Exploring the Challenges and Impacts of Artificial Intelligence Implementation in Project Management: A Systematic Literature Review

Muhammad Irfan Hashfi, Teguh Raharjo
Faculty of Computer Science, Universitas Indonesia, Salemba, 10430, Indonesia

***Abstract*—This paper presents a systematic literature review (SLR) investigating the challenges and impacts of implementing artificial intelligence (AI) in project management, specifically mapping them into the process groups defined in the Project Management Body of Knowledge (PMBOK). The study aims to contribute to the understanding of integrating AI in project management and provides insights into the challenges and impacts within each process group. The SLR methodology was applied, and a total of 34 scientific articles were analyzed. The results and analysis reveal the specific challenges and impacts within each process group. In the Initiating Process Group, AI tools and analysis techniques address challenges in risk assessment, cost prediction, and decision-making. The Planning process group benefits from various tools and methodologies that improve risk assessment, project selection, cost estimation, resource allocation, and decision-making. The Execution process group emphasizes the importance of advanced tools and techniques in enhancing productivity, resource utilization, cost reduction, and decision-making. The Monitoring and Controlling process group demonstrates the potential of advanced tools in achieving efficiency, cost reduction, improved quality, and informed decision-making. Lastly, the Closing process group emphasizes the importance of utilizing advanced tools to minimize waste, optimize resource utilization, reduce costs, improve quality, and project closure success. Overall, this research provides valuable insights and strategies for organizations seeking to implement AI in project management, thereby enhancing the potential for success within the PMBOK Process Group.**

Keywords*—*Artificial intelligence; project management; PMBOK process groups; challenge; impact

I. Introduction

Industry 5.0 is an evolution of Industry 4.0, focusing on a more human-centric approach while leveraging advanced technologies like Artificial Intelligence (AI) and big data. It aims to create a sustainable and resilient industry by combining technological advancements with human needs [1], [2]. Project management has experienced a paradigm shift because of the quick development of AI technology. The way projects are planned, carried out, and controlled may be completely transformed using AI [3], [4]. The incorporation of AI into project management techniques, however, comes with a unique set of difficulties and has a big influence. Organizations need to address these challenges to fully harness the potential of AI in project management [5], [6]. Therefore, it is essential to investigate and understand the challenges faced and impacts observed during the implementation of AI in project management [6].

Given the transformative impact of AI, there is an increasing significance in studying the process of AI adoption. Numerous studies have been conducted to explore the driving factors, barriers, challenges, and overall performance impact associated with AI implementation in organizations [6], [7]. The accuracy and appropriateness of data pertaining to project management tools are crucial. Initial AI tools for project management heavily depend on individuals to accurately input data, timely update tools, and make necessary corrections [8].

The integration of Artificial Intelligence (AI) into business operations has given rise to the emergence of intelligent environments, including advanced monitoring systems for project management. Similarly, AI has been embraced in the field of project management, offering promising prospects for the future of project management activities [3], [9]. Moreover, AI has the capability to monitor project status and make adjustments when required. Integrating AI into project management allows for minimal human intervention by utilizing intelligent machines and large data sets to automate decision-making and task management. This automation enables AI to play a guiding role in projects, automating tasks and aiding in decision-making processes [6], [10], [11].

This paper aims to conduct a systematic literature review (SLR) to investigate the challenges faced and impacts observed during the implementation of AI in project management, specifically mapping them into the process groups defined in the PMBOK [12], [13]. The research questions derived from this objective are as follows:

RQ1: What are the challenges faced and impacts observed during the implementation of AI in project management?

RQ2: How does the implementation of AI in project management incorporate the mapping of challenges and impacts into the process groups defined in the PMBOK?

By conducting a comprehensive review of existing literature, the findings will provide insights into the challenges and impacts specific to each process groups, helping organizations effectively address these challenges and leverage the potential benefits of AI in project management.

This paper follows a systematic process, commencing with a Literature Review section that evaluates existing studies on AI implementation and process groups in project management.

Then the Methodology section consists of three phases: planning the Systematic Literature Review (SLR), executing the SLR, and presenting the SLR findings. Within the Results and Analysis section, two subsections are delineated. The first subsection maps AI tools, implementation challenges, and impacts based on prior research, while the second subsection aligns AI tools, challenges, and impacts with PMBOK Process Groups (initiating, planning, execution, monitoring and controlling, closing). Lastly, the paper concludes by summarizing key findings, discussing their implications for project management, and suggesting directions for future research.

II. Literature Review

A. Artificial Intelligence and Data Mining

Artificial intelligence (AI) is a field within computer science that aims to develop intelligent machines for the benefit of humans. However, there is ongoing debate among researchers regarding the definition of AI due to its evolving nature. Various definitions exist in the literature, reflecting researchers' specializations and interests, all striving to explain the concept of AI and provide a wide range of technologies that enhance performance and interaction within organizations [3], [14]. AI has traditionally been approached from four perspectives: thinking and acting, which encompass thought processes, reasoning, and behavior. These perspectives can be further categorized into a human-centered approach based on human behavior observations, and a rationalist approach combining mathematics and engineering concepts [1].

Data mining is a branch of Machine Learning and Artificial Intelligence that involves analyzing a dataset using algorithms to uncover patterns and relationships. It allows users to analyze data from multiple perspectives, categorize information, and draw conclusions. The process involves searching for correlations between different fields in a database to extract valuable insights and information [15]–[17]. Machine learning enables the categorization of data processing methods in data mining into distinct categories such as classification, regression analysis, association rules, and clustering. Each of these mining methods can be executed using various machine learning techniques [18].

B. Process Groups of Project Management

Project management procedures are organized into logical groups of inputs, tools and techniques, and outputs that are tailored to the needs of the organization, the project, and the stakeholders. Instead of being interchangeable with project phases, these process groups work together during each stage of the project's life cycle. In order to maintain flexibility and adaptation throughout the project, the number of iterations and interactions across processes can change based on the demands of the project [12], [13]. As shown in Fig. 1, participation with the remaining Process Groups is required to fully realize the collaborative aspect of project management.

Projects that adopt a process-based approach can be structured into five groupings based on different processes:

1) The initiating phase of a project involves defining and obtaining authorization for a new project or phase [12]. This phase includes creating a project charter and implementing a formalized project initiation process to support project management decisions and ensure project success [19].

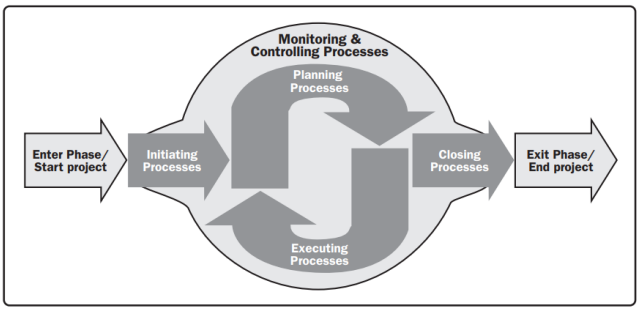

Fig. 1. Project management process groups [13].

