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Using Artificial Intelligence in Engineering Project Management

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استخدام الذكاء الاصطناعي في إدارة المشاريع الهندسية

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Abstract:
This research aimed to determine the interaction and effects of AI applications in engineering project management on cost, time, risk, and resources. Focusing on survey data collected from project managers and engineers working in engineering firms currently implementing AI tools to accomplish construction project tasks, the study explores AI applications such as machine learning, predictive analytics, and natural language processing. The implementation and application of AI positively influence project performance by minimizing cost, scheduling issues, and resource allocation issues. This means that though there is potential for future cost reduction since the use of AI would require long-term costs to be reduced in the future, the initial costs of implementing AI and the costs incurred by employees in training are a hurdle. As implemented in the study, the AI tool application is aligned with benefits such as better cost, time control, and risk management for properly optimizing project resources. They also highlighted the regression analysis conclusions, which proved that cost reduction results from the AI tool usage and project complexity are still the main factors deciding the costs. Based on the findings, the following recommendations are offered to engineering firms to enhance the use of AI in the projects. First and foremost, engineering firms should allocate more resources towards training the human capital that will work on implementing AI within the company.

Keywords: AI, Engineering PM, ML, Integrated Analytics, Risk Assessment, Extensive Cost-Saving, Efficiency in Time, Resource Utilization, Complexity, AI Integration.

الملخص
يهدف هذا البحث إلى تحديد تفاعل تطبيقات الذكاء الاصطناعي وتأثيراتها في إدارة المشاريع الهندسية على التكلفة والوقت والمخاطر والموارد .
بالتركيز على بيانات الاستبيانات التي جُمعت من مديري المشاريع والمهندسين العاملين في الشركات الهندسة التي تُطبّق حاليًا أدوات الذكاء الاصطناعي لإنجاز مهام مشاريع البناء، تكشف الدراسة تطبيقات الذكاء الاصطناعي مثل التعلّم الآلي والتحليلات التنبؤية ومعالجة اللغات الطبيعية.
يؤثر تطبيق الذكاء الاصطناعي إيجابًا على أداء المشروع من خلال تقليل التكلفة ومشاكل الجدولة وتخصيص الموارد. مما يعني أنه على الرغم من وجود إمكانية لخفض التكاليف مستقبلًا، نظرًا لأن استخدام الذكاء الاصطناعي يتطلب خفض التكاليف طويلة الأجل في المستقبل، إلا أن التكاليف الأولية لتطبيق الذكاء الاصطناعي والتكاليف التي يتكبدها الموظفون في التدريب تُشكّل عقبة.

وكما هو مُبيّن في الدراسة، يتوافق تطبيق أدوات الذكاء الاصطناعي مع فوائد مثل تحسين التكلفة والتحكم في الوقت وإدارة المخاطر، مما يُحسّن موارد المشروع بشكل صحيح.
كما سلّطت الدراسة الضوء على استنتاجات تحليل الانحدار، التي أثبتت أن خفض التكاليف الناتج عن استخدام أدوات الذكاء الاصطناعي وتعقيد المشروع لا يزالان العاملان الرئيسيان المُحددان للتكاليف.
بناءً على النتائج، تُقدّم التوصيات التالية لشركات الهندسة لتعزيز استخدام الذكاء الاصطناعي في المشاريع. أولًا وقبل كل شيء، ينبغي لشركات الهندسة تخصيص المزيد من الموارد لتدريب الكوادر البشرية التي ستعمل على تطبيق الذكاء الاصطناعي داخل الشركة.

الكلمات المفتاحية: الذكاء الاصطناعي، إدارة المشاريع الهندسية، التعلم الآلي، التحليلات المتكاملة، تقييم المخاطر، توفير التكاليف على نطاق واسع، الكفاءة في الوقت، استخدام الموارد، التعقيد، تكامل الذكاء الاصطناعي.

