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# The Integration of Artificial Intelligence in Project Management: A Review

**Nouf Almojel [1, 2] \*, Omer Alrwais [1]**

[1] *King Saud University, Department of Computer Science, P.O. Box 51178, Riyadh, 11543, Saudi Arabia*
[2] *Majmaah University, Department of computer sciences, P.O. Box 66, Majmaah, 11952, Saudi Arabia*
*\*Corresponding author E-mail: noufahmadm@gmail.com*

## Abstract

Project management is the coordination of a number of procedures to achieve the desired goals of a project. It involves planning, monitoring and execution. The over expansion of IT projects increased their complexity, uncertainty and its variability. Therefore, it has become difficult for traditional methods to manage these projects effectively. As these methods rely on experience and intuition and cannot deal with vast amounts of data, repetitive tasks or high variability. As a result, the outcomes maybe prone to errors. Consequently, the failure rate of IT projects increases. Since technology is an essential element for any organization, they have to find solutions in order to manage IT projects. AI has proven its effectiveness in many fields. In this research, through a literature review, we will study the most prominent aspects of integration between AI and project management in terms of challenges and impacts. As well as the contribution of AI in the knowledge areas of project management. We will focus on exploring how AI improves these specific knowledge areas: risk management, cost management, and scheduling management. From this research, we conclude that AI proved its ability to enhance many aspects of project management. Therefore, the research offers important insights for organizations that attempt to adopt AI into project management.

*Keywords*: *Project Management; Knowledge Area; AI; Scheduling Management; Cost Management; Risk Management.*

## 1. Introduction

Project management (PM) involves the processes of planning, executing, and controlling projects to achieve defined objectives. According to the Project Management Institute (PMI), by 2027, employers will need 87.7 million project management workers. On an annual basis, employers will need 2.2 million new project jobs each year through 2027 [1]. This reflects the importance and growing need for project management, especially as projects expand and become more complex. Efficient and accurate project management reflects the effectiveness and capacity of an organization[2]. Traditional project management methods rely heavily on intuition and experience, which can be subjective and error-prone [3] and are difficult to use to accommodate big data, repetitive processes, unexpected changes, uncertainty and emerging risks in real time, leading to a number of problems that affect the project workflow [2]. Project managers need to find other ways to make effective decisions that deal with the uncertainty and complexities of current projects using advanced analytical techniques. One such approach is artificial intelligence (AI), which is shaping the technological landscape. AI will increase the work of intelligent agents with minimal human intervention, in order to automate task management processes. Thus, improving the quality of project management (PM) [4] [5]. Artificial intelligence includes many different methods and algorithms that give accurate results, thus enabling more accurate management decisions in different knowledge areas of project management. According to the results of the Project Management Institute (PMI), annual global survey on project management, artificial intelligence (AI) is already having an impact on the industry; 21% of respondents are using AI to some extent, while 82% of senior leaders expect it to impact project management over the next five years [6]. This research aims to conduct a literature review to examine the difficulties encountered and the impacts observed while integrating AI into project management, and relate them to the knowledge areas described in the PMBOK [7]. We will focus on exploring how AI can be leveraged to enhance risk management, cost management, and schedule management. The outline of this paper is as follows. Section 2 gives a brief summary of the concept of project management, and what is the knowledge areas that PMBOK described. Section 3 presents an overview of artificial intelligence (AI), its definitions and algorithms. Section 4 introduce the difficulties and the impacts observed while integrating AI into project management. In section 5, we will discuss the main impacts that we observed from the literature review. Finally, drawing an overall conclusion about the paper, and future directions in section 6.

## 2. Project Management

Project Management is "the application of knowledge, skills, tools, and techniques to project activities to meet project requirements" [7]. A project is created to achieve specific goals that serve the strategic goals of the organization. A project needs resources to achieve its
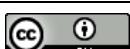
goals. These resources are limited. So, a project must be implemented within its limitations, such as people, money and time [8]. Multiple dimensions must be assessed to properly evaluate the project's success. The common way to evaluate the success of the project is to use the triangle of goals: scope, cost and time. But there are other aspects such as quality and stakeholder satisfaction. Therefore, these aspects affect to some extent how the project activities are managed and coordinated [9]. These aspects represent areas of knowledge that enable the project manager to plan, execute, monitor and schedule. The project management body of knowledge (PMBOK), released by PMI, contains the ten project management knowledge domains that serve as the foundation for the research model, which are: integration, scope, schedule, cost, quality, resource, communications, risk, procurement, and stakeholder management [7].