2) The planning phase of a project involves establishing the project's scope, refining objectives, and determining the necessary actions to achieve those objectives [12]. This phase encompasses defining the course of action, making decisions, and formalizing the project's direction. Planning is a crucial step in project management, involving the conscious determination of actions to accomplish goals, and it is typically conducted after business planning and before project execution in fields such as construction [20].

3) The execution completing the tasks listed in the project management plan in order to comply with the project's criteria [12]. It encompasses the actual performance of project tasks and activities as outlined in the plan to fulfill the project's objectives [20].

4) The monitoring and controlling phase of project management involves tracking progress, reviewing performance, and making necessary changes to ensure project success [12]. Studies have emphasized the importance of timely control information and the ability to handle unexpected crises as critical factors in effective monitoring and control [20].

5) The closing phase of project management involves formally completing all activities and closing the project, phase, or contract [12]. Research conducted by Amponsah [21] focused on project failure/success factors in Ghana's agriculture, banking, and construction sectors. The study identified project management tools, techniques, and methods used by project managers and recommended that companies in Ghana focus on improving their project management activities for better outcomes.

C. Challenges and Impact of AI Implementation in Project Management

Over time, project management has undergone significant changes and has become increasingly valuable to organizations. The collaboration between humans and machines in the face of major technological advancements presents significant opportunities for both businesses and individuals. One such advancement is Artificial Intelligence (AI), which is expected to greatly influence the role of project managers [6]. AI, despite its complexities, has the potential to

increase productivity and reduce errors in various fields, including software development projects. By providing insights into probable outcomes and removing extraneous information, AI improves project management and enables a focus on relevant facts [22].

The challenges of implementing AI in project management include barriers such as limited data availability, high costs of operation and equipment, and potential unemployment as AI replaces human workers. The successful adoption of AI requires technical staff with specialized skills and experience, along with a clear understanding of system integration and interoperability challenges [3]. While AI offers benefits like cost-effectiveness and reliability, it also raises issues of uncertainty and highlights both the positive and negative aspects of its adoption [23].

The adoption of AI in project management enhances decision-making quality by providing insights and support for potential outcomes. AI systems streamline information by eliminating redundancy, and auto-scheduling improves the robustness of project planning. Planning tools powered by AI, including hybrid computer systems, facilitate project control and objective configuration [8]. While contemporary management strategies like continuous alignment and agile approaches help overcome uncertainties, predictive analytics and machine learning contribute to better project outcomes in areas like KPIs, resource management, and estimate [3], [24].

III. Methodology

This section explains the literature review process using the Systematic Literature Review (SLR) method. This method is used to evaluate and interpret all research related to the research questions, topic areas, or desired phenomena [25]. The goal of Systematic Literature Review is to generate accurate evaluations of the research topic using reliable, meticulous, and auditable methodologies. It is divided into three parts based on the Kitchenham [25] and references [26], [27]: Planning, Implementation, and reporting of SLR stages.

A. Planning the SLR

In this stage, keyword generation is conducted based on the main keywords and synonyms obtained at the beginning of the research, namely Artificial Intelligence and Project Management. Subsequently, these keywords are combined using "AND" to connect the main keywords and "OR" for each synonym or simpler word. The keywords and their synonyms or equivalents are as follows:

- *"Artificial Intelligence", synonym: "data mining", "machine learning"*
- *"Project Management"*

These keywords and their synonyms are combined to form the search keywords as follows:

("artificial intelligence" AND "project management") OR ("data mining" AND "project management") OR ("machine learning" AND "project management")

Then the search is conducted on several reputable literature and journal websites, based on title, abstract, or keywords. The databases are IEEE Xplore, Springer Link, Emerald Insight, SAGE Journals, Science Direct, Scopus, and ACM Digital Library.

After determining which databases to use for the search, the researcher proceeds with the study selection process. This is intended to identify key studies within a research as direct evidence related to the previously obtained keywords [25]. The criteria for the study selection process in this research can be seen in Table I.

TABLE I. Criteria for Study Selection

Inclusion Criteria	IC1	Publications written in English
	IC2	Publications starting from 2018 until 2023
	IC3	Publications that truly focus on the keywords: artificial intelligence / data mining / machine learning and project management
	IC4	Publications that increasingly focus on the root problem, specifically discussing the challenges and impact of AI / DM / ML on project management
Exclusion Criteria	EC1	Research not written in English
	EC2	Research that discusses topics other than AI / DM / ML and project management
	EC3	Research published before 2018

B. Implementation of SLR

In the second phase of the Systematic Literature Review (SLR), the focus is on conducting an extensive search and selecting relevant literature. This involves identifying pertinent studies, extracting relevant information, and synthesizing the findings to obtain a comprehensive understanding of the research topic. Fig. 2 represents the flow diagram illustrating the selection process conducted from the initial data collection in various databases using the inclusion and exclusion criterias specified in Table I.

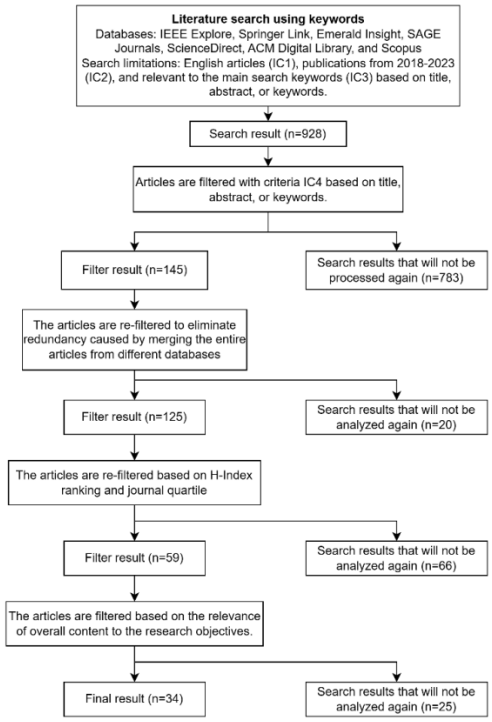

Fig. 2. Flow diagram of SLR implementation.

The total number of articles that will undergo further analysis related to the challenges and impacts on project management amounts to 34 articles, obtained from various high index journals and proceedings based on Scimago.

C. Reporting the SLR

The final step of the Systematic Literature Review (SLR) is reporting the results. Table II presents a summary of all relevant article titles aligned with the research objectives, including information on the year and reference citation coding.