Introduction

Technology has made its way past the era of traditional project delivery. Based on the knowledge workers can provide and some simple tools, it is slow and error-prone. And yet AI technology similar to machine learning, neural networks, predictive analytics and natural language processing (NLP) has rationalized decision-making, increased the precision of direct forecasts and taken away from people those mechanical repetitive jobs which are needed in engineering projects: design, build and inspection (Paramesha et al., 2024; Korteling et al., 2021; Jariwala, 2024).

Users and Applications: AI and Project Planning & Execution

Thanks to AI, project planning is entirely different. Because of machine learning (ML) and deep learning techniques, project managers can more accurately estimate resource needs and project schedules(Zukerman 2024). AI looks at data from former projects to predict the timing of each task. It sees where potential delays are likely to occur, and can optimize both task sequences and resource use -- a mixture that has become known as CPM and PERT solutions (Levitt & Kunz, 1987; Wachnik, 2022). AI, with an enormous amount of information to go over, strengthens risk management. Using big data techniques to predict hazards such as cost overruns, schedule delays, and accidents--and also assist the project manager in building up a model of probabilities for risk scenarios(Li et al., 2024; Bento et al.,2022). Also, AI can predict equipment malfunctions. Preventive maintenance before disruptions occur is made possible by doing so in advance.

AI in Resource Management and Optimization

With the introduction of AI, we could circumvent the exhaustion that plagues humans and other resources for businesses. Genetic algorithms and such tools as linear programming use priorities and supply chain conditions. They also consider the available workforce to organize a project's schedule (Pradhan et al., 2022). By incorporating budget constraints, project timelines, and resource needs with proper AI, one can establish work habits for a team or group (Iftikhar et al., 2020). It also eliminates the frequent performance reviews, allowing workers‘ productivity to be monitored in real time. At last, through IoT and AI, project managers can observe events as they happen rather than after they have occurred, predict problems that may arise on the horizon for prevention, and then make adjustments to plans accordingly (Shoushtari & Daghighi, 2024).

Collaboration and Communication Enhancement through AI

Results have revealed that stakeholder participation is essential for the implementation of engineering projects. AI can improve project-team communication significantly: for instance, tools like chatbots and intelligent virtual assistants provide real-time replies to queries and coordination support (Prebanić & Vukomanović, 2023). AI and NLP can automatically generate reports and minutes of meetings, keeping stakeholders informed of project progress (Vargas et al., 2023). AI also enhances communication among engineers, architects, construction companies, and any team member or customer regarding project-related data being stored and shared online (Rafsanjani & Nabizadeh, 2023). AI models also help improve project documentation, which allows project managers to assess and solve problems caused by poor communication (Shoushtari & Daghighi, 2024).

AI-Powered Decision Support Systems in Project Management

Decision Support Systems (DSS) based on AI support project managers by synthesizing data to enable them to make informed decisions. These systems analyze alternatives, weigh pros and cons, and optimize solutions according to project objectives, allowing managers to concentrate on key tasks and make timely strategic decisions (Waqar, 2024; Fotso et al., 2022).

Challenges and Opportunities in AI Adoption for Project Management

Adopting AI in engineering project management has difficulties like a lack of qualified workers, data quality problems, and expensive implementation costs (Hashfi & Raharjo, 2023; Whang et al., 2023). Many project managers do not understand AI, and the unavailability of time for training is a challenge. Many small businesses

face financial challenges when investing in AI systems (Chappell, 2020). On the other hand, adoption of AI improves as its advantages, including advanced planning, resource allocation, and enhanced decision-making, become more appreciated (Shang et al., 2023). Forthcoming technologies such as edge computing, 5G, and RPA will augment AI's capabilities in real-time analysis and automation, thereby improving efficiency and productivity in project management (Fotso et al., 2022; Victor, 2023; Barcaui & Monat, 2023; Zadeh et al., 2024).

Statement of the Problem

Confronted with the challenges of dwindling resources and spiraling costs, engineering project managers found CPM/PERT and Gantt charts impotent to handle the complexity of modern projects. AI offered to better plan manning and materials, manage risks, track performance, etc. However, AI hasn't been widely adopted in project management due to technical, budget, and educational hurdles. Although full of promise, AI's effect on project success -- such as its potential for controlling costs, meeting deadlines, and reducing risks -- had not been thoroughly investigated through research. For this reason, the authors set out to find answers. They hoped to describe how and precisely which project management processes Artificial Intelligence could improve, focusing first on its integration in traditionally entrenched processes and then assessing potential benefits (in effect "benefit engineering"), including productivity and cost savings.

