

Adoption of AI-Based Project Management Tools and their Effect on Engineering Project Performance

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Abstract

AI-based project management tools adoption is transforming engineering project management by enhancing data-driven decision-making and improving project outcomes. This study investigates AI-Based Project Management Tool Adoption effect on Engineering Project Performance and examines Decision-Making Effectiveness mediating role. Guided by TAM and IDT, a quantitative cross-sectional research design was employed. Data were collected from 150 engineering professionals, including project managers, engineers, and IT specialists, through a structured questionnaire. Statistical analyses, including correlation, regression, and mediation analysis, were conducted using SPSS and PROCESS Macro. Findings revealed that AI-Based Project Management Tool Adoption significantly improves Decision-Making Effectiveness and Engineering Project Performance. Decision-Making Effectiveness also demonstrated a significant positive effect on project performance and partially mediated relationship between AI adoption and project performance. Study concludes that AI-enabled project management tools enhance engineering project success by strengthening managerial decision-making capabilities and overall project execution.

Key Words: Artificial Intelligence, AI-Based Project Management Tools, Decision-Making Effectiveness, Engineering Project Performance

Introduction

Engineering project management (PM) is a key to a complex project successful implementation in terms of cost, time and quality (Hossain et al., 2024; Kozhakhmetova et al., 2024). Technologies advancement has made engineering projects more challenging because they have extensive infrastructure requirements and expectations (Zabala-Vargas et al., 2023; Nadukuru, 2024). These projects can contain a lot of interacting activities, changing situations and confusion, and can require some mechanisms to co-ordinate and make decisions (Amin, 2025).

Traditional PM techniques have enjoyed popularity in managing projects but are limited in several ways in managing contemporary engineering projects (Mlybari & Elgohary, 2025). These methods are based on manual project planning, rigorous scheduling and simplistic data analysis (Manu, 2024). Hence, they are not well-developed regarding change adoption, big data and predicting risks (Sanusi et al., 2020; Kausar et al., 2022).

Artificial Intelligence (AI) has transformed PM over last few years (Elfirjani et al., 2025; Aurangzeb, 2025). AI-based tools are increasingly becoming popular in engineering projects to maximize efficiency and accuracy of project planning, scheduling, monitoring and decision-making (Alhasan and Alawadhi, 2024; Imran et al., 2025). They are tools that employ machine learning, predictive analytics, and automation to help project managers make data-driven decisions (Choi et al., 2021; Zaheer et al., 2025).

A significant trend in PM has been adopted by AI (ATA), as organizations increasingly seek to improve engineering project performance (EPP) and reduce inefficiencies (Aliyev, 2025). Ability to anticipate delays, improve resource allocation and manage risk has increased with AI technologies (Rana, 2025; Keshireddy, 2023). This has led to engineering firms shifting to AI-based technology application in industry to increase efficiency and competitiveness in this rapidly evolving industry (Savaş, 2025; Iqbal et al., 2025).

Although AI technology is evolving rapidly, engineering projects are still characterized by delays, cost increase and quality issues. Traditional PM tools might be ineffective in real-time management of complex project information, uncertainties and risks (Sanusi et al., 2020). Although businesses have started to implement AI-based PM systems, these systems' success in enhancing engineering projects performance is still to be established (Reznikov, 2025; Hossain et al., 2024). Moreover, lack of concrete empirical and quantitative data proving relationship between AI implementation and EPP in engineering projects exists (Zabala-Vargas et al., 2023; Rana, 2025).

Literature Review

Concept of PM in Engineering

Knowledge, skills, tools and techniques use to manage engineering projects to successfully meet intended time, cost and quality goals is engineering PM (Zabala-Vargas et al., 2023; Taboada et al., 2023). Resource management, risk mitigation and successful accomplishment of project objectives depend greatly on it (Imtiaz, et al., 2025; Amin, et al., 2024; Imtiaz, Malik & Khan, 2024). Traditional PM models are usually based on linear or predictive project planning models like Waterfall and Critical Path Method (CPM) that focus on completion significance of tasks in order and adherence to a schedule. In engineering, key performance indicators (KPIs) are usually applied in measuring EPP (Adebayo et al., 2025; Yazidi & Rana, 2025). These are time, cost, quality, resource efficiency and customer satisfaction (Amin, 2025; Hossain, et al., 2025). Engineering projects, however, are multifaceted and traditional methods have trouble keeping forecasts and control on right track (Shabeer et al., 2024).