TABLE II. SUMMARY OF ALL RELEVANT ARTICLES

No	Title	Year	Index	Code
1	A BIM-data mining integrated digital twin framework for advanced project management	2021	Q1	[28]
2	A Machine Learning Study to Enhance Project Cost Forecasting	2022	Q3	[29]
3	A new hybrid ahp and dempster—shafer theory of evidence method for project risk assessment problem	2021	Q2	[30]
4	Activity classification using accelerometers and machine learning for complex construction worker activities	2021	Q1	[31]
5	An Approach Based on Bayesian Network for Improving Project Management Maturity: An Application to Reduce Cost Overrun Risks in Engineering Projects	2020	Q1	[32]
6	Application of Data Mining Technology in Field Verification of Project Cost	2021	Q4	[33]
7	Application of lean techniques, enterprise resource planning and artificial intelligence in construction project management	2019	Q4	[34]
8	Automated progress monitoring of construction projects using Machine learning and image processing approach	2022	Q2	[35]
9	Combined machine-learning and EDM to monitor and predict a complex project with a GERT-type network: A multi-point perspective	2023	Q1	[36]
10	Comprehensive project management framework using machine learning	2019	Q4	[37]
11	Data on Field Canals Improvement Projects for Cost Prediction Using Artificial Intelligence	2020	Q2	[38]
12	Data-driven project buffer sizing in critical chains	2022	Q1	[11]
13	Decision support system for final year project management	2019	Procd	[39]
14	Development and comparative of a new meta-ensemble machine learning model in predicting construction labor productivity	2022	Q1	[40]
15	DevOPs project management tools for sprint planning, estimation and execution maturity	2020	Q2	[41]
16	Empirically Exploring the Cause-Effect Relationships of AI Characteristics, Project Management Challenges, and Organizational Change	2021	Procd	[5]
17	Estimating production and warranty cost at the early stage of a new product development project	2021	Q3	[42]
18	Estimation of Risk Contingency Budget in Projects using Machine Learning	2022	Q3	[43]
19	Explainable machine learning for project management control	2023	Q1	[44]
20	Forecasting the scheduling issues in engineering project management: Applications of deep learning models	2021	Q1	[9]
21	Information Technology (IT) Governance Framework with Artificial Neural Network and Balance Scorecard to Improve the Success Rate of Software Projects	2022	Procd	[45]
22	Intelligent purchasing: How artificial intelligence can redefine the purchasing function	2021	Q1	[46]
23	Machine learning in project analytics: a data-driven framework and case study	2022	Q1	[47]
24	Project engineering management evaluation based on GABP neural network and artificial intelligence	2023	Q2	[48]
25	Project management: openings for disruption from AI and advanced analytics	2021	Q1	[49]
26	Proposal of a framework and integration of artificial intelligence to succeed IT project planning	2019	Q4	[50]
27	Recommendation of Project Management Practices: A Contribution to Hybrid Models	2022	Q1	[51]
28	Safety risk factors comprehensive analysis for construction project: Combined cascading effect and machine learning approach	2021	Q1	[52]
29	Symbiotic organisms search-optimized deep learning technique for mapping construction cash flow considering complexity of project	2020	Q1	[53]
30	The effectiveness of project management construction with data mining and blockchain consensus	2021	Q1	[54]
31	The impact of entrepreneurship orientation on project performance: A machine learning approach	2020	Q1	[55]
32	The value of data from construction project site meeting minutes in predicting project duration	2022	Q2	[56]
33	Using an Artificial Neural Network for Improving the Prediction of Project Duration	2022	Q2	[57]
34	Visual System Development for Construction Project Management by Using Machine Learning Algorithm	2022	Q2	[58]

Furthermore, the distribution of the scientific articles based on their publication years is presented in Fig. 3.

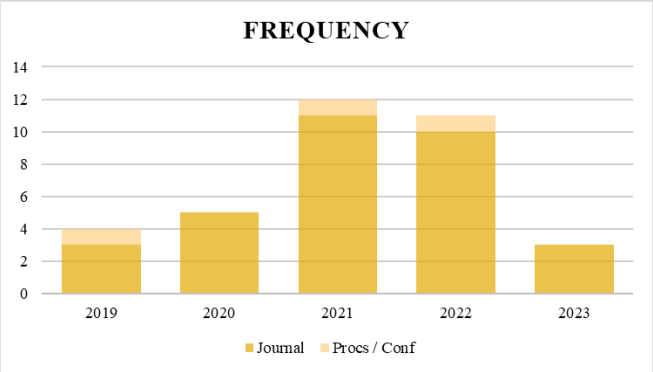

Fig. 3. Distribution of study per year.

IV. Results and Analysis

In accordance with the objective of this research, a thorough mapping and analysis of the literature obtained will be conducted using the Systematic Literature Review (SLR) method described in the previous chapter. The outcomes obtained from this process will be divided into the mapping of AI tools used, challenges, and the impact of AI implementation on each article, as well as their summaries.

A. Mapping the AI tools, Implementation Challenges and Impacts based on Related Studies

Table III presents the further analysis results of the articles obtained in the previous SLR process, where the analysis is conducted regarding the AI tools used in the referenced studies, as well as the challenges and impacts of implementation in those studies. These AI tools can include algorithms, software, models, or others.

TABLE III. Mapping the AI tools, challenges, and Impact of the AI Implementation

Ref	AI Tools	Challenge	Impact
[28]	BIM, IoT, DM techniques, process mining, time series analysis, fuzzy miner algorithm, ARIMAX model	Real-time IoT data mapping and complexity management in large-scale projects.	AI enables early bottleneck detection, future workload prediction, and proactive decision-making for enhanced efficiency and adaptability.
[29]	Moving averages, schedule and cost performance factors	Nonlinear budget acquisition and cost growth patterns not accurately captured by traditional index-based models.	AI provides reliable and accurate cost estimates, improving project cost forecasting and maintaining positive stakeholder relationships.
[30]	Hybrid PCA-agglomerative unsupervised ML algorithm, Delphi method, statistical analysis, Taguchi Method	Uncertainty and variability of risk factors not accurately addressed by traditional decision-making methods.	AI quantifies risk factors for more informed project selection and improved decision-making, potentially enhancing project success rates.
[31]	Machine learning algorithms (e.g., K-Nearest Neighbors, Gradient Boosting), wearable accelerometers, feature selection techniques	Dealing with realistic scenarios, bias minimization, imbalanced datasets, and optimizing classifier performance with activity transitions.	AI enhances project decision-making, resource management, worker performance, and safety in construction, contributing to automation and process-level knowledge.
[32]	Bayesian networks	Integrating PMM models with Bayesian networks, formalizing expert knowledge, and addressing sector-specific factors and project drifts.	AI-based PMM diagnoses and predicts project performance failures, identifies drifts, and suggests corrective actions for comprehensive project success analysis.
[33]	Statistical data mining technology (not specified)	Developing a comprehensive organizational structure, implementing advanced management practices, improving cost communication, and addressing cost verification shortcomings.	AI introduces a data-driven approach, improving visualization, resource management, data collection, and cost control in project management.
[34]	Voice command, optical character recognition, LiDAR sensors	Integrating multiple systems, ensuring compatibility, overcoming resistance to change, and addressing complexity and uncertainty in construction projects.	AI minimizes waste, optimizes resource utilization, reduces costs, improves delivery time and quality, and enhances productivity in the construction industry.
[35]	Deep learning models, supervised CNN classifiers, image processing techniques	Reluctance, data standardization, and accuracy of automated tracking	Supervised CNN classifier improves activity recognition, enhancing supervision and progress tracking in construction projects.
[36]	Monte Carlo simulation, machine learning regression algorithms	Analyzing complex networks and selecting suitable algorithms	AI improves project monitoring, deviation identification, and completion time estimation, enhancing project performance and decision-making.
[37]	Artificial Intelligence (AI), machine learning models, online solutions (not specified)	Model selection, training, integration, data accuracy, and user interface development.	AI improves planning, decision-making, automation, and holistic solutions for project management.
[38]	Machine learning and AI techniques (Regression, Fuzzy, ANN, SVM, and others)	Dataset quality, algorithm selection, and interpretation/validation.	Understanding factors influencing project outcomes improves planning and resource allocation in sustainable projects.
[11]	Full-factor design of experiments, Monte Carlo simulation, regression techniques	Designing experiments, simulations, and ensuring model validity,	AI-based buffer sizing improves project planning and timeliness compared to traditional methods.
[39]	Naïve Bayes algorithm, JSP technology	Database organization, accuracy of Naïve Bayes, and technical issues.	AI platform for matching students with project topics and supervisors improves the quality and efficiency of final year research projects.
[40]	Ensemble machine learning algorithms	Preprocessing, algorithm selection, converting models, and case studies.	Accurate labor productivity prediction and influential factors guidance improve construction project management and overall productivity.