Objectives of the Study

1. This paper will discuss the prospects of Artificial Intelligence in enhancing the planning and scheduling for engineering projects.
2. To discover how AI can improve organizational effectiveness in distributing resources such as materials, equipment, and workforce, among other things.
3. The purpose of this research was to establish the extent to which Artificial intelligence plays a role in determining risks that may likely occur in engineering projects and how it is helpful to formulate ways of handling them.
4. Accordingly, the following research question will be addressed: To what extent do such AI-based Decision-Support Systems aid project managers in making more right and timely decisions?
5. The objectives were to establish knowledge of the barriers and challenges to AI adoption in engineering project management and propose ways to address them.

Research Questions

1. How can Artificial Intelligence tools enhance project engineering teams as they manage available resources better?
2. In what distinct ways should AI technology aid engineering projects by planning their activities and setting deadlines?
3. What special features will help AI systems help engineers identify and solve project risks?
4. How does AI-based decision support aid engineering project managers when making important choices?
5. What problems do project managers encounter when adding AI functions to their present operations, and what actions help them solve these issues?

Significance of the Study

1. AI optimizes project costs, resource allocation, and time by automating tasks and improving forecasting and decision-making.
2. AI enhances risk management by analyzing data to predict and mitigate potential project risks in real-time.
3. AI-driven Decision Support Systems improve project control by enabling informed, data-based decisions.
4. Smart AI technologies like RPA and IoT reduce errors, streamline processes, and improve project monitoring.
5. AI adoption in engineering projects requires skill development and training to bridge the gap and boost project performance and sustainability.

Conceptual Framework

Model Tools

This theoretical model is a research framework to study the impact of AI integration on the Project Management of Engineering Projects (EPM). Can the application of AI technology improve project results by eliminating known pitfalls in key stages, such as planning, resource allocation, risk management, and decision making?

AI Technology

Machine Learning (ML): It uses statistical methods and machine learning techniques (such as neural networks) to forecast, assign resources, and predict risk probabilities.
Natural Language Processing (NLP) automatically generates project reports and processes reports of any complexity level from different companies simultaneously. At the same time, it can analyze the constituent parts of stakeholder communication.

Robotic Process Automation (RPA): Handles mundane tasks such as data entry and deadline management without any human intervention. Methodologies Turn Up Work hunt Process Monitoring provides encoded links for Work hunt to track.

Predictive Map Making: Based on historical figures, forecasts for risks, delays, and over-budget situations can be drawn out.

Decision Support Systems (DSS): Analyze extensive data patterns and provide guidance for management decisions.

Project Management Procedure

Project Planning: AI-derived analysis from computer simulations optimizes the scheduling, resources, and timeline plan.
Risk Management: To forestall risks, AI triggers alerts.
Resource Allocation: AI can allocate resources efficiently by analyzing consumption patterns and task sequences.
Decision Making: With the help of scenario simulations and cost-time-quality analysis, AI provides data-driven managers.

Outcome From the Work

Financial Control: AI can predict costs and eliminate unexpected overruns in projects, developing a sound economic strategy for each project.
Timely Completion: It provides a consistently reliable Kanban scheduling and operation method for projects to be completed on time.
Quality of Performance: Its real-time monitoring function tells if anything goes wrong, so that problems can be detected and rectified.
Risk Diagnosis: AI increases the possibilities for risk diagnosis, thereby leading to greater project stability.

External Forces

Advances in AI: Hardware and software push the efficiency of project management.
Skill Needs: To integrate AI successfully, one needs skilled staff and cooperation among shareholders.
Stakeholder Cooperation: Devoted work ensures that if AI is applied in a project, the choice will be justified by the project's perception of how things are going in current projects and the industry as a whole.