Project integration management is important for coordinating all project activities and ensuring that they are aligned with project objectives. Project scope management involves defining the work that will achieve the project objectives, and identifying the activities that will achieve these objectives, ensuring these activities are within the defined scope of work. Project quality management ensures that the project meets the needs and objectives for which it was implemented. Project resources management ensures that human and material resources are used most effectively. Project stakeholder management involves analyzing stakeholder expectations, identifying all the people who are affected by the project and have an interest in its success [7]. Project schedule management involves estimating the timing of project activities while ensuring that the project is completed on time. Project cost management involves the cost of the resources needed to complete all project activities, while ensuring that the project is completed within the approved budget. While project risk management increases the chances of project success by estimating potential negative risks and developing plans to eliminate these risks or reduce their impact. If risks remain unmanaged, this may result in delays, cost overruns, or loss of reputation[10]. Project activities are implemented based on traditional methods that rely on intuition and experience which have a high error rate [3]. These methods, with the expansion and complexity of projects, are no longer sufficient to accommodate huge and unstructured data. They also cannot manage unexpected changes that occur in real time [2]. Project managers must find other ways to manage complex project activities that are highly variable and uncertain. One of these methods is artificial intelligence (AI), which has great importance at the forefront of the technological scene. AI automates and improves project management quality by reducing human intervention in machine and data-driven tasks [4] [5]. In 2020 [11], researchers studied the opinions of a group of experts in project management on the impact of AI on the knowledge areas of project management over the next ten years. It showed that artificial intelligence will have the highest impact on project cost management by 58%, a high impact on project schedule management by 51% and on risk management by 47%.

Given the potential of AI to improve project management, we aim to answer the following research questions:
Can AI be applied to project management?
What aspects (domains) of project management can benefit the most out of AI?
What are the difficulties of integrating AI into PM?
What is the impact of AI on PM?

# 3. Artificial Intelligence (AI)

## 3.1. What is AI?

There are different definitions of AI. IBM defines it as a "technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy"[12]. In [13], AI is "a broad field of computer science dedicated to creating systems capable of performing tasks that typically require human intelligence". Others have defined it as "the ability of a machine to mimic intelligent human behavior, thus seeking to use human-inspired algorithms for approximating conventionally defiant problems" [4]. AI is the system that simulate human intelligence by machines, planned to replicate human cognitive functions and behaviors. It involves capabilities such as problem-solving, learning, and decision-making [14]. From a business perspective, it is "the replication of human analytical and/or decision-making capabilities" [15].

## 3.2. Artificial intelligence algorithms

There are two main areas of artificial intelligence: machine learning and deep learning. Machine learning (ML) is a computational technique for discerning patterns and features in training data to inform future predictions or classifications. Machine learning is a process that learns from experience over time [16]. It analyzes data to reveal patterns and is thus effective in areas such as resource allocation and scheduling [3]. Deep learning models are utilized to extract intricate and latent connections from unstructured datasets, including project risk reports and narrative documents [4] Deep learning can extract useful information from a complex and large dataset and enable project managers to make decisions based on facts rather than intuition or experience.

ML algorithms can be classified into unsupervised learning, supervised learning, and reinforcement learning. Supervised learning involves training the model on a labeled dataset, where the results are known. The model learns to predict outcomes from the input data by minimizing the error between its predictions and the actual results. Supervised learning problems can be divided into either classification or regression problems [13]. For unsupervised learning, the model is trained without supervision on an unlabeled dataset, and the model attempts to identify patterns and structures within the data. Unsupervised learning problems can be divided into aggregation and association problems [4]. Reinforcement learning relies on a dynamic learning approach where the reinforcement agent tries to maximize the outcomes (rewards) by making decisions based on feedback from the environment [16].