[41]	Real-time project data analysis, sprint estimation techniques, sentiment analysis	Real-time data analysis, accurate predictions, consensus, and sentiment analysis.	AI tools streamline project timelines, increase productivity, and improve decision-making in a DevOps environment.
[5]	AI techniques, machine learning algorithms, data analysis methods	Addressing AI's characteristics and implications in organizational settings.	Understanding the relationships between AI characteristics, project management practices, and organizational change improves AI implementation and decision-making.
[42]	Artificial neural network, linear regression techniques	Defining variables, acquiring data, and simulating cost variants.	Systematic consideration of cost factors and constraints improves cost estimation and optimization in new product development projects.
[43]	Machine learning algorithms, Monte Carlo simulation	Defining risks, selecting algorithms, and ensuring accuracy	Integration of machine learning techniques enhances Contingency Budget estimation accuracy and risk management in projects.
[44]	Monte Carlo simulation, statistical/machine learning models, explainable machine learning with SHAP	Integrating simulation and explainability, selecting models, and handling complexity.	Integration of Monte Carlo simulation, machine learning, and explainable machine learning improves project control and decision-making in uncertain environments.
[9]	LSTM and GRU models	Forecasting model selection, data quality, and interpretation.	LSTM and GRU models enable effective scheduling, resource allocation, and decision-making, improving overall project efficiency.
[45]	Artificial Neural Network (ANN) method, Balanced Score Card framework	Top management commitment, solution finding, and data availability.	AI integration in software project management enables informed decision-making and better outcomes, leading to the development of new project life-cycle solutions.
[46]	Automated systems for purchasing, and decision support	Resistance, integration, data quality, and training.	AI systems redefine purchasing roles, improve decision-making, supplier relations, and interdepartmental collaboration, highlighting the potential of AI capabilities in supplier management.
[47]	Machine learning algorithms (e.g., support vector machine, logistic regression, neural networks) using Python's Scikit-learn package	Limited evaluation, feature selection, and data imbalance.	AI-driven data analysis improves decision-making and understanding in construction project management.
[48]	BP neural network, genetic algorithms	Data availability, neural network limitations, and minimizing subjectivity.	AI-based system optimizes time, personnel, and resource utilization, improving engineering project management efficiency.
[49]	Software tools with AI and analytics features	Project managers adapting to software features	AI and analytics tools enhance project management with increased support, automation, and adaptive practices, emphasizing stakeholder relations and risk management.
[50]	Knowledge base, questioning system	Data acquisition, correctness, and risk management.	AI-based solution improves accuracy and efficiency of IT project planning, reducing failure rates and enabling cost savings.
[51]	Cluster analysis, association rule technique	Data collection, accuracy, and validation.	Guidance for selecting practices to enhance project management agility and effectiveness, suggesting avenues for further research in customizing hybrid models.
[52]	Machine learning, safety risk factor mining, AON networks	Abundant data, algorithm optimization, and quantifying risk impact.	AI improves safety risk analysis in construction projects, enhancing risk management, with further research needed for data independence and cost considerations.
[53]	Symbiotic organisms search (SOS) algorithm, LSTM, neural networks	Cash flow, model optimization, and data availability.	AI model accurately forecasts and controls cash flow in construction projects, improving cost management, decision-making, and resource allocation.
[54]	AI middle office, AI algorithms, blockchain technology, BIM	Data availability, integration, and consensus building.	Integration of AI middle office, BC technology, and BIM technology enhances trust, transparency, accuracy, security, and project management efficiency.
[55]	Machine learning algorithms (e.g., lasso, ridge, support vector machines, neural networks, random forest)	Algorithm selection, performance metrics, self-assessment, and generalizability.	AI techniques provide insights into operations and project management research, highlighting the potential of predictive analytics and entrepreneurial orientation for project success.
[56]	Data mining algorithms, random forest	Meeting minute data extraction, time-consuming capture, and data quality.	AI enables accurate project duration prediction, facilitating timely actions and improving project planning, leadership, and governance.
[57]	Artificial neural networks, genetic algorithms	Diverse datasets, adaptation to different organizations, and validation.	AI accurately predicts project duration for different organizations, adapting to various methods and datasets, enhancing project management decision-making.
[58]	Graph neural network, deep learning algorithms	Complex building data, accuracy of traditional algorithms, and limited early-stage.	Integration of complex data and machine learning algorithms improves building management efficiency, information access, communication, energy conservation, and safety.

Artificial intelligence tools in project management based on the related studies mentioned include BIM, IoT, DM techniques, process mining, time series analysis, fuzzy miner algorithm, ARIMAX model, moving averages, schedule and cost performance factors, hybrid PCA-agglomerative unsupervised ML algorithm, Delphi method, statistical analysis, Taguchi Method, machine learning algorithms (such as K-Nearest Neighbors and Gradient Boosting), wearable accelerometers, feature selection techniques, Bayesian networks, voice command, optical character recognition, LiDAR sensors, deep learning models, supervised CNN classifiers, image processing techniques, Monte Carlo simulation, artificial neural networks, full-factor design of experiments, Naïve Bayes algorithm, ensemble machine learning algorithms, real-time project data analysis, sprint estimation techniques, sentiment analysis, software tools with AI and analytics features, knowledge base, questioning system, cluster analysis, association rule technique, safety risk factor mining, symbiotic organisms search (SOS) algorithm, LSTM,

AI middle office, lasso and ridge regression, support vector machines, random forest, data mining algorithms, genetic algorithms, and graph neural network.