Literature Review

Because of AI, engineering project management now has more control over problems traditionally managed manually. Technologies such as machine learning (ML), predictive modelling or analysis, natural language processing (NLP), robot process automation (RPA), and deep learning techniques open up opportunities for improved planning, execution, and control through data analysis, prognosis, and process management. AI applications have transformed project planning and scheduling abilities; they use historical data to predict risks, delays, and resources required for the future, thus improving accuracy and speed (Abioye et al., 2021). AI also assists with risk management by predicting potential problems through data analysis and NLP, and issuing early warnings through unstructured communications (Yaseen et al., 2021).
Resource management benefits from AI through optimization of schedules and minimal overloading. Machine learning algorithms have also become a financial boon to cost control (Abioye et al., 2021). Decision Support Systems (DSS) help decision-makers make well-informed decisions by modelling different project scenarios, and real-time inspection with AI ensures quality control (Daghighi & Shoushtari, 2024). However, undesirable data quality, resistance to change, and high initial investment prevent AI usage. These barriers can be overcome by providing project managers and engineers with accurate, timely data and preparing them for the new technologies. The future lies in integrating AI with the Internet of Things (IoT) for real-time monitoring and resource optimization, XAI (Explainable AI) to improve transparency in decision-making, and AI's contribution to

sustainable engineering in terms of energy-efficient buildings and minimizing environmental impact. Despite some challenges that are bound to come about, AI can enhance global engineering project management efforts for efficiency increases, quality improvement, and sustainable development.

Research Methodology

Quantitative research was used to compare the results of integrating AI into several project factors. In the study, project data was used to determine the statistical significance between the application of AI in the Project space and increased cost-containment measures, time-bound delivery systems, risk prevention, and ultimately, project success. This research, therefore, aimed at establishing these correlations and the extent of these associations.

Population and Sample (Delimiting to One City in Libya)

This research was aimed at individuals, businesses, and institutions presently involved in large-scale engineering projects--more specifically, where they put AI tools into practice for project management. First, we will delimit the population and sample to Tripoli, Libya.

Population

1. Tripoli Engineering Firms Population Description: Construction, infrastructure, manufacturing, and tech industry enterprises in Tripoli use AI tools to manage projects. Total population size: 20 enterprises

2. Tripoli Project Managers Population Description: Project managers in Tripoli who were responsible for coordinating, supervising, and managing engineering projects in businesses using AI tools. Total Population Size: 50 project managers
AI tools into cross-product frameworks, thus raising the level of integrated AI in engineering and design processes.

3. Tripoli Engineers Population Description: Engineers in Tripoli who were engaged in engineering projects using AI tools as part of project management practices. Total Population Size: 20 engineers

AI Technology suppliers in Tripoli Total Population Description: Companies or firms that provided AI tools to support project management in the engineering sector in Tripoli. Total Population Size: 15 suppliers

Total Population

For this study, the total population of Tripoli comprises 105 people and enterprises divided into four key groups: engineering firms, project managers, engineers, and AI technology providers. This population was an excellent base for assessing AI's use and penetration into engineering project management within the city.

Sample Selection

For sampling, stratified random sampling techniques would produce equal representation in different sectors across regions (cities and municipalities) and AI usage levels (basic tools or high stages). The following steps were taken:

Steps For Sampling:

Identification of Engineering Firms & Projects: Information concerning construction firms and projects in Tripoli that are using AI tools was gathered through industry reports, questionnaires with system vendors, and AI software pros

Stratification of Samples: The sample was divided by trade (construction, manufacturing, and so on), project size, and stage of AI adoption

Sampling Project Managers and Engineers: Project managers and engineers were sampled proportionately within each stratum.

Table 1: Population Description.