There are several machine learning and deep learning algorithms, each with distinct characteristics and mechanisms. Table 1 reviews a few of these algorithms. The selection of AI algorithms depends directly on the nature of the issue in different knowledge areas of project management. Some algorithms are used to predict continuous values, such as estimating cost or project duration. XGBoost has demonstrated remarkable success in project cost estimation [17]. In contrast, the K-means algorithm partitions the risk register into homogeneous clusters, enabling the binary distribution model to perform more accurately and overcome the inherent limitations of the EMV method, resulting in a more reliable estimate of the contingency budget [18]. While algorithms, such as artificial neural networks (ANNs), can be adapted to perform various tasks, including predicting project cost or duration, they can also be used to analyze potential risks in the early stages of a project [19 - 21]. Several studies have employed AI algorithms combined with various methods such as genetic algorithms and fuzzy knowledge maps. Genetic algorithms (GA) offer adaptive methods that are capable of finding solutions to solve optimization and search problems that depend on the genetic process of living things. The strength of GAs is that they present a robust technique and can successfully handle a wide variety of problems in different domains. However, it does not guarantee finding the optimal solution for a specific problem, although empirical evidence suggests that they can offer acceptable solutions in a timely manner [20]. Fuzzy Cognitive

Maps (FCM) is a modeling and reasoning technique that models the dynamic interactions in complex systems (for example how different concepts or factors influence each other in these systems). It uses the theory of fuzzy sets to represent causal relationships between concepts. It excels in handling complex problems that involve inaccurate and ambiguous information. It uses "what-if" analysis to simulate the effects of changes. However, building fuzzy rules requires detailed and comprehensive knowledge of the problem domain.

**Table 1:** Algorithm Functions, and Characteristics

| Algorithm/ Method | Classification of Learning | Primary Function | Characteristics |
| --- | --- | --- | --- |
| Artificial Neural Network (ANN) [22] | Deep Learning | The primary function of an Artificial Neural Network (ANN) is to learn from data through interconnected layers by iteratively adjusting the weights to minimize error using a process called backpropagation. | Ability to work with incomplete knowledge. Fault tolerance. |
| XGBoost [17] | ML Supervised Learning | XGBoost accurately predicts a target variable by combining the predictions from an ensemble of simpler and weaker models. It is utilized for both classification and regression tasks. | High scalability, effective in handling overfitting issues. Offers superior performance in forecasting, a fast ability to process noisy data, a low computational cost, and a faster learning process. |
| Logistic Regression (LR) [16] | ML Supervised Learning | LR Mainly used for binary classification tasks. Used to predict one of two possible values (e.g., true/false or 0/1) of an outcome called the dependent variable, based on the independent variables' values in the data. | Simple and effective algorithm. Performance is not very good on nonlinear data or datasets with highly correlated attributes. |
| Support Vector Machine (SVM) | ML Supervised Learning | SVM finds the hyperplane in a high-dimensional space to separate data classes with the maximum margin or fit data within a margin of tolerance [23]. | SVM can handle both linear and nonlinear classification tasks. Widely used in machine learning. It takes a long time to process large data sets [22]. |
| K-means | ML Unsupervised Learning | K-means is a simple approach that groups data into k clusters by assigning data points to the nearest centroid and repeatedly adjusting centroids to reduce variance within clusters [24]. | Used largely due to its simplicity. Used for preprocessing in other algorithms, especially for identifying an initial configuration. Not able to guarantee optimal convergence. Very time-consuming [22]. |
| Decision Tree | ML Supervised Learning | A decision tree uses a tree-based decision model, with the root at the top, then split into conditions through the use of different branches (edges). When a branch is no longer assigned, the decision has been reached [16]. | Decision trees are often used in classification tasks. It is excellent for interpreting results easily and clearly. Provides better prediction results than traditional methods such as EVM, especially when the training and test sets are similar. Also, it is effective with nonlinear data, which is difficult to handle. |
| Random Forest [16] | ML Supervised Learning | Combines the results of several decision trees to increase their accuracy. Used for regression and classification tasks. | More superior than decision trees. Better at handling large datasets and missing data. Less prone to overfitting. |
| Extreme Learning Machines (ELM) [25] | ML Supervised Learning | ELM is a single-hidden-layer feedforward neural network. Its hidden layer parameters are initialized randomly, and the output weights are computed analytically. | It is faster than traditional neural networks. The random initialization process leads to better generalization but may cause variability in performance. It is interpretable due to the analytical computation. However, it needs to be well controlled, or it may cause overfitting. |

