

**Exploring the application of artificial intelligence in project management: A systematic literature review****Mohammad Senisel Bachari<sup>a\*</sup>, Ali Solouki<sup>b</sup> and Hossein Ghanbari<sup>b</sup>**<sup>a</sup>*Petroleum University of Technology, Iran*<sup>b</sup>*School of Engineering, Department of Industrial Engineering, Iran University of Science and Technology, Iran***ABSTRACT***Article history:*

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Projects play a crucial role in the success and development of industries, organizations and businesses, hence making project management an important practice which needs to be up to date with new trends and modern technology such as artificial intelligence (AI). With the advent of artificial intelligence there have been a number of studies aimed to design and introduce new ways and means of utilizing this phenomenon into project management. This research aims to find AI methods, tools, approaches, models and frameworks for each of the project management knowledge domains introduced by PMBoK. The methodology followed the PRISMA guidelines for systematic literature reviews to collect, screen and analyze the literature to find relevant studies. The findings presented bibliographic data on the topic and current trends, frequently used AI methods and project management techniques and tools which benefit from these AI methods under each project management domain.

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**1. Introduction**

With the rapid advancements of artificial intelligence (AI) and AI technologies, project management has experienced change in many forms. The implementation of AI in project management practices is altering project aspects in the stages of planning, execution, and monitoring/control, while also introducing new challenges and complexities (Alshaikhi & Khayyat, 2021; Costa et al., 2022). These changes may also bring challenges; researchers predict that AI will surpass 50% of human tasks by 2050 (Grace et al., 2018). As AI gains more popularity, industries, organizations, and businesses are increasingly awakening to and adapting to these inevitable changes. However, in most industries, there is still reluctance and skepticism regarding its full adoption. This has been mentioned in (Dwivedi et al., 2021) where authors even point out the uncertainty of the path. However, there are clear signs that AI has great potential, which cannot be ignored, and that is recognized by companies that believe humans and AI will work together in the future (Candelon et al., 2021). Due to the visible 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 (Bodea et al., 2020; Yang, 2022). Despite the decline in academic contributions to new AI in recent years relative to industrial advancements (Ali & Ali, 2024), there remains a significant scholarly interest in AI and its implications for management and associated methodologies (Borges et al., 2021; Raisch & Krakowski, 2020) which would include the different fields of project management.

**1.1 Artificial intelligence**

Artificial Intelligence (AI) is defined as a computational agent that acts intelligently to maximize chances of success by perceiving the environment (Russel & Norvig, 2020). This definition stems from the understanding that intelligence, in the human context, is the “ability to learn, to deal with new situations, to understand and handle abstract concepts, and to use knowledge to manipulate one’s environment” (Legg & Hutter, 2007; Sternberg, 2018).

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The first instance of AI is attributed to Alan Turing, who began researching it as early as 1947 by raising the question, “Can machines think?” (Turing, 1950), Turing's studies are credited with the commencement of the modern notion of AI, where intelligent machines emulate human reasoning processes to solve problems and make decisions. Throughout the subsequent years, alongside the remarkable advancements in robotics, computer science, and technology as a whole, the field of AI has also progressed to a considerable degree (Buchanan, 2005; Kaplan & Haenlein, 2019). Within the century, AI has increasingly progressed, and offers an evolutionary effect on society (Gruetzemacher & Whittlestone, 2022; Sharma, 2023) and organizations (Arslan et al., 2022; Hendriksen, 2023; Jarrahi et al., 2023). Due to its numeric and flexible nature, AI has been reported to have potential in fields such as international security (Agarwala & Chaudhary, 2021; Thakkar & Lohiya, 2022), healthcare (Frazer et al., 2021; Jiang et al., 2017), finance and banking (Columbus, 2019; Warin & Stojkov, 2021) and transportation (Joshi, 2019). It has also been mentioned that AI has the potential to acquire social skills by comprehending and forecasting human thoughts, emotions, and behaviors (Williams et al., 2022).

There are many techniques and methods and sub-techniques that contribute to the field of AI. Some of the of the main techniques which are associated with AI include (Elmas & Babayev, 2021):

- Machine Learning (ML): MLs are able to learn and adapt using algorithms and statistical models without following explicit instructions (X.-D. Zhang, 2020)
- Deep Learning (DL): a division of machine learning methods based on artificial neural networks which are used when natural data in the raw form needs to be processed (LeCun et al., 2015)
- A support vector machine (SVM): a type of supervised learning algorithm used in machine learning to solve classification and regression tasks (Cristianini & Ricci, 2008)
- Artificial Neural Networks (ANNs): are computer systems inspired by biological Neural Networks similar to that of the human brains, used in classification, prediction, filtering, optimization, pattern recognition, and function approximation (Yegnanarayana, 2005)
- Genetic Algorithms: are commonly used to generate high-quality solutions to optimization (Katoch et al., 2021)
- Fuzzy approaches: Fuzzy logic is a form of many-valued logic in which the value of variables may be any number between 0 and 1 (in contrast to a Boolean value), used to solve problems which are related to uncertainty and vagueness (Zadeh, 1965)

Another classification of AI methods would be; particle swarm optimization, evolutionary intelligence algorithms, fuzzy logic, and artificial neural networks (Rahmanifard & Plaksina, 2019). Apart from the mentioned, there are more AI concepts that are newer emerging, Fig. 1. displays the connection and relationship of the mentioned titles (Yli-Olli, 2019):

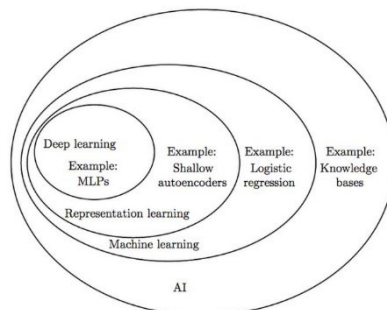


Fig. 1. A Venn Diagram that shows how each subset of AI is related to one another Yli-Olli, 2019.

Apart from the mentioned AI techniques there are also multiple stages which AIs are classified in based on their inherit intelligence (weak, strong and super-intelligent AI). Traditional AI are able to perform tasks which they are trained for, however; newer AI are not trained but independently learn from previous historical data (Haenlein & Kaplan, 2019; Madakam et al., 2022). The classification that will be used to classify methods into different groups in this study will follow the taxonomy presented by Contreras & Vehi 2018, which is illustrated in Fig. 2 (Contreras & Vehi, 2018).