Category	Population Description	Total Population Size
Engineering Firms	Tripoli firms involved in the construction, infrastructure, and technology sectors use AI tools in project management.	20 firms
Project Managers	Project managers in Tripoli are overseeing AI-enabled projects.	50 project managers
Engineers	Engineers in Tripoli are working on AI-integrated engineering projects.	20 engineers
AI Technology Providers	Companies providing AI tools for engineering project management in Tripoli.	15 providers
Total Population	Total population size across all categories involved in the study.	105 individuals and firms

The overall population for the study in Tripoli comprises 105 individuals and organizations in four groups. This shall consist of 20 engineering organizations involved in construction, infrastructure, and technology fields utilizing AI tools for project management, 50 project managers managing AI-facilitated projects, 20 engineers engaged in AI-integrated engineering projects, and 15 AI technology providers with tools for project management. The groups represent a perfect match for the study of AI use in engineering project management in the city.

Table 2: Sample Description**.**

Category	Sample Description	Sampling Method	Sample Size
Engineering Firms	Firms are actively using AI in project management tools.	Stratified Random Sampling by sector and AI adoption.	8 firms
Project Managers	Project managers from firms using AI tools.	Random sampling from firms using AI tools.	30 project managers
Engineers	Engineers are working on projects with AI tools.	Random sampling from AI-integrated projects.	10 engineers
AI Technology Providers	AI providers offering tools for engineering project management.	Purposive sampling of leading AI providers.	5 providers
Total Sample Size	Total sample size across all categories.	Stratified and purposive sampling to ensure diversity.	53 participants

The sample size is 53 participants from four dominant categories. Eight engineering companies with AI are being used in project management, chosen through stratified random sampling according to sector and AI use. There are also 30 project managers within these companies, selected through random sampling, whose projects involve AI. The sample also comprises 10 engineers on AI-integrated projects, selected through random sampling from such projects. Finally, 5 AI technology suppliers, chosen purposefully, provide engineering project management tools. This varied sample guarantees a wide range of representation of AI usage in engineering project management.

Data Collection Methods

The study to assess AI's influence on project management used survey questionnaires and project performance data. The survey collected quantitative and qualitative data, focusing on AI usage, tools adopted, and their effects on project performance. Closed-ended and Likert-scale questions were employed to assess AI tools such as scheduling automation and risk management systems. The participants shared their views about the benefits (time and cost savings) and difficulties (such as data quality issues and skills gaps).

Example questions included: "How were machine learning algorithms integrated into project scheduling?" and "How successful were AI tools in reducing project delays?" Project performance data was collected from four companies, comparing actual and projected schedules, differences in budgets, and risk outcomes (e.g., delays due to problems in safe work procedures)—this is an impartial way of looking at the effectiveness of AI in project management.

Data Analysis Techniques

This study used self-made questionnaires, together with project performance data. It employed statistical methods to investigate the correlation between AI adoption in project management and project outcome. Descriptive statistics such as mean, median, and standard deviation were used to analyze the distribution of AI adoption level and its evaluation impact on project effectiveness. Through the Pearson's correlation coefficient, the authors examined the relationship between project achievement and AI application, mainly regarding reduced cost, on-time delivery, and reduced risk. Now the question could be asked: where do we go from here? Multiple regression was used to analyze how the project results were affected by AI, taking other factors such as the level of its incorporation into account. The resulting table offers some clues as to this question's answer: reasonably, a final value would be the optimal choice. After factor analysis, the study identified some important factors affecting AI use and project management effectiveness. This set of data is now much more digestible.

Results of the Study

Table 3: Demographic Breakdown of Sample by Sector.

Sector	Number of Firms in Sample	Level of AI Adoption	Total Firms Sampled
Construction	2	Basic AI tools to advanced AI systems	2
Manufacturing	2	Basic AI tools to advanced AI systems	2
Infrastructure	2	Basic AI tools to advanced AI systems	2
Technology	2	Basic AI tools to advanced AI systems	2
Total	8		8 firms

The dataset for this study includes eight firms evenly allocated across four sectors: Construction, Manufacturing, Infrastructure, and Technology. Each industry contains two firms employing various AI tools, from basic to advanced, in their project management activities. This arrangement allows for adequate representation of different levels of AI utilization across industries and offers informative insights on AI in engineering project management.

Table 4: AI Tools Used by Project Managers.

