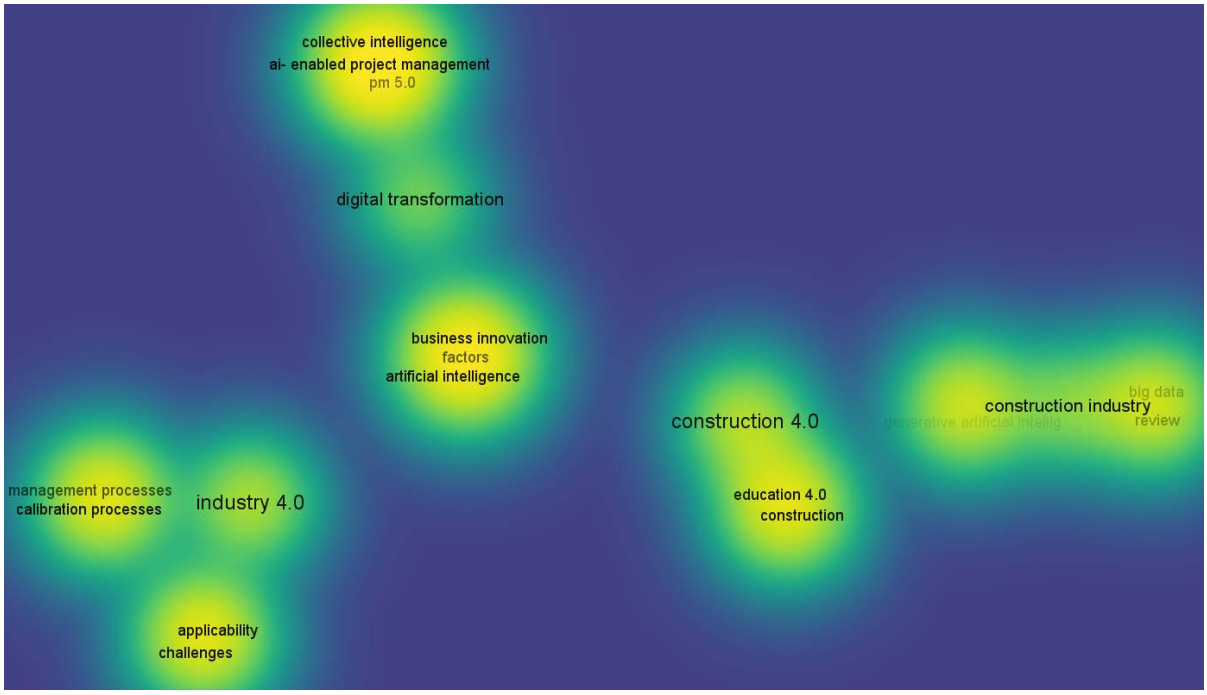

Figure 6 – Density visualization of publications in the field

Note: prepared by the authors based on Scopus data using VOSviewer software

These focal areas suggest that the field is characterized by three primary directions: digital PM, industry-specific applications (construction), and adoption drivers.

On the other hand, subjects, such as digital infrastructure (“measurement”, “calibration processes”), as well as “applicability” and “challenges”, are positioned in sparsely populated zones, suggesting limited research attention despite their critical importance for implementation. This disparity indicates that modern research is primarily opportunity-driven and fixed on technological benefits without equal attention to constraints, adoption challenges, and practical applicability.

Table 3 describes the clusters’ compositions and provides further insights into the bibliometric structure of the field.

Table 3 – Keyword co-occurrence clusters and their thematic interpretation

Cluster	Thematic focus	Representative keywords	Interpretation
C1	AI-enabled PM and socio-technical systems	AI-enabled project management; collective intelligence; digital transformation; human-centric innovation; networked leadership; PM 5.0; project management 5.0; project manager 5.0; socio-technical systems	This cluster reflects the developing theoretical perspective focused on AI-enabled PM and PM 5.0. The keywords manifest a transition to agile, team-based, and innovative PM practices, associated with Industry 5.0.
C2	AI implementation in construction and digital transformation	artificial intelligence adoption; big data; computer vision; construction industry; digital transformation in construction; generative AI; safety management; technology acceptance model	The given cluster covers research on the application of AI technologies within construction industry, as well as the determinants influencing the adoption success.
C3	Organizational and innovation factors in AI adoption	artificial intelligence; business innovation; construction firms; organizational behavior; project management; smart buildings	This cluster encompasses studies on organizational determinants influencing AI adoption in construction projects.
C4	Industry 4.0 infrastructure and measurement systems	calibration processes; digital metrology; Industry 4.0; management processes; measurement; software	This cluster aligns with the core principle of Industry 4.0, where technological infrastructure, such as sensor-driven technologies and software systems determine success of industrial projects.
C5	Construction 4.0 and education ecosystem	construction; construction 4.0; education 4.0; industry; innovation; students	This cluster underscores the significance of AI training and innovation culture in organizations' transition towards Industry 4.0, particularly within construction setting.
C6	Applicability and implementation challenges	applicability; challenges; public building construction; service engineering 4.0; smart building services	This cluster concentrates on AI adoption challenges within industrial PM, indicating their lack of exploration in the current body of knowledge.