AI in PM

AI in PM refers to intelligent systems use that 'mimic' human intelligence (Elfirjani et al., 2025; Qasim et al., 2025). AI technologies include machine learning, predictive modelling, natural language processing and scheduling automation. PM systems are integrating these to improve decision making (Amin, Said & Butt, 2025; Shah, Amin & Khan, 2025; Dash, et al., 2025). AI PM is a practice that involves planning, scheduling, resource allocation, risk management and monitoring process (Wang, 2023; Choi et al., 2021). These systems read and process real-time data and give insights to managers. AI dashboards and automation increase engineering visibility and efficiency (Ghazanfar & Ul Haq, 2025).

AI and Project Efficiency

AI enhances projects efficiency through automation and scheduling (Kozhakhmetova et al., 2024; Almalki, 2025). It also improves management effectiveness by predicting delays and recommending solutions to them. AI enhances teamwork and coordination, aligning processes (Adamantiadou and Tsironis, 2025). Research has indicated that productivity goes up and project time needed goes down when AI tools are used. As an example, Rana (2025) discovered that AI scheduling tools increased completion rate of tasks in construction projects because of better resource allocation and reduced delays. In a similar study, Alhasan and Alawadhi (2024) found out that AI automation not only saved time in planning but also enhanced efficiency of engineering projects demands (Aslam et al., 2025).

AI and Cost Control

Cost management is very important for engineering projects. AI tools are helpful in budgeting, forecasting cost overruns risks, and cost management (Sanusi et al., 2020; Shamim et al., 2025). AIs utilizes previous completed projects data and can use data on current variability of a project to forecast potential cost overruns. In one of reports prepared by Zaheer et al. (2025), researchers proved that predictive algorithms created by AI improved budgeting process as they identified cost risks at early phases of construction projects. Additionally, AI tools prevent unnecessary spending of resources by regulating them and helping eradicate delays (Saddique & Haq, 2025; Kausar et al., 2021).

AI and Project Quality

Project quality maintenance and quality improvement are also important AI application areas (Elfirjani et al., 2025; Nabeel, 2024). Predictive analytics and machine learning models are used to monitor quality standards and detect deviation during project execution. These aids facilitate compliance with engineering needs and standards and reduce defects. Studies have revealed that AI-powered surveillance systems can improve quality assurance processes. To illustrate point, Alhasan and Alawadhi (2024) found that AI-based quality control systems in infrastructure projects significantly reduced error rate and increased compliance with technical requirements. AI systems are constantly examining performance data to see when there may be quality issues before they get out of control.

Theoretical Framework

Current study is informed by Technology Acceptance Model (TAM) and Innovation Diffusion Theory (IDT). TAM explains technology application based on perceived usefulness and ease of use, meaning that engineering profession is more likely to implement AI tools if they can find apparent performance benefits (Hajira et al., 2025). IDT refers to stages of introducing new technology to organizations over time and aspects influence such as relative advantage, compatibility, and complexity on AI implementation in engineering departments (Adebayo et al., 2025; Taboada et al., 2023).

Empirical Studies

Empirical studies have investigated AI impact on PM. Hossain et al. (2024) and Saleem et al., (2025) found out that AI application significantly influenced project scheduling accuracy in significant engineering projects in a positive way. Similarly, Kozhakhmetova et al. (2024) established that decision-making and project delays speed was reduced to minimal levels through AI-based tools when developing infrastructure projects. In another study, Adebayo et al. (2025) and Zubair et al., (2024) established that organizations that had AI-based PM systems had superior risk management and experienced higher project success rates compared to their counterparts that relied on traditional PM systems (Amin, 2025; Soma, et al., 2025; Amin, Daudpota & Khan, 2025). However, there are also other studies that refer to obstacles in adopting AI such as high implementation cost, dependency on data and resistance to technological changes (Al-Arafat et al., 2025; Hashfi and Raharjo, 2023).