# 4. Integrating AI in Project Management

Artificial Intelligence (AI) is among the advanced technologies capable of profoundly impacting the project management sector. According to Gartner, AI is expected to handle 80% of routine project management work by 2030, reducing the current workload [26]. Also, in [27] researchers emphasize that AI must be used to automate processes and enhance administrative functions. AI is a replication of analytical processes from a business perspective [15]. By helping project managers gain a comprehensive understanding of all project aspects, AI can serve as a valuable tool for reducing uncertainty. This is achieved through the ability of the AI to overcome the restrictions of the traditional methodologies that cannot deal with the overcomplexities for projects and the large amounts of data [13]. Artificial Intelligence (AI) tools in project management come in the form of algorithms and machine learning programs that enable everyday project management and administration without the need for human interaction. These algorithms and techniques offer a number of uses including analyzing large datasets to extract information and patterns, which may take a long time to extract by humans or may be overlooked. Also, real-time data analysis for specific aspects of the project is possible with action recommendation. Moreover, predicting future outcomes based on current data and trends is possible which enables anticipating risks and help in making immediate interventions to ensure the project's workflow [28]. Virtual assistants, data analytics and optimization are some of AI's abilities in PM. Therefore, they allow managers to prepare the budget, create preliminary schedules and automatically allocate material resources efficiently. The integration of AI represents a major shift for project management [29] [26].

## 4.1. Constraints of using AI in project management

Multiple factors must be taken into account for the application of artificial intelligence technology in the field of project management. Each project is unique and differs from other projects. Therefore, when creating an application for artificial intelligence, the characteristics of the project must be taken into account, such as the scope, and the goal of the project, and its participants. Dealing with artificial intelligence applications must be easy to use and not complicated. Understanding the mechanism of the artificial intelligence system by the project manager is essential in order to be able to evaluate the results. Adaptation and compatibility with the scope and degree of standardization of project activities is also critical. Another constraint is the ability to integrate AI with the existing PM software (Microsoft Project, Trello, Jira or others). More importantly, AI systems must be compatible with the software development methodology (such as Waterfall or Scrum) [8].

## 4.2. Challenges of applying AI in project management

The application of artificial intelligence in project management offers many advantages but still faces many challenges. After reviewing the related literature, the most important challenges and problems that hinder the effective use of artificial intelligence technologies in project management were the following:

1) Data: One of the major challenges during the development of an intelligent system is obtaining the required data, data quality, integrity, and completeness. To ensure data quality, data governance practices must be applied.

2) Bias in training data which leads to wrong decisions. Therefore, AI suggestions must be evaluated during its development to ensure objectivity and accuracy [3].

3) Transparency and accountability: Decisions provided by or based on AI systems must be accurate; otherwise, they may lead to negative results. To address this, the transparency necessary for users to trust these systems must be provided, which requires a full understanding of the mechanism by which the intelligent system processes data and how to build a decision based on that data. Thus, the ability to evaluate the validity and accuracy of the extracted results is reflected in the decision-making process. However, what hinders transparency is that some advanced AI models, such as ANNs, often appear as "black boxes," making it difficult to explain how they arrived at their final results [19]. This necessitates accountability in the event that incorrect decisions are made based on these inexplicable results. Accountability can be achieved by providing responsibility and setting clear lines of accountability that are consistent with ethical principles and project objectives. This involves identifying the responsibility for the system's output, whether it lies with the project manager, the AI developer, or the decision-maker [3].

4) Choosing the appropriate technology or algorithm based on the field of project management must be addressed. Each type of algorithm has specific uses. The type of data appropriate for the system must also be determined, and the sources from which the data is collected must be taken into account [30].

5) Artificial intelligence can provide valuable insights, but some decisions do not depend on data alone. There are several aspects that artificial intelligence lacks, such as critical thinking, emotional intelligence, and creativity[3].

6) Project managers must play a supervisory role on the intelligent system and its data which is one of the main pillars on which the decisions are built. In addition, they should possess technical skills and knowledge of AI technologies that enable them to evaluate the results produced by the intelligent system[11]. Project managers can use the power of AI to increase the chances of project success. Managers can thus dedicate their precious time to duties that are exclusive to humans. In fact, all levels of management will need to adapt to working with AI as part of their job. AI will likely prove to be more effective than humans at doing tasks. This does not mean that machines will completely take over all tasks [10].

7) Another problem is how to integrate AI systems with the project management program. Successful integration of AI systems into project management systems requires careful consideration of the challenges: preparing the technological infrastructure, providing data and ensuring its quality, and developing the skills of workers in the AI field. In addition, comprehensive frameworks for AI-based models must be developed due to the significant lack of research on standardization. Finally, knowledge of AI ethics must be also considered [30].