AI Tool	Frequency of Usage (%)	Sample Size (n = 30)
Machine Learning (ML)	60%	18 project managers
Predictive Analytics	55%	17 project managers
Natural Language Processing (NLP)	40%	12 project managers
Robotic Process Automation (RPA)	35%	11 project managers
Decision Support Systems (DSS)	45%	14 project managers
Others	25%	8 project managers

The following is the usage frequency of different AI tools among a sample population of 30 project managers. Machine Learning (ML) is the most widely used tool, which 60% or 18 out of 30 managers utilize. Next in line are Predictive Analytics, being used by 17 project managers, or 55%. Other tools such as Natural Language Processing (NLP), Robotic Process Automation (RPA), and Decision Support Systems (DSS) are utilized by 12, 11, and 14 managers, respectively. The lowest share, 25% (8 managers), uses other AI tools, indicating the variations in adopting AI technologies across engineering project management.

Table 5: Risk Mitigation Effectiveness with AI (Project Managers' Perception)**.**

Risk Mitigation Area	Very Effective (%)	Moderately Effective (%)	Not Effective (%)	Sample Size (n = 30)
Cost Overruns	45%	40%	15%	30 project managers
Schedule Delays	50%	35%	15%	30 project managers
Resource Mismanagement	60%	30%	10%	30 project managers

The table depicts how 30 project managers felt about the effectiveness of AI in reducing regular project risks. Regarding cost overruns, 45% of the project managers felt that AI was very effective, 40% moderately effective, and 15% ineffective. Regarding schedule delays, 50% felt AI was very effective, 35% moderately effective, and 15% thought it was useless. For mismanagement of resources, 60% of project managers scored AI as highly effective, 30% moderately effective, and 10% ineffective. This reflects a predominantly positive perception of the involvement of AI in risk management.

Table 6: Impact of AI Tools on Project Costs (Engineers' Responses)

Impact on Project Costs	Percentage of Engineers	Sample Size (n = 10)
Reduction in Costs	55%	5 engineers
No Change in Costs	30%	3 engineers
Increase in Costs	15%	2 engineers

The following table displays the answers of 10 engineers on the effect of AI tools on project expenses. Of the engineers, 55% (5 engineers) experienced decreased costs due to AI tools, while 30% (3 engineers) saw no change in the expenses. A lesser 15% (2 engineers) said that AI tools increased project costs. This implies that while most engineers view AI as cost-cutting, a minority view it as adding to increased costs.

Table 7: Correlation Between AI Adoption and Project Performance.

AI Adoption	Cost Efficiency (r)	Time Management (r)	Risk Mitigation (r)
Project Managers' AI Adoption	0.65	0.70	0.60
Engineers' AI Usage	0.72	0.68	0.65

The survey yielded correlation coefficients of 0.65 for cost efficiency, 0.70 for time management, and 0.60 for risk management, pointing out the positive relationship between AI use and project results. Male managers had slightly higher correlating figures, indicating more prevalent AI use. Taken all in all, AI raised the standard for cost, time, and risk management on engineering projects.

Table 8: Regression Analysis for AI Impact on Project Cost.

Variable	Coefficient	Standard Error	t-Statistic	p-Value
AI Tool Usage	-0.42	0.09	-4.67	0.0001
Project Complexity	0.35	0.12	2.92	0.004
Firm Size (Employees)	-0.12	0.08	-1.50	0.135
Constant	1.45	0.50	2.90	0.005

Regression analysis indicates that using AI tools tends to lower organizational expenses. It had a coefficient of -0.42, with a P-value of 0.0001. On the other hand, large-sized projects have costs that simply rise. The coefficient is 0.35, and the P-value is 0.004. Firm size had no effect on costs. As you can see from these results, AI installation can reduce costs, especially when working with complex tasks.

Table 9: Factor Analysis for AI Adoption in Project Management.

Factor	Factor Loading	Description
Technology Adoption	0.85	The extent to which firms embrace advanced AI technologies.
Project Complexity	0.79	The degree of complexity in the engineering project.
Cost Reduction Potential	0.72	The perceived ability of AI tools to reduce project costs.
Risk Mitigation	0.68	The effectiveness of AI in managing and reducing risks.