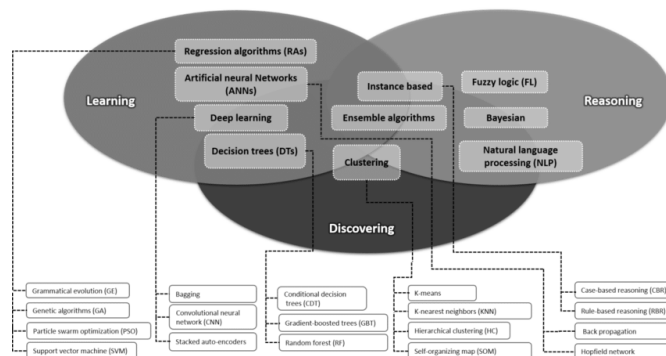
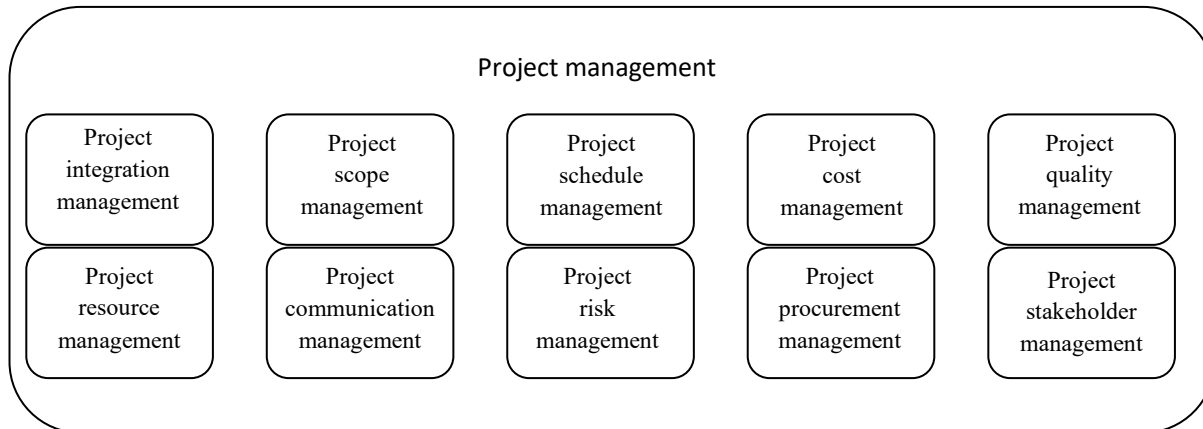


Fig. 2. Classification AI methods (based on the study of Contreras & Vehi, 2018 with permission from the respective authors)

## 1.2 Project management

Projects are temporary endeavors aimed at bringing about positive transformations, such as the delivery of products or services. Project management is the process by which such changes are successfully accomplished (PMI, 2017). Projects account for over 20% of global economic activity and surpass 30% of economic activity in certain emerging economies (Turner et al., 2013), thus they are perfect tools to enlist change within industries, organizations or businesses, or implement certain standards. Project management, emerging from a decentralized management approach, incorporates stochastic flexibility into the planning and programming of new ventures. As projects serve as instruments for implementing corporate strategies, it is imperative to integrate and evaluate sustainable development at the operational level (Obradović et al., 2012). Following the Project management body of knowledge standard (PMBoK 6<sup>th</sup> edition) (PMI, 2017); project management is considered the simultaneous coverage of multiple managerial areas of knowledge which are presented in Fig. 3.



**Fig. 3.** Knowledge areas of project management PMI, 2017

Change management is a crucial part of managing projects entitling managers to adapting to new emerging phenomena (such as AI) and keeping up the performance (Xanthakis, 2024). The integration of Artificial Intelligence (AI) in project management has gained significant attention in recent years (Fridgeirsson et al., 2021; Holzmann et al., 2022). There are multiple areas which AI has been reported to impact more frequently namely; data collection, risk estimation and management, resource management, cost management, monitoring performance and time management and scheduling (Elmas & Babayev, 2021; Mikhaylov, 2023), And this use of AI is not just reserved for traditional project management practices but there also studies emphasizing the use of AI into agile project management as well (Dam et al., 2018; Lei et al., 2024). Given the rise of new agile principles and the necessity for projects to adjust to dynamic changes, PMI (Institute, 2021) is contemplating a practice-focused approach to project management that prioritizes delivering desired outcomes and value, rather than solely focusing on processes and deliverables.

Traditionally, project management follows a set of methods and techniques to optimize the processes and flow of each phase of the project, these techniques span from simple planning approaches to mathematical optimization methods, most notably; scheduling techniques, estimation methods, risk analyses, earned value management, etc. there have been several reviews which presented a long list of these techniques, for this study the techniques presented by (Cheng, 2014; Ferreira et al., 2013) will be considered. With the advent of artificial intelligence and its ever more creeping transition into project management it is important for managers to keep up with the current trends and new tools introduced, hence; the aim of this research is to systematically find, collect, screen and analyze previous studies on AI tools, approaches and methods used in project management and synthesize them into each of the mentioned knowledge areas of project management aiming to reach the following goals:

- Presenting bibliographic findings and current trends within the relevant literature
- Finding and sorting the relevant studies in their respective project management domain
- Presenting the AI-based techniques, methods and tools which have been introduced by the relevant studies

Continuing the paper; section 2 presents the historic background of the topic with some similar research, section 3 depicts the research method, section 4 presents the findings into sub-sections for each project domain, sections 5&6 address the discussion and conclusion of the research respectively.

## 2. Background

Over the years there have been a number studies on AI in project management specifically within the past two decades. These studies go as far back as using the basic artificial intelligence algorithms such as the use of expert systems (Probst et al., 1988;

Smith, 1987) and the use of knowledge-based systems (Currie & Drabble, 1992), (E Diekmann, 1992) to applications utilizing numerical data for tasks like (Cubric, 2020) such as cost management (M.-Y. Cheng & Roy, 2011), scheduling (Wauters & Vanhoucke, 2016) and effort estimation (Song & Minku, 2023). There are also other fields of project management which have been studied on such as the AI applications for risk management (Barta & Göröcsi, 2021), quality management (Parra et al., 2015), and project selection (Costantino et al., 2015; Haghghi Rad & Rowzan, 2018; F. Liu et al., 2019). Other studies reported the expectations of project management practitioners (Holzmann et al., 2022) on the impact of AI on the workplace.