From a project management standpoint, AI has the capability to replicate human cognitive functions such as decision-making and problem-solving [3]. These tools bring advanced capabilities to project management, enabling tasks such as data analysis, risk assessment, decision-making, performance monitoring, and optimization [42], [49]. They leverage AI, machine learning, and statistical techniques to improve project planning, resource allocation, cost estimation, risk mitigation, and overall project outcomes [43], [52]. These tools enhance efficiency, accuracy, and insights in project management processes, ultimately leading to improved project success rates and delivery [50], [54]

B. Mapping AI Tools, Challenges, and Impacts of Articles based on PMBOK Process Group

Next is to map the process groups of PMBOK, which according to the literature are divided into 5, namely Initiating, Planning, Execution, Monitoring and Controlling, and Closing [12]. This mapping aims to integrate project management processes and product-oriented processes, ensuring proper coordination and alignment. The function of mapping the process group is to achieve this integration throughout the project lifecycle by tailoring the application of processes to meet the project's specific requirements and actively managing process interactions and tradeoffs to meet stakeholder needs [13]. The mapping results are presented in Table IV.

Based on the mapping results of the reference articles to the Process Groups in PMBOK, the next step involves reviewing the summaries of AI Tools used in each stage of the Process Group. Additionally, the challenges and their respective impacts on each process will be explored based on the conducted literature study.

TABLE IV. MAPPING RELATED STUDIES TO PROCESS GROUP

No	Process Group PMBOK	Reference	Freq
1	Initiating	[30], [38]	2
2	Planning	[5], [11], [29], [30], [32], [34], [37], [38], [41]–[43], [46]–[52], [54]	19
3	Execution	[34], [37], [39]–[41], [49]	6
4	Monitoring and Controlling	[9], [28], [31], [33]–[36], [44], [45], [49], [53]–[58]	16
5	Closing	[34], [49]	2

1) Initiating process group: In the Initiating process group of the PMBOK, both papers discussed the application of AI tools and analysis techniques to address challenges in risk management and cost prediction in projects.

The first paper [30] utilized a hybrid AHP and Dempster-Shafer methods along with various AI tools such as machine learning algorithms, Delphi method, statistical analysis, and Taguchi Method to tackle the challenge of uncertainty and variability in risk factors. These AI tools had a significant impact by offering a more reliable approach to project selection through the consideration and quantification of risk factors, enabling informed decision-making and potentially improving project success rates.

Similar to the first article, the second paper [38] used Machine Learning and AI methods to estimate and forecast the cost and length of field canal development projects. These methods included regression, fuzzy logic, artificial neural networks, support vector machines, and others. Despite challenges related to dataset quality, algorithm selection, and interpretation/validation, the application of these techniques positively influenced the understanding of factors influencing project outcomes, leading to improved planning and resource allocation in sustainable projects.

In summary, within the Initiating process group, the integration of AI tools and analysis techniques in project management addresses challenges in risk assessment, cost prediction, and decision-making. These advancements provide more reliable approaches for project selection, considering and quantifying risk factors, and improving the overall success rates of projects. Additionally, the utilization of Machine Learning and AI techniques enhances the understanding of project outcomes and aids in better planning and resource allocation. However, challenges such as uncertainty, variability, and dataset quality need to be carefully addressed to ensure accurate predictions and interpretations in project management.

2) Planning process group: This comprehensive analysis summarizes the key findings and contributions of 19 scientific papers related to project management. These papers utilize various tools and techniques such as machine learning, artificial intelligence (AI), data mining, and statistical analysis to address challenges and enhance the process of group planning within the PMBOK framework. By leveraging these advanced tools, project managers can enhance decision-making, risk assessment, resource allocation, and project planning.

The application of these tools and methodologies in project management has significant impacts. By incorporating hybrid models, advanced algorithms, and statistical techniques, projects can benefit from improved risk assessment, more reliable project selection, accurate cost estimation, optimized resource utilization, and enhanced decision-making [29], [30], [38]. These advancements contribute to higher project success rates, improved project outcomes, and efficient resource allocation.

Furthermore, the integration of machine learning, artificial intelligence, and data analytics in project management processes enhances real-time data analysis, sentiment analysis, and decision support. This results in streamlined project timelines, increased productivity, and improved project management within a DevOps environment [41]. Additionally, the adoption of AI and advanced analytics tools in project management opens opportunities for disruption, automation, adaptive practices, and better stakeholder relations and risk management [32].

The construction industry also benefits from the application of AI, machine learning, and lean techniques. These

technologies enable the optimization of resource utilization, reduction of project costs, improvement of project delivery time and quality, and enhancement of overall productivity and efficiency [34], [52]. Moreover, the integration of AI in the South African construction project management industry contributes to job security, accident reduction, automation of high-risk tasks, and the creation of new job opportunities, thereby fostering regional development [59].

In summary, the 19 scientific papers examined showcase a wide range of tools and methodologies that address various challenges in project management. The application of these tools has a profound impact on risk assessment, project selection, cost estimation, resource allocation, decision-making, and overall project success rates. Additionally, the integration of AI and data analytics enhances real-time analysis, automation, adaptive practices, and stakeholder relations in project management processes. These advancements contribute to improved project outcomes, increased productivity, and regional development within the construction industry.

3) Execution process group: The analysis reveals valuable insights into the application of various tools, challenges, and impacts associated with the execution process group in PMBOK. These findings shed light on the utilization of tools such as lean techniques, enterprise resource planning (ERP), artificial intelligence (AI), machine learning models, and decision support systems to enhance project execution, productivity, process streamlining, and decision-making in different domains.

However, the implementation of these tools is not without challenges. The papers [34], [39] emphasize the challenges of integrating multiple systems, ensuring compatibility, overcoming resistance to change, addressing complexity and uncertainty, and dealing with technical issues. For example, a research [40], focuses on the challenges related to preprocessing, algorithm selection, converting models, and conducting case studies in the context of predicting construction labor productivity using ensemble machine learning models. These challenges necessitate comprehensive strategies and skillful implementation to successfully employ the identified tools in project execution.

Despite the challenges, the implementation of the identified tools brings about significant impacts on the execution process group. The papers highlight outcomes such as minimizing non-value-added efforts and waste, optimizing resource utilization, reducing project costs, improving project delivery time and quality, enhancing overall productivity and efficiency, and improving decision-making [34], [40], [41], [49]. For instance, a paper [34] discusses the impact of lean techniques, ERP, and AI in construction project management, which results in minimizing waste, optimizing resource utilization, reducing project costs, and improving project delivery time and quality within the construction industry.

Furthermore, the papers emphasize the potential of AI and advanced analytics tools in disrupting project management practices. These tools enhance productivity, support decision-making, automate processes, and emphasize stakeholder relations and risk management [37], [49]. A paper specifically highlights the opening for disruption from AI and advanced analytics tools, underscoring their potential to transform project management practices through increased support, automation, and adaptive practices [49].

