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NAVIGATING THE APPLICATION OF ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT: A SCIENTOMETRIC ANALYSIS

This comprehensive literature review delves into the extensive body of research exploring the role of artificial intelligence (AI) in project management. Its primary objective is to amalgamate current knowledge while discerning prevalent trends, challenges, and advantages associated with incorporating AI into project management methodologies. The study employed bibliometric analysis using VOSViewer® software to scrutinize 246 pertinent publications sourced from the Scopus database, spanning the years 2013 to 2023. The findings from the Association Strength and Density Analysis revealed distinct clusters: Cluster 1 elucidated strong associations with terms like «construction project» «technology» «algorithm» «performance» and «time»; Cluster 2 emphasized «case stud.» «decision» and «cost»; while Cluster 3 concentrated on «literature» «industry» and «framework» Moving forward, promising areas for further exploration encompass the refinement of AI algorithms, exploration of AI's impact on project outcomes, and the fusion of AI with emergent technologies like blockchain and the Internet of Things (IoT). This research serves as a foundational roadmap for future investigations aiming to leverage AI to enhance project management effectiveness and efficiency.

Keywords: scientometric analysis, bibliometric review, project management, artificial intelligence, Machine Learning, cluster analysis, research trends.

Introduction

The volatile nature of the 21st-century economy and stiff competition force organizations to complete projects within tighter schedules and limited resources [1]. Project managers seek innovative approaches due to today's challenges. Artificial intelligence (AI) has transformed industries, including project management (PM), by addressing human limitations and reducing errors [2; 3]. AI-powered tools analyze historical data to predict risks and automate tasks like scheduling and budgeting, boosting project efficiency and performance [4].

AI can seamlessly integrate into project management through predictive analytics, natural language processing, and machine learning, empowering data-driven decisions and enhancing project efficiency [5; 6]. While AI holds promise for transforming project management by improving efficiency, reducing costs, and enhancing success rates, this study explores current professional perspectives on AI's role in project management over the past decade.

This bibliometric review examines the current research landscape of applying artificial intelligence (AI) in project management (PM) to identify gaps and future research directions, providing insights into AI's evolution, impact on project success, challenges, and guiding both project managers and researchers. The study is divided into several sections. Section 1 presents the relevance and the goal of the research. Section 2 contains the literature review on applying AI in PM. Section 3 describes the methodology used in the study. Section 4 outlines the results and research findings. Section 5 concludes the study.

Materials and methods

This section outlines the concept of applying AI in PM and compares the previous bibliometric reviews on this topic. Thus, the literature gives us some insight into the scope and potential of AI. Ju et al. [7] showed that AI positively impacts company performance, and [8] note that with the new era of data, the application of artificial intelligence will significantly expand.

The potential of using AI to improve processes and optimize strategies in various fields is discussed in Elmousalami [9] and Fridgeirsson et al. [10]. For example, Elmousalami [9] focuses on applying AI in the procurement function, using AI algorithms to analyze market data, suppliers, and customer preferences to make informed decisions and achieve efficiency gains, cost reductions, and competitive advantages for the business.

Fridgeirsson et al. discuss AI's role in project management based on PMI's Project Management Body of Knowledge (PMBOK). They anticipate significant AI impacts on cost, schedule, and risk management, leveraging historical data for estimation and planning. However, AI's influence may differ in areas requiring human leadership and interpersonal skills. Additionally, ML studies in project

management have applied techniques to predict project duration and costs, enhancing project success through experiential learning [11; 12]. A hybrid AI approach predicts construction project delays using AI, Blockchain Consensus technology, and building information modeling [13], enhancing management efficiency and reducing contract disputes. Workforce innovation management utilizes workplace data for electronic performance monitoring, building information modeling, smart contracts, and AI [14], emphasizing innovative technology adoption in workforce management.

Javed et al. [15] use LSTM-based deep learning to assess software developers' coding skills, achieving 96.25 % accuracy. This informs development process optimization and developer allocation, with considerations for limitations and future research. Lok [16] applies artificial neural networks to analyze outsourcing relationships in global facilities management. Surveys and quantitative methods categorize relationships and develop sustainable models for the industry.

Researchers use AI and natural language processing to develop a model explaining Lean Six Sigma's impact on quality, customer satisfaction, and business performance [9]. Another group explores cognitive digital twins in architecture, engineering, and construction for Construction 4.0, evaluating their applicability and integrability to enhance efficiency and decision-making [17].