8) The reviewed studies have confirmed these challenges. The study in [19] faced an issue related to the use of a real risk register data, which because of confidentiality, resulted in a smaller dataset. The small dataset size affected the model's generalizability. In addition, the researchers adjusted the structure of the ANN algorithm to avoid the risk of overfitting. In another study [21], the researchers faced a shortage of available data for early project cost estimation. To overcome this, they built a local dataset of software projects. However, the limited size and local nature of the dataset increased the risk of bias and limited the model's generalizability, also raising the possibility of overfitting. Another study in [17] confirmed the problem of data scarcity in this field. Although a real, local dataset of projects from multiple sectors was used, the bias in the nature of the local data and its small size limited the model's generalizability. Additionally, the dataset suffered from quality issues, as there was significant variation in budget sizes, which was addressed through a normalization technique.

## 4.3. AI applications in IT project management

This section reviews selected studies to examine how artificial intelligence improves cost, schedule, and risk management in project management. Table 2 summarizes these studies by organizing them according to the knowledge area, AI techniques, and the issues they address. Figure 1 illustrates the distribution of algorithms across different PM areas. It is clear from the figure that the ANN algorithm is used across all areas, confirming its significant performance and versatility. Furthermore, most of these algorithms are not used in isolation but are utilized through hybrid techniques to improve their performance.
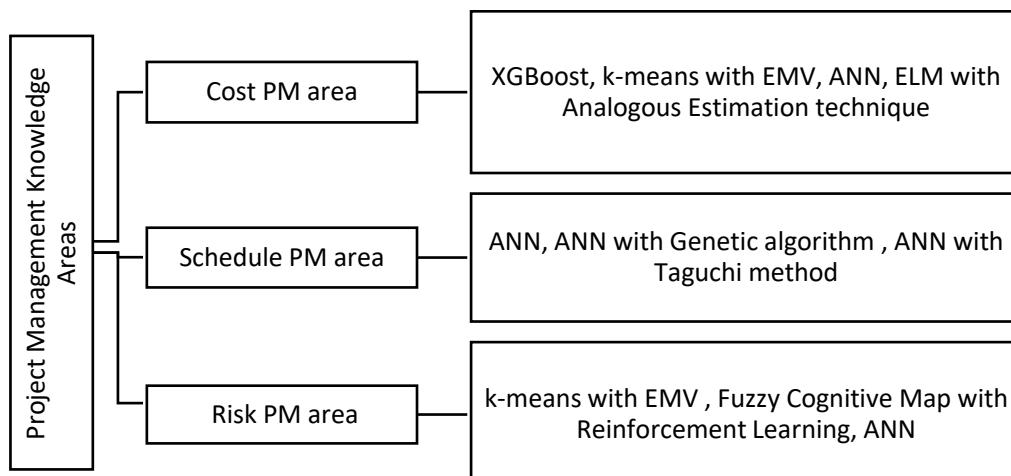


**Fig. 1:** Distribution of AI Algorithms across Project Management Areas.

**Table 2:** AI Applications Across Projec Management Areas

| Paper Name Year published | knowledge area | AI Algorithm | Issues | Suggested solution |
|---|---|---|---|---|
| A machine learning study to improve the reliability of project cost estimates [17] 2024 | Cost | XGBoost | The process of estimating project costs is one of the aspects that enable project managers to monitor and control projects to ensure the project progress. Earned Value Management (EVM) technique is widely used to estimate project costs in project management, but this method has limitations, such as supposing linearity in cost spending and producing unreliable estimates in the early stages of the project. | A mechanism for predicting project costs based on machine learning techniques was proposed. The XGBoost model is used to predict costs at different stages of the project. The model provided accurate estimates of project duration in the initial stages of project, which helped to estimate costs more accurately. The results showed that the XGBoost model outperformed the EVM model and other machine learning models in terms of accuracy, timing, and reliability in most of the projects tested. The model has been trained and tested on real project data. |
| Estimation of Risk contingency budget in project using machine Language [18] 2022 | Risk, Cost | k-means clustering model integrates with EMV approach | One of the ways to address identified risks in the event of their occurrence is to determine the contingency budget (CB) within the project budget. There are several ways to estimate the contingency budget, including: taking a certain percentage of the project budget or adopting a fixed value. These ways are deterministic and do not take into account uncertainty. Also, they are determined at the project level and are often defined based on similar projects. Since each project is unique, these traditional methods do not take into account the characteristics of the project. In addition, they do not provide a detailed quantitative analysis of the risks inherent in the project. | A model has been presented to calculates the CB with high accuracy. The model builds based on machine learning technique to estimate CB. It used k-means clustering technique with EMV approach and binomial Distribution. When EMV is combined with the machine learning algorithm, the process of estimating the CB is improved through clustering of risks' probabilities and impacts. The estimates of the proposed model were compared with the results obtained from Monte Carlo simulation and showed better accuracy. |