In summary, the analysis of the six papers highlights the significance of employing advanced tools and techniques in the execution process group in PMBOK. While the adoption of these tools offers numerous benefits, challenges related to system integration, resistance to change, and technical issues need to be addressed. The positive impacts resulting from their implementation include improved productivity, resource utilization, cost reduction, and enhanced decision-making. Further research and focused efforts are required to overcome the identified challenges and fully harness the potential of these tools for effective project execution.

4) Monitoring and controlling process group: The analysis of the 16 papers reveals significant insights into the utilization of tools, challenges, and impacts related to the monitoring and controlling process group in PMBOK. These papers highlight the application of various advanced tools and techniques such as Artificial Intelligence (AI), Building Information Modeling (BIM), Internet of Things (IoT), Data Mining (DM), machine learning, and image processing algorithms. These tools offer promising capabilities in enabling effective project control and monitoring in the construction domain. They facilitate complex data analysis, performance prediction, bottleneck detection, risk identification, and decision-making support.

However, the integration of these tools into project management practices is not without challenges. The papers emphasize the challenges associated with system integration, resistance to change, technology adoption, data accuracy, and project complexity [33], [34], [58]. The integration of multiple systems [45], [54], including voice command, optical character recognition, and LiDAR sensors, as mentioned in the certain paper [34], necessitates the overcoming of compatibility issues and resistance to change. Furthermore, the complexity and uncertainty inherent in construction projects pose additional challenges that demand comprehensive strategies and skilled implementation.

Despite these challenges, the implementation of the identified tools brings about significant impacts on the monitoring and controlling process group. The papers highlight outcomes such as enhanced efficiency, cost reduction, improved project quality, and timely delivery [9], [33], [34], [53], [57]. Moreover, the utilization of these tools fosters better decision-making, efficient resource management, improved stakeholder relations, and enhanced risk management [49], [57]. Other paper based on literature review [59] discusses the impact of AI integration in the construction industry, leading to improved job security, reduced accidents, automation of high-risk tasks, and the creation of new job opportunities.

In summary, the comprehensive analysis of the 16 papers underscores the significance of employing advanced tools and techniques for the monitoring and controlling process group in

PMBOK. While the adoption of these tools holds immense potential in project control and monitoring, challenges pertaining to system integration, resistance to change, technology adoption, and project complexity necessitate strategic interventions. However, the positive impacts resulting from their implementation include increased efficiency, cost reduction, improved quality, and informed decision-making, thereby driving effective project management. Further research and focused endeavors are required to address the identified challenges and fully harness the potential of these tools for improved project outcomes.

5) Closing process group: The two papers discussed the application of various tools and technologies in the Closing Process Group of project management according to the PMBOK. First paper [34] highlighted the use of tools like voice command, optical character recognition, and LiDAR sensors for what-if scenarios in construction project management. The challenges identified in this paper included integrating multiple systems, ensuring compatibility, overcoming resistance to change, and addressing complexity and uncertainty in construction projects. The impact of these tools was seen in minimizing non-value-added efforts, optimizing resource utilization, reducing project costs, improving project delivery time and quality, and enhancing overall productivity and efficiency within the construction industry.

Second paper [49] focused on the disruptions caused by AI and advanced analytics tools in project management. The tools discussed in this paper were software tools incorporating AI and analytics features. The main challenge highlighted was project managers adapting to these software features. However, the impact of these tools was significant, enhancing project management through increased support, automation, adaptive practices, and emphasis on stakeholder relations and risk management in the closing phase.

In summary, both papers emphasized the importance of utilizing advanced tools and technologies in the Closing Process Group of project management. The tools offer solutions to challenges such as system integration, resistance to change, and adaptation to software features. Moreover, the impacts mentioned, such as minimizing waste, optimizing resource utilization, reducing costs, improving quality, and enhancing productivity, align with the desired outcomes of the Closing Process Group in PMBOK.

V. CONCLUSION

The findings of this systematic literature review (SLR) provide significant insights into the implementation of AI within the process groups defined in the PMBOK. The result highlights the importance of utilizing advanced tools and techniques in each process group and emphasizes the need to address specific challenges for successful AI implementation. Within the Initiating process group, AI tools and analysis techniques were effective in addressing challenges related to risk assessment, cost prediction, and decision-making. In the Planning process group, the application of AI and data analytics tools improved risk assessment, project selection, cost estimation, resource allocation, and decision-making. The Execution process group experienced improved productivity, resource utilization, cost reduction, and enhanced decision-making through the use of advanced tools and techniques. The Monitoring and Controlling process group also demonstrated the potential of advanced tools and techniques in achieving increased efficiency, cost reduction, improved quality, and informed decision-making. Lastly, the Closing process group highlighted the value of incorporating AI, lean techniques, ERP, and machine learning, resulting in benefits such as cost reduction, efficiency improvement, and project closure success.

Overall, this SLR provides valuable insights for organizations aiming to integrate AI into their project management practices. By aligning the challenges and impacts with the PMBOK process groups, this research offers a structured framework that allows organizations to navigate the implementation of AI effectively. Understanding the specific challenges and impacts associated with each process group can help organizations address these issues and capitalize on the potential benefits of AI in project management, ultimately leading to improved project outcomes and increased productivity.

A. Limitations of Study

The limitation of this study is that it should be noted that the authors have not explored or presented specific solutions to address the identified challenges discussed in the literature.

B. Future Works

In future research, it is important to conduct a bibliographic analysis to identify relevant tools and map them into a specific framework. Additionally, creating a comprehensive mapping of the identified challenges within the framework will provide a better understanding of their origins and facilitate the search for effective solutions.

REFERENCES

[1] Taboada, A. Daneshpajouh, N. Toledo, and T. de Vass, “Artificial Intelligence Enabled Project Management: A Systematic Literature Review,” Applied Sciences (Switzerland), vol. 13, no. 8, 2023, doi: 10.3390/app13085014.

[2] V. Maphosa and M. Maphosa, “Artificial Intelligence in Project Management Research: a Bibliometric Analysis,” J Theor Appl Inf Technol, vol. 100, no. 16, pp. 5000–5012, 2022, doi: 10.5281/zenodo.7134073.

[3] A. Alshaikhi and M. Khayyat, “An investigation into the Impact of Artificial Intelligence on the Future of Project Management,” 2021 International Conference of Women in Data Science at Taif University (WiDSTaif), 2021, doi: 10.1109/WiDSTaif52235.2021.9430234.

[4] S. Bento, L. Pereira, R. Gonçalves, Á. Dias, and R. L. da Costa, “Artificial intelligence in project management: systematic literature review,” International Journal of Technology Intelligence and Planning, vol. 13, no. 2, pp. 143–163, 2022, doi: 10.1504/ijtip.2022.126841.

[5] C. Engel, P. Ebel, and B. van Giffen, “Empirically Exploring the Cause-Effect Relationships of AI Characteristics, Project Management Challenges, and Organizational Change,” Lecture Notes in Information Systems and Organisation, vol. 47, no. February, pp. 166–181, 2021, doi: 10.1007/978-3-030-86797-3_12.