There are many records and articles on AI in project management such as the examples mentioned above, these records will be systematically collected and analyzed and afterwards grouped within the respective project management knowledge area domain and presented in this article. There are also recent review papers which employ a systematic literature review (SLR) on AI in project management; presenting an overview of previous studies with regard to the use of AI techniques to enhance project management or provide other sorts of insight into relative matters. Some of these SLRs together with their respective focus are illustrated in Table 1.

**Table 1**  
Recent similar studies using the SLR methodology

Author/year	Main topic
(Miller, 2021)	AI project success factors related to moral decision-making with algorithms
(Taboada et al., 2023)	applications of different AI techniques in the project management
(Costa et al., 2022)	potential and limitations of AI in specific area of project management
(Hashfi & Raharjo, 2023)	provides insights into the challenges and impacts of integrating AI in project management
(Bahroun et al., 2023)	A Bibliometric Analysis on the use of AI in project scheduling
(Velezmoro-Abanto et al., 2024)	Project resource management strategies supported by artificial Intelligence
(X. Zhang et al., 2024)	AI's influence on organizational justice and project performance

### 3. Methods and tools

The research method employed in this study is a literature review, aimed at gathering and analyzing sufficient articles and records to meet the research objectives. The research process followed steps similar to those of the systematic literature review (SLR) framework (Paul et al., 2021; Petticrew & Roberts, 2006); more specifically following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) procedure (Liberati et al., 2009); in which a set of pre-determined keywords with specific options (regarding time period and relevant fields) are entered into search engines to find relevant records, the records are then screened in multiple stages (each progressively stricter to narrow down the most relevant records), leading to the synthesis of data needed to answer the research question, however, the review conducted differs from the standard PRISMA in which there will be multiple searches for each project management body of knowledge which could be more similar to an iterative SLR or an umbrella review (Cant et al., 2022; Kosztyán et al., 2021). Nevertheless; the research will follow the mentioned steps while considering the PRISMA guidelines (Liberati et al., 2009), the databases used for the research are Scopus and Web of Science to find the most accurate and reputable articles and records, ResearchGate and Google Scholar to find all relevant records and to have a comprehensive view on the otherwise grey literature. To find the desired outcomes the prompts shown below will be entered in the mentioned search engines:

**Title** (" -subject- ") AND ("Artificial Intelligence" OR "data mining" OR "machine learning" OR "Artificial neural network" OR "Deep Learning" OR "Fuzzy" OR "Support Vector")  
**Abstract & Keywords** ("Project" AND ("method" OR "tool" OR "approach" OR "Model" OR "framework" ))

\*In which -subject- represents the project management body of knowledge which will be analyzed.

\*\*Note that not all search engines can receive such a prompt but for different engines a similar prompt was developed.

Thus, there will be a total of 10 different searches for each body of knowledge to collect the records and subsequent screening process for each field, afterwards the records are collected and screened, the relevant records are stored and synthesized in a spreadsheet (<sup>MS</sup>EXCEL or GoogleSheets) to reach the research goal.

### 4. Findings

Through the process of data and record collection a total of 972 records were identified (aggregation of all search engines and project management domains), after the first title screening the duplicate and irrelevant titles were eliminated reducing the number of records to 402. Most of these articles were related to the domains of cost, schedule and risk management, other more qualitative natured domains did not amass many relevant records. Afterwards the next stage of screening involved reading through the abstracts and conclusion which lowered the number of relevant records to 132, after a full text analysis this number reached 60 of which 43 were relevant and of reputable sources (the study analyses 60 records i.e. including the grey literature). A visualization of re-occurring words has been shown in Fig. 5. Apart from the re-occurring keywords, a similar visualization has been provided for Author re-occurrence on Fig. 9.

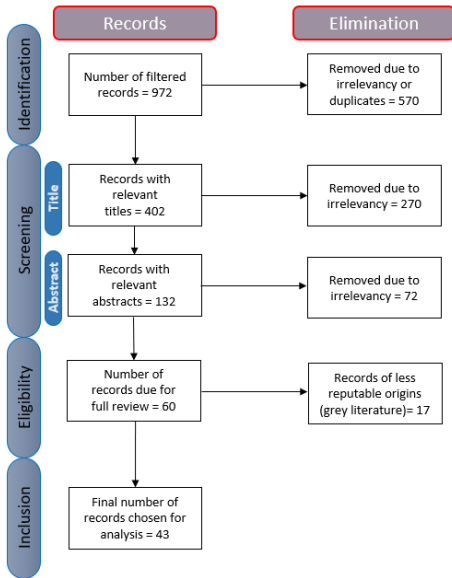


Fig. 4. Record selection process

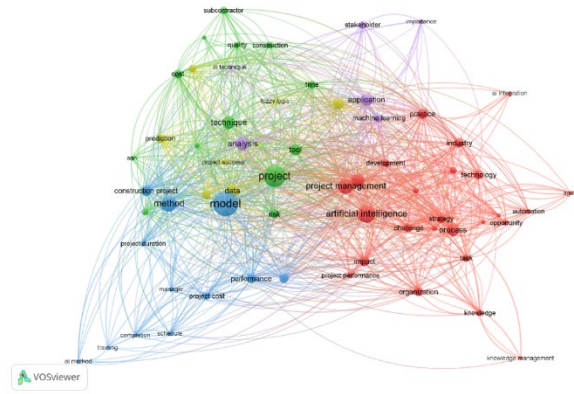


Fig. 5. Network Visualization of re-occurring words (made using VOSviewer)