| Paper Name Year published | knowledge area | AI Algorithm | Issues | Suggested solution |
|---|---|---|---|---|
| Risks Analyzing and Management in Software Project Management Using Fuzzy Cognitive Maps with Reinforcement Learning [31] 2021 | Risk | Fuzzy Cognitive Map & Reinforcement Learning | Software projects include a lot of complexity and uncertainty. Therefore, there must be ways to manage project risks on order to reduce the possibilities of project failure. Using traditional methods for risk analysis is difficult to apply in this type of projects. | The paper introduced a method to define the project risks and propose solutions to mitigate them. The method is a combination of fuzzy cognitive maps (FCM) and reinforcement learning (Q-Learning). FCM models the complex relationships between different risk factors (weak scheduling - unqualified developers) and their impacts on project outcomes (delay - high cost). Q-Learning enhances the FCM by learning optimal risk mitigation from data and improve its results over time. |

| Paper Name Year published | knowledge area | AI Algorithm | Issues | Suggested solution |
|---|---|---|---|---|
| Using an Artificial Neural Network for Improving the Prediction of Project Duration [20] 2022 | Schedule | Artificial Neural Network (ANN) with genetic algorithm | Each project is unique and has characteristics that distinguish it from other projects. Many projects of various types face the problem of exceeding the schedule. Due to inaccuracy of estimating the project duration. Many practical tools have been designed to estimate the duration of a project, including the Gantt chart, the Critical Path Method (CPM), and the Program Evaluation and Review Technique (PERT). These techniques provide Inaccurate estimates of the project duration due to the lack of certainty in the planning process on which these tools base their estimates. Design a single tool that estimates project duration is a major challenge. Where each organization has different methodology, techniques, expertise, and resources, as well as different types of projects. | A dynamic machine learning model was designed to improve the accuracy of project duration prediction using an artificial neural network (ANN) .The model was trained multiple times using different architectures and uses a genetic algorithm to select the most accurate architecture. AI techniques were chosen for their many advantages, most notably their ability to perform complex calculations, analyze large amounts of data, and recognize patterns effectively . Studies have shown that relying on information from previous projects improves new project duration prediction. The tool was designed to provide a dynamic method for project duration prediction that can be used by many types of organizations despite their many differences. It has proven its effectiveness in improving project duration prediction compared to traditional forecasting methods, and has been validated with real projects. The tool includes auto-adjustment to different features and formats that organizations have. |

| | | | | |
|---|---|---|---|---|
| Neural Network Intelligence Model for Software Projects Cost Prediction [21] 2023 | Cost | Artificial Neural Networks (ANNs) | Estimating the total cost of a project in its early stages depends on a number of factors, many of which may be difficult to estimate at that stage. The lack of experience of the project manager and lack of knowledge affect the project cost estimate. Traditional methods provide inaccurate estimates, as cost estimate before the detailed plans for projects are developed. time using old methods that do not take into account the project complexity factors. Therefore, the paper focused on the need to estimate the factors and conditions that lead to losses when the project completion time is exceeded, such as hoursman in intensity labor. Adequate estimation of the project completion time would organize the project management process and improve resource management, thus leading the project to success | The paper presents a neural network model that predicts the cost of a project based on a number of parameters such as the project scope and work plans. These parameters are determined from previous projects data that have the same characteristics as the current project. The data is collected based on specific criteria predictions of the new projects schedule. The results showed that the proposed model reduces the failure rates associated with this type of project. |