[6] C. Bodea, D. Ronggui, O. Stanciu, and C. Mitea, Artificial Intelligence impact in Project Management. International project management association, 2020.

[7] S. Yang, "A systematic literature review on the disruptions of artificial intelligence within the business world : in terms of the evolution of competences," no. June, pp. 0–39, 2022.

[8] A. Belharet, U. Bharathan, B. Dzingina, N. Madhavan, C. Mathur, and Y.-D. B. Toti, "Report on the Impact of Artificial Intelligence on Project Management," pp. 1–53, 2020.

[9] S. Liu and W. Hao, "Forecasting the scheduling issues in engineering project management: Applications of deep learning models," Future Generation Computer Systems, vol. 123, pp. 85–93, 2021, doi: 10.1016/j.future.2021.04.013.

[10] A. T. T. Foster, "ARTIFICIAL INTELLIGENCE IN PROJECT MANAGEMENT.," Cost engineering : a publication of the American Association of Cost Engineers., vol. 30, no. 6. The Association, Morgantown, WV :, pp. 21–24. doi: info:doi/.

[11] H. Li, Y. Cao, Q. Lin, and H. Zhu, "Data-driven project buffer sizing in critical chains," Autom Constr, vol. 135, no. December 2020, p. 104134, 2022, doi: 10.1016/j.autcon.2022.104134.

[12] P. M. I. (ASV), The standard for project management and a guide to the project management body of knowledge (PMBOK) 7th Edition., no. July. 2021.

[13] PMI, A Guide to the Project Management Body of Knowledge (PMBOK) Fifth Edition, vol. 6. Project Management Institute, Inc., 2013.

[14] B. Dickson, "What is artificial narrow intelligence (Narrow AI)?," 2020. https://bdtechtalks.com/2020/04/09/what-is-narrow-artificial-intelligence-ani/ (accessed Jun. 12, 2023).

[15] DAMA International, DAMA-DMBOK : data management body of knowledge 2nd Edition. 2017.

[16] H. K. Mohamed, S. M. El-Debeiky, H. M. Mahmoud, and K. M. El Destawy, "Data mining for electrical load forecasting in Egyptian electrical network," in 2006 International Conference on Computer Engineering and Systems, ICCES'06, 2006, pp. 460–465. doi: 10.1109/ICCES.2006.320491.

[17] R. Shukla, P. Sharma, N. Samaiya, and M. Kherajani, "WEB USAGE MINING-A Study of Web data pattern detecting methodologies and its applications in Data Mining," 2020. doi: 10.1109/IDEA49133.2020.9170690.

[18] S. Li, "Research on Data Mining Technology Based on Machine Learning Algorithm," J Phys Conf Ser, vol. 1168, no. 3, 2019, doi: 10.1088/1742-6596/1168/3/032132.

[19] D. S. Hayes, "1999 International Student Paper Award Winner: Evaluation and Application of a Project Charter Template to Improve the Project Planning Process," Project Management Journal, vol. 31, no. 1, pp. 14–23, Mar. 2000, doi: 10.1177/875697280003100104.

[20] A. P. Singh, "Project Management Process Group and Knowledge Area: Review," pp. 1–20, 2018, [Online]. Available: www.ijarse.com

[21] C. and P. M.) Amponsah, Richard (School of Property, "Improving Project Management Practice in Ghana with Focus on Agriculture, Banking and Construction Sectors of the Ghanaian Economy," Thesis, vol. 8, no. July, p. 441, 2010, [Online]. Available: https://researchbank.rmit.edu.au/view/rmit:10389

[22] N. O. C. Victor, "How Artificial Intelligence Influences Project Management," Res Sq, no. February, p. 19, 2023, doi: 10.21203/rs.3.rs-2535611/v1.

[23] M. Chowdhury and A. W. Sadek, "Advantages and limitations of artificial intelligence," Transportation Research Circular, no. E-C168, pp. 6–8, 2012.

[24] R. E. Levitt and J. C. Kunz, "Using artificial intelligence techniques to support project management," AI EDAM, vol. 1, no. 1, pp. 3–24, 1987, doi: DOI: 10.1017/S0890060400000111.

[25] B. A. Kitchenham and S. Charters, "Guidelines for performing Systematic Literature Reviews in Software Engineering (Software Engineering Group, Department of Computer Science, Keele …," Technical Report EBSE 2007- 001. Keele University and Durham University Joint Report, no. January, 2007.

[26] T. Raharjo and B. Purwandari, "Agile project management challenges and mapping solutions: A systematic literature review," ACM International Conference Proceeding Series, pp. 123–129, 2020, doi: 10.1145/3378936.3378949.

[27] P. Marnada, T. Raharjo, B. Hardian, and A. Prasetyo, "Agile project management challenge in handling scope and change: A systematic literature review," Procedia Comput Sci, vol. 197, no. 2021, pp. 290–300, 2021, doi: 10.1016/j.procs.2021.12.143.

[28] Y. Pan and L. Zhang, "A BIM-data mining integrated digital twin framework for advanced project management," Autom Constr, vol. 124, no. July 2020, p. 103564, 2021, doi: 10.1016/j.autcon.2021.103564.

[29] T. Inan, T. Narbaev, and Ö. Hazir, "A Machine Learning Study to Enhance Project Cost Forecasting," IFAC-PapersOnLine, vol. 55, no. 10, pp. 3286–3291, 2022, doi: 10.1016/j.ifacol.2022.10.127.

[30] S. M. Albogami, M. K. A. B. M. Ariffin, K. A. Ahmad, and E. E. B. Supeni, "A new hybrid ahp and dempster—shafer theory of evidence method for project risk assessment problem," Mathematics, vol. 9, no. 24, 2021, doi: 10.3390/math9243225.

[31] L. Sanhudo et al., "Activity classification using accelerometers and machine learning for complex construction worker activities," Journal of Building Engineering, vol. 35, no. October 2020, 2021, doi: 10.1016/j.jobe.2020.102001.

[32] F. Sanchez, E. Bonjour, J.-P. Micaelli, and D. Monticolo, "An Approach Based on Bayesian Network for Improving Project Management Maturity: An Application to Reduce Cost Overrun Risks in Engineering Projects," Comput Ind, vol. 119, p. 103227, 2020, doi: https://doi.org/10.1016/j.compind.2020.103227.

[33] Y. Jiang, "Application of Data Mining Technology in Field Verification of Project Cost," Advances in Multimedia, vol. 2021, 2021, doi: 10.1155/2021/3585878.

[34] V. Vickranth, S. S. R. Bommareddy, and V. Premalatha, "Application of lean techniques, enterprise resource planning and artificial intelligence in construction project management," International Journal of Recent Technology and Engineering, vol. 7, no. 6C2, pp. 147–153, 2019, [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85067860685&partnerID=40&md5=b12e982df42fa91150 4460e636f9f6a2

[35] G. A.S. and J. B. Edayadiyil, "Automated progress monitoring of construction projects using Machine learning and image processing approach," Mater Today Proc, vol. 65, pp. 554–563, 2022, doi: 10.1016/j.matpr.2022.03.137.