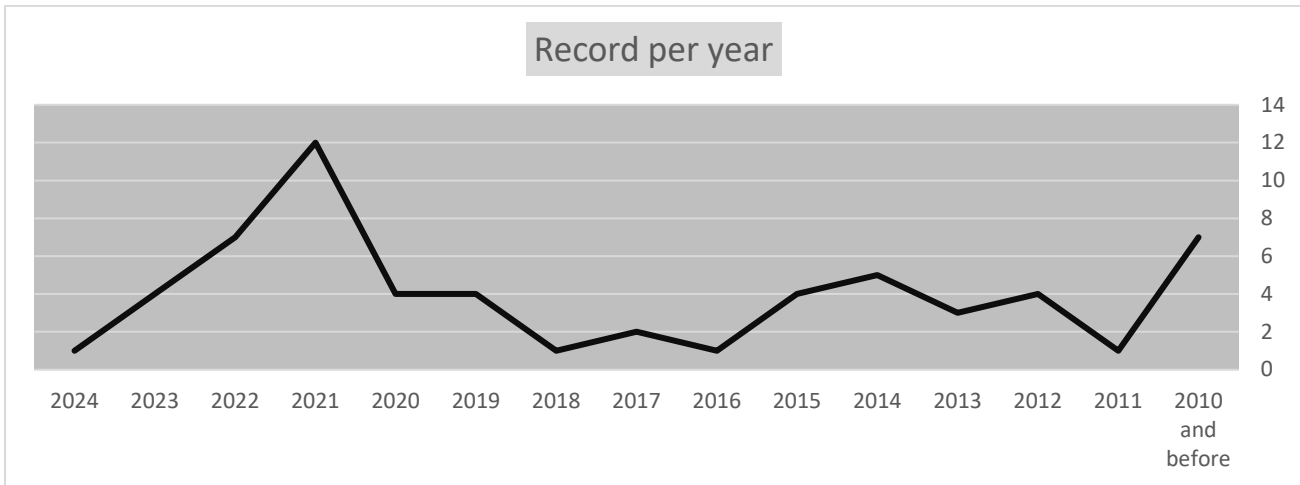


Fig. 6. Number of Relevant records published per year

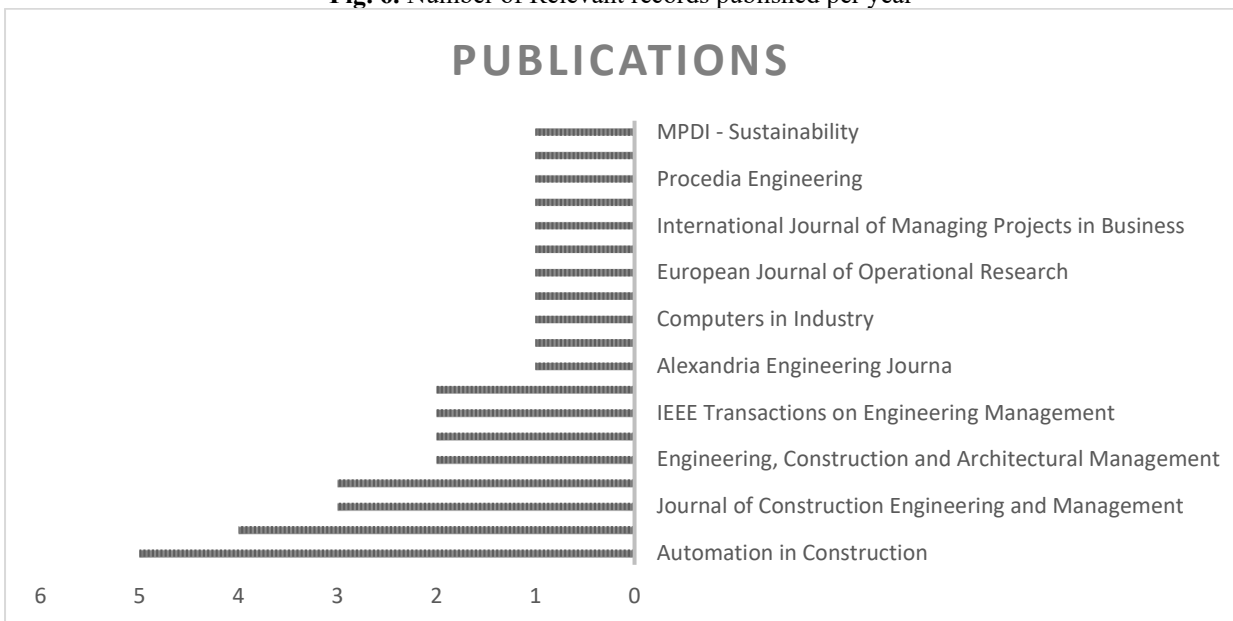
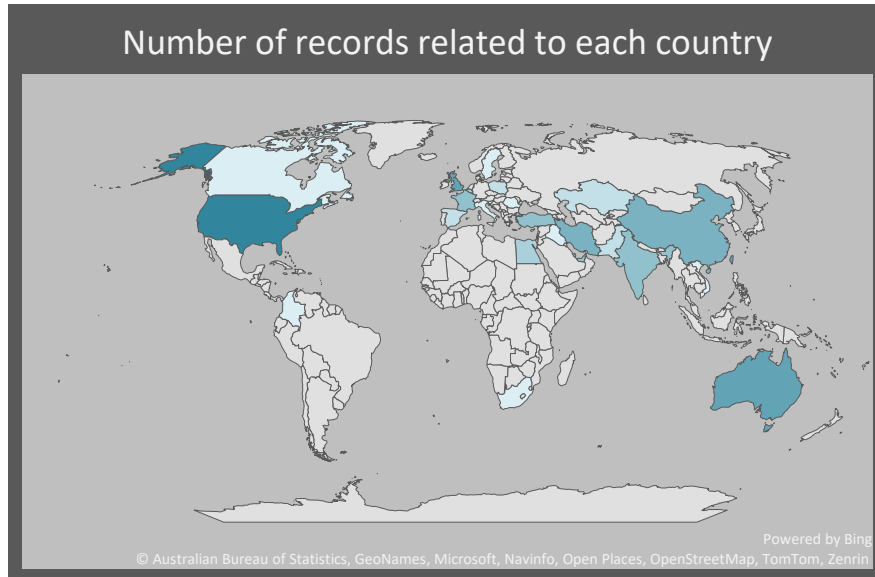


Fig. 7. Journals of used records in the study

The case of the studies usually revolved around construction projects or in other cases software development projects, besides these two there were very little records using a different case such as; oil and gas projects or organizational development projects. There was a focus on only including articles which were relevant and released within the current decade; the records show that annually on average there are 4 articles published, with the years 2021 and 2022 having the most records, the finer details are illustrated in Fig. 6. The records were published by different journals, journals such as *Automation and construction* followed by *International journal of project management* had published the most articles as seen in Fig. 7, depicting a number of journals and their respective number of publications. Another aspect would be the country of origin of the records; the United States, United Kingdom and China had the highest number of records as illustrated in Fig. 8.