| Paper Name Year published | knowledge area | AI Algorithm | Issues | Suggested solution |
|---|---|---|---|---|
| A Data-Driven Artificial Neural Network Approach to Software Project Risk Assessment [19] 2023 | Risk | Artificial Neural Network (ANN) | One of the factors that contribute to the success of software projects is the prediction and mitigation of risks. Risks in the field of software projects are defined as the probability of success or failure of the project .Factors for failure include lack of information in the early stage of the project, increasing cost and time over previous estimates. The research stated that 3 out of 5 reasons for the failure of IT projects in the case of the study (IT projects in Pakistan) are due to insufficient risk assessment. | The research presents a robust data-driven approach based on artificial neural network (ANN). The algorithm focuses on predicting the overall and individual project risks at the initiation stage of the software development life cycle for timely risk management. The study provides a more detailed view by Predicting individual risk factors, which allowing project managers to identify specific areas of concern and take targeted actions to mitigate those risks. The model was trained on historical data of completed projects. They improved the neural network architecture to achieve high accuracy in prediction by using the mean absolute error (MAE) function. The research has proven the capability of the model to assess project risks with high accuracy when applied to new data. |
| Software Project Estimation Using Machine Learning [25] 2023 | cost | Extreme Learning Machine (ELM) & Analogous Estimation technique | Estimating the cost of a project is an important aspect that is reflected in the planning process and resource allocation. Traditional methods for estimating projects cost are ineffective because they rely on expert judgment, which is subjective and prone to error. Also, some of them can analyzing historical data but not as effective as AI algorithms that can explore complex patterns. | The paper presented an Extreme Learning Machine (ELM) model that uses analog estimation technology to estimate the cost of the project and the required number of employees. Analogous estimation uses historical data to find projects similar to the new project by determining the characteristics of the projects and identifying the similarity between them. While the machine learning model is trained on historical data of similar projects and takes advantage of the data of those projects to predict the cost and effort of the new project. The results showed that the proposed model outperformed the algorithms (SVM, KNN, COCOMO) with an accuracy rate of 90%. |

| Paper Name Year published | knowledge area | AI Algorithm | Issues | Suggested solution |
|---|---|---|---|---|
| Proposal of a framework and integration of artificial intelligence to succeed IT project planning [33] 2019 | Risk, Cost, schedule | Framework | The paper indicated that the failure rate of IT projects is high due to problems in the planning phase. The planning phase involves defining a number of key aspects of the project such as determine tasks, resources, risks, communication methods, time and cost estimates. Planning aims to reduce project uncertainty and ensure project implementation. | The paper proposed a framework that enabling the utilization of AI for planning process in IT project. The framework aims to predict of costs and project duration, identify dependencies between tasks, and suggest optimal resource allocation. The paper indicates that the theoretically proposed framework must be programmed and presented as an intelligent system. The intelligent system consists of a knowledge base and a mechanism for collecting feedback. The knowledge base contains data from previous projects, it analyzes data, finds patterns and connections between previous and current projects. While the feedback mechanism continuously collects data and observations from |

| Predicting project duration using a coupled artificial neural network and Taguchi method approach [34] 2024 | schedule | Artificial Neural Networks (ANNs) & Taguchi method | In large projects, design process requires the coordination of many tasks. Consequently, the design process becomes more complex, leading to iterative modifications. Project managers must ensure that the project is running smoothly and mitigate potential task failures while taking time into consideration. Traditional tools such as GANTT and PERT do not support this iterative nature. | projects throughout their life cycle, and provides them to the knowledge base for continuous improvement of the planning process. The intelligent system connects to the knowledge base to provide information and recommendations to project managers on new projects. A model combining ANN and taguchi method was developed to improve the accuracy of project duration prediction. At the beginning, the project is represented as a network of activities with its durations with success probabilities and dependencies. Then, neural networks predict the total project duration, while taguchi method improves the prediction ability of the neural network. The neural network uses several factors like success probability, effort, and learning factor. Taguchi method efficiently optimizes the parameters of the neural network by discovers the training parameters that minimize the mean square error (MSE) and then trains the neural network on these optimized parameters to improve the prediction accuracy. Simulation results of the methodology showed accurate results. |

## 5. Discussion

The review of existing research confirms that established methodologies exist for deploying AI in this field. There are multiple AI techniques, each of which has different characteristics and serves different aspects of the knowledge areas. Selecting the optimal AI technology requires a thorough assessment of both the project's requirements and the expected AI-driven outcomes. It is also necessary to take into account the requirements for applying AI techniques in project management to obtain accurate results. The strength of AI lies in its ability to analyze historical data, leading to more accurate predictions in the domains of project time, cost, and risk. Since these areas are related to multiple aspects of the project, managing them well impact the success of the project. The processes of estimating the time and costs of the project depend on several factors that must be taken into account when designing an AI model to obtain accurate estimates. AI can be applied in project time management to accurately predict project schedules based on machine learning and neural network techniques. In cost management, machine learning and neural network techniques can identify the parameters that affect project costs, and thus accurately estimate costs. There are also approaches that combine AI techniques with traditional estimation methods. The application of AI in risk management predicts potential risks and provides mitigation strategies. Since risks are described by uncertainty and ambiguity, Fuzzy Knowledge Maps (FCM) are utilized which take the best solution based on the circumstances. They are combined with machine learning algorithms to assess risks.