[36] A. Liang, L. Tao, and H. Lei, "Combined machine-learning and EDM to monitor and predict a complex project with a GERT-type network: A multi-point perspective," Comput Ind Eng, vol. 180, no. April, p. 109256, 2023, doi: 10.1016/j.cie.2023.109256.

[37] K. S. N. Prasad and M. V. Vijaya Saradhi, "Comprehensive project management framework using machine learning," International Journal of Recent Technology and Engineering, vol. 8, no. 2 Special Issue 3, pp. 1373–1377, 2019, doi: 10.35940/ijrte.B1256.0782S319.

[38] H. H. Elmousalami, "Data on Field Canals Improvement Projects for Cost Prediction Using Artificial Intelligence," Data Brief, vol. 31, p. 105688, 2020, doi: https://doi.org/10.1016/j.dib.2020.105688.

[39] I. T. Afolabi, A. A. Adebiyi, E. G. Chukwurah, and C. P. Igbokwe, "Decision support system for final year project management," in Lecture Notes in Engineering and Computer Science, 2019, pp. 233–237. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85083396939&partnerID=40&md5=dd33acf7d926df5a30 ff59cfe97760ed

[40] I. Karatas and A. Budak, "Development and comparative of a new meta-ensemble machine learning model in predicting construction labor productivity," Engineering, Construction and Architectural Management, vol. ahead-of-p, no. ahead-of-print, Jan. 2022, doi: 10.1108/ECAM-08-2021-0692.

[41] J. Angara, S. Prasad, and G. Sridevi, "DevOPs project management tools for sprint planning, estimation and execution maturity," Cybernetics and Information Technologies, vol. 20, no. 2, pp. 79–92, 2020, doi: 10.2478/cait-2020-0018.

[42] M. Relich and I. Nielsen, "Estimating production and warranty cost at the early stage of a new product development project," IFAC-PapersOnLine, vol. 54, no. 1, pp. 1092–1097, 2021, doi: 10.1016/j.ifacol.2021.08.128.

[43] C. Capone and T. Narbaev, "Estimation of Risk Contingency Budget in Projects using Machine Learning," IFAC-PapersOnLine, vol. 55, no. 10, pp. 3238–3243, 2022, doi: 10.1016/j.ifacol.2022.10.140.

[44] J. I. Santos, M. Pereda, V. Ahedo, and J. M. Galán, "Explainable machine learning for project management control," Comput Ind Eng, vol. 180, no. April, 2023, doi: 10.1016/j.cie.2023.109261.

[45] M. M. A. Ranesh, S. J. Samuel, R. Natchadalingam, and P. Jeyanthi, "Information Technology (IT) Governance Framework with Artificial Neural Network and Balance Scorecard to Improve the Success Rate of Software Projects," in 2022 6th International Conference on Electronics, Communication and Aerospace Technology, 2022, pp. 1216–1221. doi: 10.1109/ICECA55336.2022.10009299.

[46] O. Allal-Chérif, V. Simón-Moya, and A. C. C. Ballester, "Intelligent purchasing: How artificial intelligence can redefine the purchasing function," J Bus Res, vol. 124, no. October 2020, pp. 69–76, 2021, doi: 10.1016/j.jbusres.2020.11.050.

[47] S. Uddin, S. Ong, and H. Lu, "Machine learning in project analytics: a data-driven framework and case study," Sci Rep, vol. 12, no. 1, 2022, doi: 10.1038/s41598-022-19728-x.

[48] L. Yu, "Project engineering management evaluation based on GABP neural network and artificial intelligence," Soft comput, vol. 27, no. 10, pp. 6877–6889, 2023, doi: 10.1007/s00500-023-08133-9.

[49] F. Niederman, "Project management: openings for disruption from AI and advanced analytics," Information Technology & People, vol. 34, no. 6, pp. 1570–1599, Jan. 2021, doi: 10.1108/ITP-09-2020-0639.

[50] R. Hassani and Y. El Bouzekri El Idrissi, "Proposal of a framework and integration of artificial intelligence to succeed IT project planning," International Journal of Advanced Trends in Computer Science and Engineering, vol. 8, no. 6, pp. 3396–3404, 2019, doi: 10.30534/ijatcse/2019/114862019.

[51] M. J. Bianchi, E. C. Conforto, E. Rebentisch, D. C. Amaral, S. O. Rezende, and R. de Pádua, "Recommendation of Project Management Practices: A Contribution to Hybrid Models," IEEE Trans Eng Manag, vol. 69, no. 6, pp. 3558–3571, 2022, doi: 10.1109/TEM.2021.3101179.

[52] G. Ma, Z. Wu, J. Jia, and S. Shang, "Safety risk factors comprehensive analysis for construction project: Combined cascading effect and machine learning approach," Saf Sci, vol. 143, p. 105410, 2021, doi: https://doi.org/10.1016/j.ssci.2021.105410.

[53] M. Y. Cheng, M. T. Cao, and J. G. Herianto, "Symbiotic organisms search-optimized deep learning technique for mapping construction cash flow considering complexity of project," Chaos Solitons Fractals, vol. 138, 2020, doi: 10.1016/j.chaos.2020.109869.

[54] W. Li, P. Duan, and J. Su, "The effectiveness of project management construction with data mining and blockchain consensus," J Ambient Intell Humaniz Comput, 2021, doi: 10.1007/s12652-020-02668-7.

[55] S. Sabahi and M. M. Parast, "The impact of entrepreneurship orientation on project performance: A machine learning approach," Int J Prod Econ, vol. 226, no. April 2019, p. 107621, 2020, doi: 10.1016/j.ijpe.2020.107621.

[56] J. van Niekerk, J. Wium, and N. de Koker, "The value of data from construction project site meeting minutes in predicting project duration," Built Environment Project and Asset Management, vol. 12, no. 5, pp. 738–753, 2022, doi: 10.1108/BEPAM-03-2021-0047.

[57] I. Lishner and A. Shtub, "Using an Artificial Neural Network for Improving the Prediction of Project Duration," Mathematics, vol. 10, no. 22, 2022, doi: 10.3390/math10224189.

[58] X. Huang and M. Liang, "Visual System Development for Construction Project Management by Using Machine Learning Algorithm," Optik (Stuttg), p. 170460, 2022, doi: 10.1016/j.ijleo.2022.170460.

[59] S. Makaula, M. Munsamy, and A. Telukdarie, "Impact of artificial intelligence in South African construction project management industry," in Proceedings of the International Conference on Industrial Engineering and Operations Management, 2021, pp. 148–162. [Online]. Available: https://www.scopus.com/inward/record.uri?eid=2-s2.0-85121110767&partnerID=40&md5=317512e166c09d24a3f00e4eefa0645a