Maphosa and Maphosa [2] conducted a bibliometric analysis of 106 articles from 2012 to 2021 on AI in PM to encourage more research interest in this area and identified research gaps. Their findings highlight neural networks, algorithms, big data, and machine learning as commonly used AI techniques in project management, suggesting a need for further research on project managers' readiness for AI integration.

In general, the literature review revealed a growing need to study trends, world practices, and the quality of literature in this area.

Data collection

The bibliometric analysis was conducted using established techniques, including keyword extraction, co-citation analysis, author co-citation analysis, and clustering techniques. The study analyzed the abstracts of 246 publications relevant to PM from the Scopus database from 2013 to 2023 to achieve the aim. The inclusion criteria encompassed peer-reviewed journal articles and reviews.



Figure 1 – Data collection process*

* – compiled by the authors based on analysis

Data processing

The findings from the bibliometric analysis were synthesized to identify emerging trends, key themes, influential authors, and significant research contributions in the field of AI in PM. Clustering techniques, such as hierarchical clustering or bibliographic coupling, are employed to group related publications based on citation patterns or thematic similarities. A Co-Word Analysis Technique (CWAT), a scientometric method for quantitative analysis of the content of academic publications, was applied for this purpose. The study used the VOSViewer® software tool to construct and visualize bibliometric maps.

Results and discussion

The quantitative analysis of existing literature found an increasing number of publications on the application of artificial intelligence in project management, indicating a growing interest in the field. Below is presented the number of documents by subject area.



Figure 2 – The sharing of documents related to subject areas*

* – compiled by the authors based on analysis

As shown in Figure 2, the top fields are Engineering (29.31 %), Computer sciences (23.1 %), and Business and Management (11.6 %). The last area was chosen as an objective of the research sample.

The following figure presents the top countries where the publications were published.

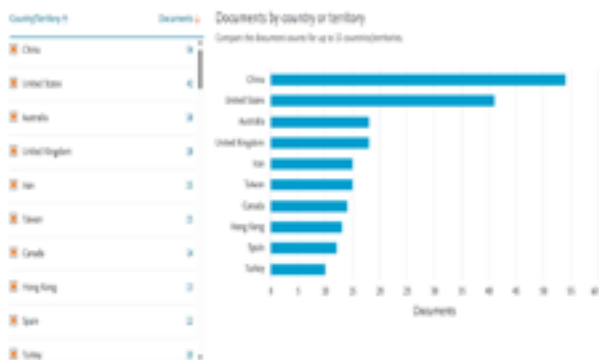


Figure 3 – Documents by top 10 countries*
* – compiled by the authors based on analysis

As shown in Figure 3, China is the leading country with 54 publications about applying AI in PM. This may be due to this country’s rapid development and adoption of advanced technologies. The second country is the USA, with 41 publications; the third is Australia, which has 18 studies in the investigated period.

The following figure outlines the top citing authors who contributed significantly to the investigated topic.



Figure 4 – Documents by top-cited authors*
 * – compiled by the authors based on analysis

Figure 4 shows the leading authors like Cheng, with six papers: Arashpour, Vanhoucke, and Wauters, who published four documents related to using AI in PM. The study can state that these authors have significantly contributed to developing knowledge in this field.

Cluster Analysis / Network Visualization Analysis

First, CWAT Results of the Abstract Terms help to apply clustering of the 36 most occurring terms. The terms were divided into three clusters representing the current Artificial Intelligence research areas in Project Management (Figure 5).



Figure 5 – Network Visualization Analysis*
 * – compiled by the authors based on analysis

Based on this, the study suggests that the three clusters correspond to the three research and knowledge domains of Artificial Intelligence in PM, which can be classified as:

Artificial Intelligence in PM: Construction Management & Machine Learning (Cluster 1);

Artificial Intelligence in PM: Decision Making (Cluster 2);

Artificial Intelligence in PM: Industry Framework Articles (Cluster 3).

Cluster 1 (AI in PM: Construction Management & Machine Learning) focuses on terms like «construction project» «construction management» «information» «technology» «machine learning» «algorithm,» «performance» «accuracy» and «time.» Machine learning algorithms enhance project performance and management by integrating with construction industry practices. Successful projects rely on quality information and technology.