Studies using AI techniques rely on analyzing historical data from previous projects to determine specific criteria upon which estimates and decisions are based. Some studies have employed standalone artificial intelligence algorithms, while others have relied on hybrid approaches that combine artificial intelligence algorithms with other techniques to improve learning performance, resulting in accurate and effective outcomes. In the field of project management cost, AI algorithms have contributed to high accuracy in cost forecasting. In the study of [17] , the XGBoost algorithm estimated project costs in the early stages, achieving a mean absolute percentage error (MAPE) of 6.22% and 9.70%, which reflects its high accuracy. It outperformed traditional models based on Earned Value Management (EVM) and other machine learning models such as Support Vector Regression (SVR), Random Forest (RF), and CatBoost. This superiority is attributed to the algorithm's ability to handle noisy data and mitigate the issue of overfitting. In another study [25], the ELM with analogous estimation demonstrated high accuracy, ranging from 85% to 90% in estimating project effort and cost, outperforming stand-alone models such as ANN, SVM, and K-Nearest Neighbors (KNN). This result demonstrates the effectiveness of integrating ML with traditional project estimation methods. The studies addressing the scheduling area of PM, show that AI has significantly improved forecasting accuracy, especially when using hybrid methods such as combining ANNs with GAs or the Taguchi methodology [20] [34] . These methods outperform traditional static forecasting methods such as Gantt charts and CPM, which fail to support the iterative nature and uncertainty of design processes. However, the heterogeneity of the data limited the model's generalization to all organizations. There are several aspects of risk assessment in project management. In the study of [18], they estimated the contingency budget (CB) using the k-means technique combined with the concept of binomial distribution. This model outperformed the traditional EMV method and Monte Carlo simulation because it overcame the limitations of EMV by clustering risks and calculating the binomial distribution. The model demonstrated significant improvements in accuracy, with the average difference between its estimates and Monte Carlo estimates being only 6%, compared to 142% for the traditional EMV model. It was also simpler to use than Monte Carlo. Another study [19] evaluated the overall risks of a project. The ANN model outperformed the LR model in risk assessment, achieving the lowest mean absolute error (MAE) and an accuracy of 97.12%. This superior performance is attributed to the neural network's ability to capture nonlinear relationships and complex patterns in the data. However, the scarcity of real and confidential data for risk registers was a major constraint, as the small dataset size made the model more susceptible to overfitting. To mitigate this issue, the researchers adjusted the structure of the ANN model. In another study [35], researchers used fuzzy cognitive map (FCM) combined with reinforcement learning (RL) to avoid ambiguity in risk assessment. This model demonstrated effectiveness in analyzing project risks and outperformed FCM models that did not use reinforcement learning. However, the qualitative and ambiguous nature of risk assessment requires complex data processing. Since each project is unique, researchers have emphasized that a framework must be designed to enable the use of AI in project management [33]. And this is another perspective of the integration process between AI and project management.

## 6. Conclusion

The profound impact of artificial intelligence is evident in its revolution of the technological world and its significant advancements in various domains. The application of AI can optimize various components of the project management process. Multiple scholarly works have contributed to the understanding of AI's capability to improve project management and validated its effectiveness. Our analysis of numerous studies focused on the different ways AI can be applied to key project management domains, specifically cost management, scheduling, and risk management. These studies rely on a number of methodologies, some used a single AI technique, while others tended

to use hybrid approaches between AI technologies and other methods in order to increase the accuracy of the results extracted from AI models. We have reviewed a number of challenges that hinder the integration between AI and project management. Maximizing AI's benefits in project management hinges on resolving issues with data quality and ensuring the intelligent system is suitable for specific project needs.

For future research, studies are needed to address the methodology of creating frameworks to enable the use of AI in project management, and find common points for generalization into a single framework. Based on our review of AI applications in the knowledge area of project management, we found that some studies have proven the AI's effectiveness. However, this aspect still needs further exploration.

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