**Fig. 8.** Countries of institutes which contributed to the studies



**Fig. 9.** Re-occurring authors

*4.1 Project integration management*

According to PMI "Project Integration Management includes the processes and activities to identify, define, combine, unify, and coordinate the various processes and project management activities within the Project Management Process Groups" (PMI, 2017), in other words it coordinating all elements of a project, including tasks, resources, stakeholders, and deliverables. Judging by its nature; the highest effect of AI on project integration management will revolve around the development of project planning, and performance of change control for the project, yet there are almost no instances of records focusing on the use of AI specifically for project integration management. Using the search engines there were no matches for the entered keywords amongst the reputable sources, however; in the grey literature there was one article by Ihekweaba et al. which introduced the idea of using intelligent agent (belonging to a field of AI) to support project integration management (Linda Ihekweaba et al., 2013).

## 4.2 Project scope management

The project scope being a fundamental element of every project and part of the project iron triangle, ensures the success of a project by including all the work required without additional goals (scope creep) (White & Fortune, 2002). It is the process that defines and outlines all of the work that is included within a project, including its: objectives, tasks, inputs, outputs, start and end date. Similar to integration management, with its qualitative nature there have not been many articles to suggest the use of AI within this field, however; there is a part in project scope management namely the process of creating a work breakdown structure (WBS) which as the name suggest is the process of breaking the project into a hierarchical decomposition of the work to be executed. On this matter there have been some studies on the use of AI to either facilitate the development of the WBS (Siami-Irdemoosa et al., 2015) or introducing a framework for AI to support the processes of the WBS (Iranmanesh & Madadi, 2009; Popa et al., 2021).

## 4.3 Project schedule management

Project Schedule Management includes processes such as; managing the schedule, defining activities and their sequences, duration estimation and schedule control which are required to manage the timely completion of the project (PMI, 2017). Due to its numeric nature, this field of project management has more potential to use AI especially for the prediction and estimation of durations, there have also been some studies focusing on project sequencing and other studies on problem detection and delay prediction within projects. The AI methods used in this field varied; there were uses of genetic algorithms, support vector machines, ANN and other machine learning related methods. The data regarding the records is displayed in Table 2.

**Table 2**  
Project schedule management related records

Author/year	Main topic	AI method/tool
(Wauters & Vanhoucke, 2017)	Introduced a project duration prediction method	k-Nearest Neighbor search (AI prediction model)
(Wauters & Vanhoucke, 2016)	Presenting 5 new methods for the prediction of projects final duration	Multiple AI methods
(Wauters & Vanhoucke, 2014)	A forecasting approach to predict project time and cost	Support Vector Regression
(Aziz et al., 2014)	Designed a model intended for planning and scheduling mega projects	Genetic Algorithm
(Wang et al., 2012)	Introducing a model to predict project cost and schedule success	support vector machines models
(Faghihi et al., 2014)	A method of data retrieval from BIM in order to form project sequencing	Generic Algorithm
(Pospieszny et al., 2018)	approach for building and deploying effort and duration estimation.	support vector machines, multilayer perceptron and general linear model
(Awada et al., 2021)	Data mining method for project scheduling focusing on critical path method (CPM)	Machine learning
(Yaseen et al., 2020)	Proposed a model for project delay prediction	Random forest & Genetic Algorithm
(S. Liu & Hao, 2021)	Proposed a model for problems detection in project scheduling	long short-term memory & gated recurrent unit (ANN)
(Cheng et al., 2019)	Introduced a model to estimate the schedule to project completion	neural network–long short-term memory
(Lishner & Shtub, 2022)	Presents a dynamic tool to estimating the duration of a project	Combination of machine learning and ANN

## 4.4 Project cost management

Project cost management being the financial pillar of project management aims to ensure that the project is completed within the agreed budget using processes such as planning, estimating, budgeting, financing, funding, managing, and controlling costs (PMI, 2017).

**Table 3**  
Project cost management related records

Author/year	Main topic	AI method/tool
(Arafa & Alqedra, 2010)	Developing a model for project cost estimation	ANN
(Wang et al., 2012)	Introducing a model to predict project cost and schedule success	support vector machines models
(Cheng et al., 2009)	Utilizing an AI method to improve cost estimation	Evolutionary Fuzzy Neural Inference Model
(Elmousalami, 2021)	A comparative study to test 20 AI models for conceptual cost modeling	Multiple AI methods
(Wauters & Vanhoucke, 2014)	A forecasting approach to predict project time and cost	Support Vector Regression
(Mir et al., 2021)	A method to predict the cost and price of construction material	ANN
(İnan et al., 2022)	Designed a model to forecast project costs (cost estimation)	seven-dimensional feature vector (machine learning)
(Jiang, 2021)	Introduced a cost information platform for the means of project cost verification	Machine learning algorithm
(PAPATHEOCHAROUS & ANDREOU, 2012)	Project cost estimation approach specifically for software development projects	Combination of Fuzzy logic and decision tress
(Cheng, Peng, et al., 2010)	Cost estimation method aimed for final project cost	Evolutionary Support Vector
(Cheng, Tsai, et al., 2010)	A method for prediction and strategic management of project cast flow	evolutionary fuzzy hybrid neural network

Similar to project schedule management, due to its numeric nature, cost management can utilize more of AIs potential. Again, similar to schedule management the main focus of most records was to provide a means to predict or estimate the cost of the project, aiming to improve the accuracy of project completion cost estimation. There were also topics on project cost verification and cashflow control. The AI methods used consisted of; support vector machines, ANN, machine learning algorithms and fuzzy-logic based methods. Table 3 presents the collected records.

#### 4.5 Project quality management

Project Quality Management encompasses the procedures involved in integrating the quality policy of the organization with respect to the planning, supervision, and regulation of project and product quality standards to fulfill the stakeholders' goals. Furthermore, Project Quality Management facilitates ongoing enhancements in processes carried out by the performing organization (PMI, 2017). There are three phases in project quality management: quality planning, quality assurance, and control all of which hypothetically can incorporate AI in quality management, in which Zhu et al. presents the use of smart technologies and AI within these phases (Zhu et al., 2022). Parra et al. presents a Project quality assessment method using machine learning techniques (Parra et al., 2015). apart from these studies there were no other records that met the criteria.