The clusters reveal a rapidly growing field, where AI adoption in industrial PM is a multidimensional and evolving process rather than a purely technological movement. The research extends from real-world applications in construction industry, through studies of adoption determinants, towards emerging AI-enabled PM perspectives, emphasizing the significance of managerial skills and innovative culture. At the same time, a thinner layer of research addresses the adoption constraints, underscoring the existing gap in transferring AI's potential into practice. From a practical perspective, these trends suggest that organizations should support technological investments with initiatives aimed at strengthening organizational readiness, workforce competencies, and managerial capabilities, while integrating AI implementation into broader digital transformation strategies and addressing implementation risks. Overall, the field is characterized by interconnections of organizational and technological dimensions, acknowledging that successful adoption of AI in industrial PM depends on their alignment.

Collectively, the results show that future research must overcome descriptive approaches towards theory-driven and empirically grounded studies that engage all dimensions of AI adoption within industrial PM. This, in turn, requires development of adoption frameworks that connect infrastructure requirements with managerial and

organizational dimensions, while also considering under-researched perspectives such as integration challenges, context limitations, and personnel readiness.

Conclusion. The present study provides a structural evaluation of the current body of knowledge on adoption and implementation of AI in industrial PM.

The analyses of the sample's metadata and leading works within the field demonstrate a rapidly expanding research field with a strong concentration of studies in engineering and computer science disciplines, as well as distinct dominance of review articles over evidence-based studies, where key areas, such as adoption approaches remain underexplored.

The results of the bibliometric analysis conducted on VOSviewer further confirm the structural fragmentation of the research field with a dominance of application-focused studies, especially within construction segment and Industry 4.0 contexts. The detailed examination of the six subject clusters shows an emerging transition from technology-driven paradigms toward human-centric and AI-enabled PM perspectives, while acknowledging the importance of management support and innovative culture.

These findings indicate the need for future cross-disciplinary and empirically grounded research that integrate the technical infrastructure and managerial practice dimensions required to support effective AI adoption within industrial project environments. By consolidating existing knowledge and identifying research gaps, this study contributes to the development of a comprehensive and practically relevant research stream in the field.

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ВНЕДРЕНИЕ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В СИСТЕМЕ УПРАВЛЕНИЯ ИНДУСТРИАЛЬНЫМИ ПРОЕКТАМИ: БИБЛИОМЕТРИЧЕСКИЙ АНАЛИЗ НАУЧНО-ИССЛЕДОВАТЕЛЬСКИХ ТЕНДЕНЦИЙ

А.О. Мырзагалиев[1], Г.С. Акыбаева[1*], Л.М. Бекенова[2]

[1]Astana IT University, Астана, Казахстан
[2]Алматинский Гуманитарно-Экономический Университет, Алматы, Казахстан

Резюме. *Стремительное внедрение искусственного интеллекта (ИИ) на промышленных рынках трансформирует традиционные подходы проектного менеджмента (ПМ). Однако исследования в этой новой области остаются разрозненными по прикладным и отраслевым аспектам. Цель данного исследования – выявить текущие тенденции и пробелы в исследованиях внедрения ИИ в индустриальном ПМ путем проведения библиометрического анализа существующих работ. Для достижения этой цели была собрана выборка из 95 журнальных статей, опубликованных в период с 2019 по март 2026 года, из базы данных Scopus с использованием соответствующих ключевых слов и проанализирована с помощью программного обеспечения VOSviewer с использованием инструментов визуализации и методов научного картирования. Результаты показывают быстро расширяющуюся область исследований с преобладающим числом статей, ориентированных на инженерные и технологические аспекты, в то время как наблюдается недостаток работ из области менеджмента. Эта тенденция выявляет растущий разрыв между исследованиями в области достижений ИИ и их внедрением в управленческую среду, а также недостаток эмпирических исследований, посвященных их практическому применению в ПМ. Данная статья вносит вклад в исследование, обобщая разрозненные знания о внедрении ИИ в системе индустриального ПМ, выявляя ключевые пробелы в исследованиях и освещая перспективы будущих исследований.*

Ключевые слова: *искусственный интеллект, проектный менеджмент, индустриальный сектор, Индустрия 4.0, библиометрический анализ, научное картирование, VOSviewer.*