Cluster 2 (AI in PM: Decision Making) emphasizes terms like «case study» «cost» «decision» «decision making» «experience» «impact» «implementation» «risk» «success,» and «uncertainty.» AI aids decision-making but doesn't replace human judgment, requiring project managers to understand AI data and algorithms for informed decisions.

Cluster 3 (AI in PM: Industry Framework Articles) explores terms such as «article» «challenge» «context» «field,» «framework» «industry» «literature» «researcher» and «use» This research contributes to AI implementation in project management within industry frameworks, advancing the PM field.



Figure 6 – Overlay Visualization Analysis*
* – compiled by the authors based on analysis

Association Strength and Density Analysis of Terms

Based on Overlay Visualization Analysis (Figure 6), terms like «decision,» «uncertainty,» and «performance» in Q3 2019 suggest AI tools for decision making. Late 2019 terms like «machine,» «challenge,» and «success» highlight ML implementation in PM. Early 2020 focuses on decision making in construction management, while Q1 2020 emphasizes ML in PM with a time scope. Recent 2021 research areas emphasize technology in construction. Overall, this highlights the importance of information, technology, machine learning, and decision making in construction projects, aligning with the study's focus on managing Information and Technology in effective Construction Management.

The grouped terms like «construction industry,» «construction project,» «performance» «time» «cost» «machine» «algorithm» «order» «impact» «accuracy,» «success,» and «risk» suggest strong associations between these concepts. Additionally, the proximity of terms such as «construction management» «information» «technology» «work» «experience» and «challenge» implies the use of emerging technologies in construction management. Overall, this Overlay Visualization Analysis underscores the complex nature of construction management and emphasizes the importance of concepts like «information» «technology» «machine» «algorithm» and «decision making» in successful construction projects.

Overall, this Overlay Visualization Analysis highlights the complex and multifaceted nature of the construction management and the importance of various concepts such as «information» «technology» «machine» «algorithm» and «decision making» in the implementation of successful construction projects.

The study highlighted that effective Construction Management involves managing Information and Technology. Consequently, the Association Strength Analysis discovered that Information and Technology were highly associated with Construction Management, consistent with the report's findings.

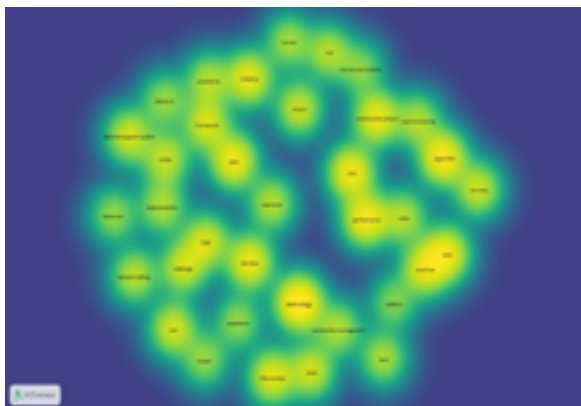


Figure 7 – Density Visualization Analysis *
* – compiled by the authors based on analysis

As Figure 7 depicts, about the interpretation of the AS Analysis with the Cluster Analysis, it is worthwhile to note that there is a much stronger relationship between Clusters 2 and 3 than between Clusters 1 and 2 and 3. This implies that the research questions related to artificial intelligence applications in project management are more closely related to the research and decision-making than to Construction Projects.

Association Strength and Density Analysis in scientometrics is crucial for exploring relationships between terms, revealing patterns in scientific literature. In a report on the applications of Artificial Intelligence (AI) in Project Management (PM), keywords like «construction project,» «technology,» «algorithm,» «performance,» and «time» showed strong associations within Cluster 1 (Figure 3), indicating their close relevance to the topic.

Similarly, terms like «case study,» «decision,» and «cost» demonstrated higher association strength and density in Cluster 2, suggesting a focus on decision-making related to project costs. In Cluster 3, terms like «literature,» «industry,» and «framework» reflected research into AI applications in PM across various industries. The analysis highlights AI's integral role in PM, with strong connections observed among terms like «technology,» «machine,» «algorithm,» indicating the impact of Machine Learning on PM's technological advancements. This study also emphasized AI's potential to enhance project performance and accuracy.

In summary, Association Strength and Density Analysis of Terms offers valuable insights into key concepts and their relationships within datasets, aiding in understanding complex interconnections in scientific research.