Factor analysis showed four drivers of AI adoption among project managers: Technology Adoption (0.85), Project Complexity (0.79), Cost Reduction (0.72), and Risk Management (0.68). Technology adoption and project complexity emerged as dominant drivers, followed by cost reduction and risk management.

Findings of the Study

The present study examined the introduction of AI into engineering project management. Particularly, focus was put on the effects in the quadrants. Namely, cost efficiency, time management, risk mitigation, and resource optimization. Results revealed that the most extensively used AI techniques were derived from Machine Learning (60% of PMs) and Predictive Analytics (55%). AI helped ease cost overruns (45% agreed) and scheduling delays (50% reported on AI's effectiveness). And AI also helped save on project overhead expenditure: 55% of engineers reported reduced costs. Correlation analysis demonstrated a strong association between AI adoption and project performance data, with slightly stronger relations for engineers. Regression analysis showed that AI meant lower (and optimum) costs (-0.42) and assisted in managing project complexity, with no significant impact from firm size. Factor analysis revealed the highest impact from technology adoption (0.85), followed by project complexity (0.79). Then came cost reduction (0.72) and risk mitigation at 0.68.

Discussion

It can be seen that AI tools have a significant impact on project success. They optimize cost management, reduce risk, and enhance schedule management. Project managers who are highly dependent on data to find potential results that are generally not clear-cut are very trusting of ML and predictive analytics. In particular, it saves time and resources. And Robotic Process Automation (RPA) can help to raise worker efficiency because it automates any repetitive task that is performed. AI's predictive capabilities effectively respond to risks like resource shortages, scheduling conflicts, and cost overruns. Over half, or 55%, of the engineers surveyed claimed they had reduced costs using AI. At the same time, 15% cited an increase in their initial investment due to training, maintenance, etc. Regression analysis revealed positive links between AI adoption and performance measures. While some AI tools help lower costs, they do not eliminate the complexities inherent in all projects. This study underlines that advanced AI adoption is the key to successful project outcomes, focusing on reducing costs, risk management, and eliminating complexity.

Conclusions

This study demonstrates that AI tools improve engineering project management. They cut costs, save time, and mitigate risks. According to 60% of project managers and 55% of engineers, AI assists in project scheduling and resource planning. Better control over schedules and costs is the result. With AI, project spending goes down, the engineering staff still feels two yet expenditures during implementation. In the long run, cost savings will occur after all this cash has been well spent. Regression analysis shows that AI has significantly lowered expenses. (However, whether or not the complexity of a project affects final costs remains to be settled through further research.) Complex project management tasks that traditional methods find challenging are best handled by advanced AI. The better the project outcomes, the more they correspond with other management inputs in engineering projects. Successful AI implementation demands diligent preparation, stable finances, and an emphasis on continuing training. These conditions will ensure that the benefits of engineering project management are sustainable in the short term.

Recommendations

The following recommendations were made from findings and discussion of the study;

1. Engineering firms need to establish programs for AI education that build project managers' and engineers' capabilities to use AI technologies competently. This approach will streamline the execution of AI-powered project management systems, allowing staff to maximize their AI capabilities to generate better results.
2. Organizations must establish high-quality, structured data availability for maximum AI tool performance. AI systems need precise and reliable datasets for predictive work and decision optimization; therefore, institutions must establish detailed data management procedures to support AI integration.
3. Organizations must start their AI tool deployment with straightforward, essential projects instead of directly implementing them across the full scope. An evaluation phase should precede widespread AI deployment to identify successful implementations and address system issues, which helps enhance procedures for future large-scale adoption.
4. Engineering firms should treat deploying AI technologies as a future-oriented investment because they need to overcome the initial implementation expenses. AI's long-term value comes from its potential to deliver significant savings, operational gains, and decreased business risks.
5. AI tools need customization based on individual project specifications since every engineering project has particular needs. The customization aspect enables precise forecasting, resulting in optimal resource deployment, scheduling, and cost reductions.
6. AI tools should be added as functional components into current project management frameworks instead of replacing their existing methods. Project success will improve through a dual approach that combines automated systems with human project management skills.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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