#### 4.6 Project resource management

Project resource management is the process of planning, organizing, scheduling and managing a project's resources such as; people, tools, equipment, materials etc., in an efficient way. Research in the use of AI in project resource management, although rare, is either focused on the management of material resources or human resources (Nobre, 2020; Ullah, 2023). There were very few researches in this field as well, there were studies mentioning the direction and use of AI in resource management (Nobre, 2020; Polishchuk et al., 2024), studies that meet the research criteria and actually introduce an AI method or tool in project resource management have been mentioned in Table 4.

**Table 4**

Project quality management related records

Author/year	Main topic	AI method/tool
(Karatas & Budak, 2024)	Designed and tested multiple models for project labor productivity prediction	Basic and ensemble machine learning
(Strnad & Guid, 2010)	Introduced an analytic project team formation model	Fuzzy logic & Genetic Algorithm
(Chen et al., 2012)	Designed a model for optimum scheduling and resource distribution	Intelligent scheduling systems (smart scheduling systems)

#### 4.7 Project risk management

Project Risk Management encompasses a series of activities that involve planning, identifying, analyzing, planning responses, implementing responses, and monitoring risks throughout a project. The primary goals of project risk management are to enhance the likelihood and/or impact of favorable risks while minimizing the likelihood and/or impact of unfavorable risks, ultimately maximizing the project's chances of success (PMI, 2017). Similar to project cost and schedule management, due to its quantitative nature this field can utilize AI methods more effectively, specifically in the risk analysis phase (usually scored by the probability of the risk multiplied by its impact) and the risk response phase (decision making). Table 5. presents the records which were found, these studies are focused on; developing models to reduce/ mitigate project risks, risk assessment and analysis models, risk prediction models and decision-making models to choose risk response strategies. There were multiple AI methods utilized most notably; Fuzzy logic, Bayesian network and Artificial neural networks (ANN).

**Table 5**

Project risk management related records

Author/year	Main topic	AI method/tool
(Jin & Zhang, 2011)	modelling risk allocation decision-making process	ANN
(Hu et al., 2013)	Risk analysis method for software projects	Bayesian Network
(Islam & Nepal, 2016)	Risk assessment model for cost overrun risk related to powerplant projects	fuzzy logic and Bayesian network
(Banerjee Chattapadhyay et al., 2021)	A prediction model for project risk probability	cross analytical-machine learning
(Sanchez et al., 2020)	A risk reduction model to reduce the risk of cost over-runs	Bayesian Network
(Fang et al., 2013)	Decision making model to choose project risk response strategies	Genetic Algorithm
(Afzal et al., 2021)	Review widely used Risk management AI methods (cost-risk assessment)	Mostly Fuzzy-logic based methods
(Khodakarami & Abdi, 2014)	A probabilistic risk analysis to quantify project uncertainty	Bayesian Network
(Yazdani-Chamzini, 2014)	Risk assessment model for underground construction projects	Fuzzy logic
(Odeyinka et al., 2013)	Risk assessment model for change in project cash flow	ANN
(Gondia et al., 2020)	A risk prediction model designed for the risk of project delay	decision tree and naïve Bayesian classification algorithms
(Capone & Narbaev, 2022)	A risk reduction method by exact estimation of project risk contingency budget	Machine learning

#### 4.8 Project communication management

Project communication management concerns the methods used for communication of information between the project team, project units and the project stakeholders over the course of the project. Project communications management consists of two parts. The first part is developing a strategy to ensure communication is effective for stakeholders, the second part is carrying out the activities necessary to implement the communication strategy (PMI, 2017). Using the search engines, there were no results for the aforementioned keyword combination, however; considering the nature of this field, the author believes that AI's function would be as a facilitator for constant data collection over the project using large language models (LLM) such as Chat-GPT or Google Gemini (formerly known as Google Bard) as mentioned by some studies (Mohammed et al., 2022; Vakilzadeh & Pourahmad Ghalejoogh, 2023), and another use would be to facilitate the communication between project team members which would take a similar role to social media, which some studies have highlighted the potentials of social media for project management (Hysa & Spalek, 2019; Kanagarajoo et al., 2019; Swart et al., 2022).

#### 4.9 Project procurement management

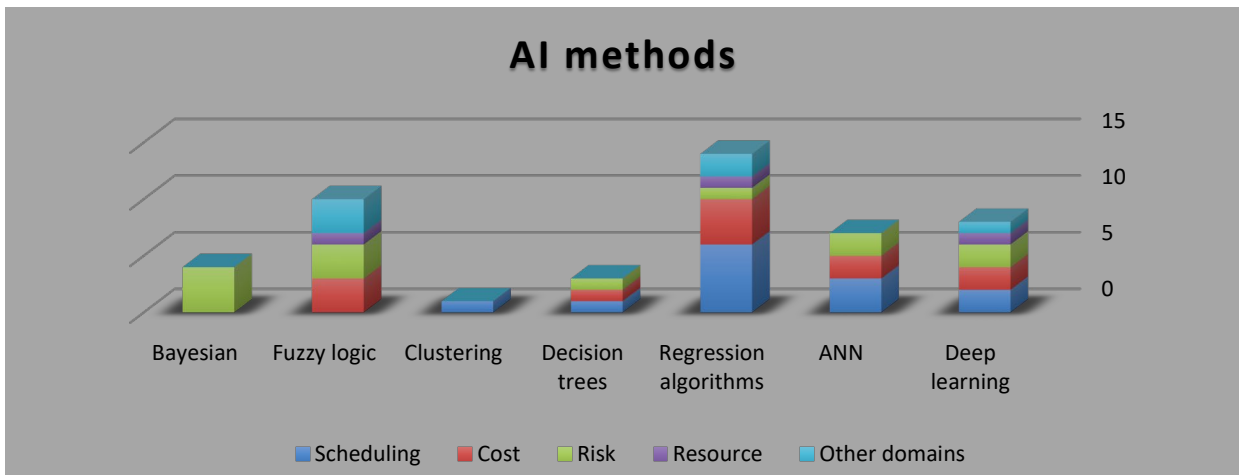
Project Procurement Management includes the processes necessary to purchase or acquire products, services, or results needed from outside the project team; referring to all the actions and strategies related to the cycle of identifying, evaluating and selecting suppliers of production inputs. In the current era with the advent of industry 4.0, new procurement methods and technologies particularly e-procurement and blockchain, have garnered substantial attention (Althabatah et al., 2023). In project management context there have been studies of the (sub)contractor selection (using decision aiding AI methods) (Polat et al., 2015; ULUBEYLI & KAZAZ, 2015), and also studies on the bidding and optimal purchasing function (Allal-Chérif et al., 2021). However; there were only two records that would specifically fit in the search criteria; first Rane & Narvel considered the industry 4.0 context and designed an agile model to manage procurement projects effectively with the aims to developing strategies for executing the project procurement management processes with more agility, utilizing Fuzzy-logic based methods (Rane & Narvel, 2021), second was Lewis et al.'s study aimed at developing an intelligent system to respond to project procurement management needs by employing a fuzzy hierarchical case-based reasoning platform (Lewis et al., 2011).