Conclusions

This bibliometric review offers a comprehensive outlook on AI's role in project management research, highlighting gaps and insights for researchers and practitioners. The synthesis reveals an evolving field with opportunities for studying AI's ethical implications, algorithm transparency, interdisciplinary collaboration, project success rates, and integration with emerging technologies like blockchain and IoT. Limitations include a focus on Scopus database sources, a preference for journal articles and reviews, and a quantitative analysis approach, suggesting avenues for broader database inclusion, expanded research samples, and qualitative methods in future studies.

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ЖОБАЛАРДЫ БАСҚАРУДА ЖАСАНДЫ ИНТЕЛЛЕКТТІ ҚОЛДАНУ БАҒДАРЫ: ҒЫЛЫМИ – МЕТРИЯЛЫҚ ТАЛДАУ

Бұл жан-жақты әдебиеттік шолу жобаны басқарудағы жасанды интеллекттің (AI) рөлін зерттейтін кең зерттеу ағынын қамтиды. Оның негізгі мақсаты – ағымдағы білімді жинақтау және жобаны басқару әдістемесінде AI интеграциясына байланысты негізгі тенденцияларды, қиындықтар мен артықшылықтарды анықтау. Зерттеу 2013–2023 жылдар аралығында Scopus дерекқорынан 246 сәйкес жарияланымдарды зерттеу үшін VOSviewer® бағдарламалық құралын пайдаланып библиометриялық талдауды пайдаланды. Ассоциативті беріктік пен тығыздық талдауының нәтижелері әртүрлі кластерлерді анықтады: 1 кластер «құрылыс жобасы», «технология», «алгоритм», «тиімділік» және

«уақыт» сияқты терминдермен күшті байланыстарды анықтады; 2-кластер «жағдайлық зерттеулерге», «шешім қабылдауға» және «шығындарға» ерекше мән берді; ал 3-кластер «әдебиет», «өнеркәсіп» және «құрылымға» бағытталған. Әрі қарайғы зерттеулердің перспективалы бағыттарына AI алгоритмдерін жетілдіру, AI-ның жоба нәтижелеріне әсерін зерттеу және AI-ны блокчейн және Интернет заттары (IoT) сияқты жаңа технологиялармен біріктіру кіреді. Бұл зерттеу жобаны басқарудың тиімділігі мен тиімділігін арттыру үшін AI-ды пайдалануға бағытталған болашақ зерттеулер үшін негіз болады.

Кілтті сөздер: ғылымметриялық талдау, библиометриялық шолу, жобаны басқару, жасанды интеллект, машиналық оқыту, кластерлік талдау, зерттеу тенденциялары.

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НАВИГАЦИЯ ПО ПРИМЕНЕНИЮ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА В УПРАВЛЕНИИ ПРОЕКТАМИ: НАУКОМЕТРИЧЕСКИЙ АНАЛИЗ

Этот всесторонний обзор литературы вдается в обширное исследовательское направление, изучающее роль искусственного интеллекта (ИИ) в управлении проектами. Его основная цель – собрать текущие знания и выявить основные тенденции, проблемы и преимущества, связанные с интеграцией ИИ в методологию управления проектами. В рамках исследования был использован библиометрический анализ с использованием программного обеспечения VOSViewer® для изучения 246 соответствующих публикаций из базы данных Scopus за период с 2013 по 2023 год. Результаты анализа ассоциативной силы и плотности выявили

различные кластеры: кластер 1 раскрывал сильные ассоциации с такими терминами, как «строительный проект», «технология», «алгоритм», «эффективность» и «время»; кластер 2 акцентировал внимание на «кейс-стади», «принятие решений» и «затраты»; в то время как кластер 3 сосредоточился на «литературе», «индустрии» и «структуре». Перспективные направления для дальнейшего исследования включают совершенствование алгоритмов ИИ, изучение влияния ИИ на результаты проектов и слияние ИИ с новыми технологиями, такими как блокчейн и Интернет вещей (IoT). Это исследование служит основополагающим маршрутом для будущих исследований, нацеленных на использование ИИ для повышения эффективности и эффективности управления проектами.

Ключевые слова: наукометрический анализ, библиометрический обзор, управление проектами, искусственный интеллект, машинное обучение, кластерный анализ, тренды исследований.

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