ИНДУСТРИЯЛЫҚ ЖОБАЛАРДЫ БАСҚАРУ ЖҮЙЕСІНДЕ ЖАСАНДЫ ИНТЕЛЛЕКТТІ ЕҢГІЗУ: ҒЫЛЫМИ-ЗЕРТТЕУ ҮРДІСТЕРІНІҢ БИБЛИОМЕТРИЯЛЫҚ ТАЛДАУЫ

А.Ө. Мырзағалиев[1], Г.С. Ақыбаева[1*], Л.М. Бекенова[2]

[1]Astana IT University, Астана, Қазақстан
[2] Алматы гуманитарлы-экономикалық университеті, Алматы, Қазақстан

Түйін. *Өнеркәсіптік нарықтарда жасанды интеллекттің (ЖИ) жедел енгізілуі дәстүрлі жобалық басқару (ЖБ) тәсілдерін өзгертуде. Дегенмен, бұл жаңадан пайда болып жатқан сала бойынша зерттеулер қолданбалы және салалық салаларға шашыраңқы күйінде қалып отыр. Бұл зерттеудің мақсаты – қолданыстағы зерттеулердің библиометриялық талдауын жүргізу арқылы индустиарлық ЖБ ландшафтында ЖИ енгізуді зерттеудегі қазіргі үрдістер мен олқылықтарды анықтау. Осы мақсатқа жету үшін 2019 жылынан 2026 жылдың наурыз айы аралығында жарияланған 95 журнал мақаласының үлгісі Scopus дерекқорынан тиісті түйін сөздерді пайдаланып жиналды және визуализация құралдары мен ғылыми картаға түсіру әдістерін қолдана отырып, VOSviewer бағдарламалық жасақтамасында талданды. Нәтижелер инженерлік және технологиялық мақалалардың басым санымен тез кеңейіп келе жатқан зерттеу саласын көрсетеді, сонымен қатар басқару саласынан үлестер жеткіліксіз. Бұл үрдіс ЖИ жетістіктеріндегі зерттеулер мен оларды басқару саласында енгізу арасындағы алшақтықтың артуын, сондай-ақ оларды ЖБ-да практикалық енгізуді қарастыратын эмпирикалық зерттеулердің жетіспеушілігін көрсетеді. Мақала өнеркәсіптік ЖБ-да ЖИ енгізудегі шашыраңқы білімді біріктіру, негізгі зерттеу олқылықтарын анықтау және болашақ зерттеулердің перспективаларын көрсету арқылы зерттеуге үлес қосады.*

Түйінді сөздер*: жасанды интеллект, жобалық басқару, индустриялық сектор, Индустрия 4.0, библиометриялық талдау, ғылыми картографиялау, VOSviewer.*

Information about the authors:

Azat O. Myrzagaliyev – PhD candidate, Astana IT University, Astana, Kazakhstan, e-mail: 242614@astanait.edu.kz, ORCID ID: 0009-0008-7622-7793.

Gulvira S. Akybayeva* – Candidate of Economic Sciences, Associate Professor, Astana IT University, Astana, Kazakhstan, e-mail: gulvira.akybaeva@astanait.edu.kz, ORCID ID: 0000-0001-8201-3638.

Lidiya M. Bekenova – Candidate of Economic Sciences, Associate Professor, Almaty University of Humanities and Economics, Almaty, Kazakhstan, e-mail: l.bekenova@ageu.edu.kz, ORCID ID: 0000-0002-0298-6817.

Авторлар туралы ақпарат:

Мырзағалиев Азат Өтемісұлы – PhD студенті, Astana IT University, Астана, Қазақстан, e-mail: 242614@astanait.edu.kz, ORCID ID: 0009-0008-7622-7793.

Ақыбаева Гульвира Советбекқызы* – экономика ғылымдарының кандидаты, қауымдастырылған профессор, Astana IT University, Астана, Қазақстан, e-mail: gulvira.akybaeva@astanait.edu.kz, ORCID ID: 0000-0001-8201-3638.

Бекенова Лидия Молдабайқызы – экономика ғылымдарының кандидаты, қауымдастырылған профессор, Алматы гуманитарлы-экономикалық университеті, Алматы, Қазақстан, e-mail: l.bekenova@ageu.edu.kz, ORCID ID: 0000-0002-0298-6817.

Информация об авторах:

Мырзагалиев Азат Отемисулы – PhD студент, Astana IT University, Астана, Казахстан, email: 242614@astanait.edu.kz, ORCID ID: 0009-0008-7622-7793.

Акыбаева Гульвира Советбековна* – кандидат экономических наук, ассоциированный профессор, Astana IT University, Астана, Казахстан, e-mail: gulvira.akybaeva@astanait.edu.kz, ORCID ID: 0000-0001-8201-3638.

Бекенова Лидия Молдабаевна – кандидат экономических наук, ассоциированный профессор, Алматинский гуманитарно-экономический университет, Алматы, Казахстан, e-mail: l.bekenova@ageu.edu.kz, ORCID ID: 0000-0002-0298-6817.

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