#### 4.10 Project stakeholder management

Project Stakeholder Management entails the procedures necessary for recognizing the individuals, teams, or entities that may have an influence on or be influenced by the project, for evaluating stakeholder expectations and their influence on the project, and for formulating suitable management tactics to actively involve stakeholders in project decision-making and implementation (PMI, 2017). Similar to the project communication domain there is a considerable amount of human interaction involved in this domain, thus; the AI suggestions which were made in that section also apply to the communication between the project team and stakeholders. Other areas of this domain would require decision-making methods to make optimum decisions regarding the stakeholders' interest or to evaluate the stakeholders on a given problem; both of which have been analyzed by using fuzzy cognitive mapping in two different studies conducted by Sperry & Jetter (Sperry & Jetter, 2019) and Hester (Hester, 2015) respectively. Other studies which evaluated the stakeholders using fuzzy-logic were Zarghami & Dumrak using a network theory and fuzzy logic approach (Zarghami & Dumrak, 2021), and Sadiq's study prioritizing stakeholders using a fuzzy-logic model (Sadiq, 2017).

### 5. Discussion

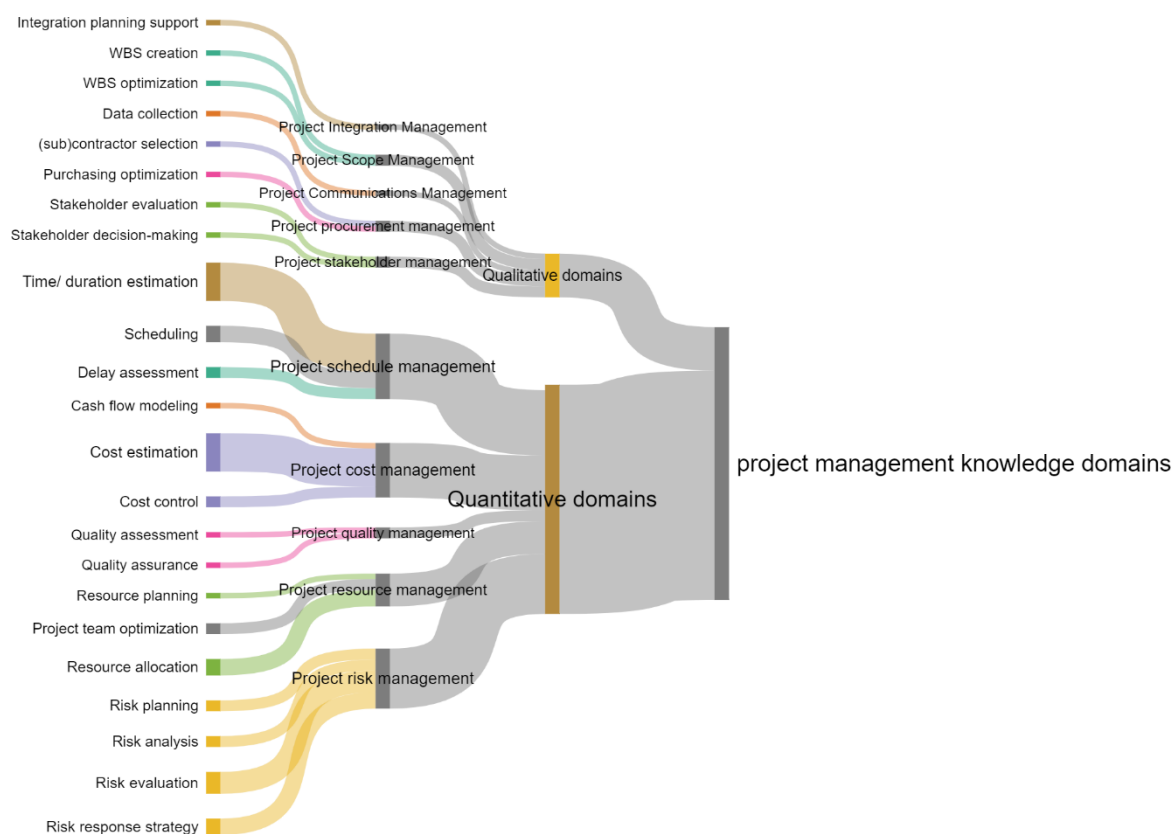
This study set out to investigate and analyze how AI technologies can contribute to enhancing project management processes across various domains. By employing a systematic literature review framework, a large number of records were initially collected. These records were rigorously screened and filtered, using multiple layers of evaluation to focus on the most relevant and high-quality studies. Ultimately, a total of 60 records were identified, and after excluding those with low citations and grey literature, 43 papers of high academic and practical relevance were selected for analysis. The findings from this analysis demonstrated that AI methods and models can significantly improve key project management functions, particularly in areas such as data collection, data analysis, estimation, and decision-making. By integrating AI, these processes not only become more efficient but also achieve higher accuracy. The automation offered by AI allows for faster processing of complex datasets, enabling project managers to make more informed decisions in a shorter timeframe. Furthermore, the analysis revealed that nearly all prominent AI techniques have been applied within the field of project management to varying degrees. Key methods such as support vector machines, artificial neural networks, genetic algorithms, Bayesian networks, intelligent and expert systems, fuzzy logic, and other machine learning techniques have all been leveraged primarily to enhance prediction accuracy and optimize the decision-making process. These AI tools can handle large datasets, perform complex analyses, and generate insights that would be difficult or time-consuming for human managers to derive manually. Fig. 10 provides a visual representation of the AI approaches used and categorizes them according to their respective project management domains, showcasing how these methods have been applied across different stages and functions within the project lifecycle. By mapping these AI tools to specific domains, this study highlights their versatility and applicability in addressing a wide range of project management challenges, further solidifying the importance of AI in the future of this field.



**Fig. 10.** AI methods/approaches and the domain

The analysis showed that the majority of AI methods were applied predominantly within the domains of schedule, cost, and risk management. These areas were particularly well-suited to AI integration due to their inherently numerical and quantitative nature, which aligns with the data-driven capabilities of AI technologies. In these domains, AI was able to automate and optimize processes like scheduling, cost estimation, and risk analysis by efficiently processing large volumes of data, identifying patterns, and making highly accurate predictions. For instance, AI algorithms were employed to predict project delays, forecast budget overruns, and assess risks in a way that traditional methods would find time-consuming or prone to human error. In other project management domains, such as project scope and resource management, AI was found to support specific aspects of the process. For example, in scope management, AI tools were developed to assist with the creation and refinement of the Work Breakdown Structure (WBS), enabling more precise project scoping and division of tasks. In the domain of resource management, AI methods were primarily focused on human resource-related challenges, such as optimizing team composition, aiding in team-building exercises, and forecasting the availability and allocation of human resources throughout the project lifecycle. These targeted applications suggest that AI can complement human decision-making by reducing manual effort and enhancing the accuracy of predictions, especially in personnel management. However, the study also revealed that certain project management domains, such as project integration, stakeholder management, procurement, quality management, and parts of scope management, showed less potential for AI integration. The main reason for this lower applicability is the qualitative and often subjective nature of these areas. For instance, managing stakeholder relationships, negotiating contracts, and ensuring quality standards involve a significant degree of human judgment, negotiation, and interpersonal skills, which are challenging for AI systems to replicate. AI's strength lies in its ability to process data and make decisions based on quantifiable factors, making it less effective in areas where human interaction and judgment are critical. Fig. 11 presents a visual summary of the various project management techniques and tools identified in the reviewed studies. This figure highlights the diversity of AI applications across different domains, reinforcing the idea that while AI holds immense potential in data-centric areas like cost, schedule, and risk management, its role in more qualitative fields remains limited but evolving. The findings underline the importance of understanding the strengths and limitations of AI in project management and suggest that AI may serve as a powerful tool to complement human decision-making rather than replace it in more subjective areas.

This research makes a significant contribution to the existing body of literature by highlighting key studies and research efforts that introduce innovative models, methods, tools, or approaches based on AI principles to support and improve various aspects of project management. By systematically reviewing and analyzing these contributions, this study offers valuable insights into how AI can be effectively applied across different domains of project management, as defined by the major project management bodies of knowledge. One of the primary contributions of this research is that it serves as a resource for project managers and field experts seeking to identify AI-driven tools that can enhance specific processes within their projects. The findings from this study provide a comprehensive overview of the AI techniques that are already in use, as well as their respective applications across different project management domains. For project managers, this information can serve as a guide for selecting appropriate AI tools to address challenges such as scheduling, cost estimation, risk management, and resource allocation. Moreover, by presenting a detailed analysis of the AI methods applied in various domains, this study offers a practical roadmap for organizations that are planning to integrate AI into their project management workflows. Additionally, this research can serve as a foundational literature review for future studies in this area. The study's comprehensive review of AI applications in project management lays the groundwork for further exploration into how AI can be harnessed to address emerging challenges in the field. By identifying gaps and areas where AI applications are still underutilized, such as in more qualitative domains like stakeholder or procurement management, this study opens up opportunities for future researchers to develop new AI-based approaches or to adapt existing methods to these less explored areas.



**Fig. 11.** Sankey diagram of project management techniques and tools which were highlighted in the literature (created using sankeyMATIC)

In conclusion, this study not only sheds light on the current state of AI applications in project management but also provides actionable insights for professionals in the field. By bridging the gap between AI technology and practical project management needs, this research paves the way for future innovations that will further transform how projects are managed, delivering enhanced efficiency, accuracy, and strategic decision-making capabilities. As organizations continue to evolve and adopt more advanced AI technologies, the relevance of this study will only grow, serving as a valuable resource for both academia and industry.

### 5.1 Future research

As mentioned previously domains such as project stakeholder, integration, scope, quality and procurement management, the reason for that lies within the nature and human-orientation of these fields, however; the author believes that there is room for research, especially within the fields of project quality and procurement management; specifically in quality monitoring and vendor evaluation and decision-making. While this study strictly focuses on the 10 bodies of knowledge presented by PMBoK, there are other project management domains that AI could assist with data collection or decision-making such as project portfolio management, project manager competency evaluation etc. another point would be that the studies analyzed were mostly concerned with traditional project management; meaning that a gap in the use of AI in agile project management practices can be seen. Finally, although the concept of sustainability and sustainable development is gaining attraction, there was no sign of sustainability implementation or consideration in the analyzed records which prompts the need for research in the sustainability of AI methods in project management.

### 5.2 Research limitations

While literature reviews are a valuable tool for synthesizing research and drawing evidence-based conclusions, they do come with some inherent limitations, this study also is no exception. Publication bias is one of these inherent problems; when studies with statistically significant results are more likely to be published than those with null or negative results. Another bias is language bias; since the focus was on studies published in English, research conducted in other languages are excluded. There is also bias in the search; most comprehensive search strategies may miss relevant studies due to limitations in search engines or databases, or the use of incorrect keywords. This can lead to incomplete reviews and potentially biased conclusions.

## 6. Conclusion

With the advent of AI in industries, organizations and businesses, this research aimed to analyze the use of AI in project management which is a crucial part of development for every industry, organization or business. Following the guidelines of PMBoK the goal was to uncover the methods, tools, approaches, models and frameworks which utilized AI to enhance the processes of the project management domains presented by the standard. To reach the goal, literature reviews were conducted for each of the project management knowledge domains, collecting relevant records. The combination of the initial searches presented 972 records, which were screened till there were only 60 left distributed amongst their respective project management domain, these were analyzed and the methods and models designed and introduced by them were presented in the finding section. The findings indicate that domains such as project schedule, cost and risk management which are quantitative in nature can utilize more of AI's potential using methods such as Artificial neural networks, genetic algorithms, fuzzy-logic, etc., other project management domains can also use some models and methods but to a limited degree (e.g. help with data collection or decision-making). The records were classified based on the knowledge domain, type of AI method and the case of the project, which were further analyzed and the findings were presented. In conclusion, this research presents multiple tested and approved methods and/or models which are aimed at aiding the processes of each of the project management body of knowledge, acting as a facilitator for future research for academics, and for on-field practitioners, it introduces novel approaches presented by reputable records.

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