Conceptual Framework

Study's conceptual framework describes relationship between ATA (independent variable) and EPP (dependent variable). AI introduction is associated with effects on three primary dimensions, namely, project efficiency, cost management, and project quality (mediating variables). The three elements are used to characterize entire project's performance.

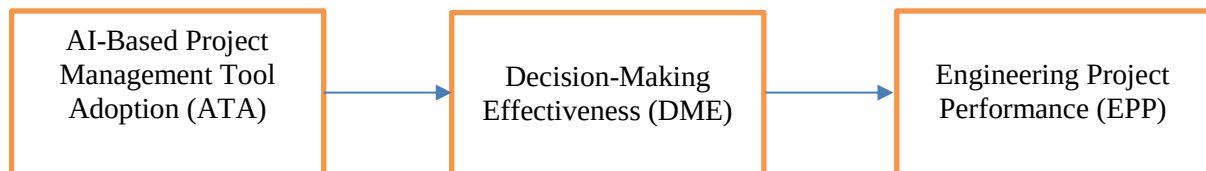


Figure 1: Conceptual framework

According to this framework, more AI tools are used, greater impact on project efficiency, cost control and quality management which ultimately lead to improved engineering EPP. It is assumed that independent variable in this research is AI-based PM tools usage, and performance dimensions mediate through project efficiency, cost control, and project quality. Overall performance of engineering projects is influenced by these dimensions' combination as dependent variable. Framework stresses that AI tools cannot just be utilized to automatize and make data-driven decisions, but also improve coordination, accuracy in planning, and resource optimization in engineering projects.

Efficiency may be characterized by planning, communication, and automation of tasks. Cost control is more reflective of better estimation, real time monitoring and correction of cost overruns. Project quality implies improved decision making, risk management and quality of outputs. Three dimensions can be combined to develop a comprehensive evaluation of AI-driven project success. Figure 1 demonstrates interrelation conceptual framework between ATA and EPP. It shows that AI tools usage directly affects three key dimensions, including efficiency, cost management, and project quality, which, in turn, will lead to improved overall EPP. Figure highlights mediating role of three dimensions in transforming ATA into measurable project deliverables such as timely completion, cost compliance and quality enhancement of deliverables.

Hypotheses Development

H1: ATA has a significant positive effect on DME.

H2: DME has a significant positive effect on EPP.

H3: ATA has a significant positive effect on EPP.

H4: DME significantly mediates relationship between ATA and EPP.

Material and Methods

Study used a quantitative research approach to examine relationship between AI-based tools utilization in PM and EPP. Study design was a cross-sectional study in which information was collected at a particular time from engineering specialists in project-based set ups. Design was found appropriate as it would enable researchers to investigate relationship between variables without manipulating study settings.

Sample population comprised engineering professionals who worked in project settings. These were project managers and civil, mechanical, electrical and information technology engineers. These professionals were ones actively engaged in project planning, execution, and monitoring processes and hence were right respondents in study.

Study size was 150 respondents. Participants were selected based on a purposive sampling technique that met certain inclusion criteria. This method was used to make sure that only relevant and experienced people were used in research. Inclusion and exclusion criteria were as follows: participants should have worked on engineering projects, learnt about PM tools, and have basic familiarity with AI-based PM tools. This made data collected well informed, relevant and in line with research objectives.

Data Collection Method

Structured questionnaire was used to gather data. Questionnaire was self-administered and could be given online and in printed version depending on respondents' availability. Participants were asked to give their answers without any interference from researchers. Data collection process was carried out until 150 responses were obtained.

Study Variables

This study has explored relationships among several variables to understand how ATA can influence engineering projects' outcome. Study's independent variable was AI Tool Adoption, which is usage and integration degree of AI-based PM tools into project processes.

Three mediating variables were also included in study to gain more insight into mechanisms by which ATA is related to outcomes. Project Efficiency gains in terms of time management and productivity. Cost Control indicates how well budgets are managed and how much of project financial resources are wasted, whereas Project Quality indicates how project products are performed regarding specified quality standards and accuracy demands.

EPP was dependent variable of study, and it measured overall success and effectiveness of engineering projects. These variables were chosen through literature that currently exists, proposing that ATA influence on EPP is not direct but rather occurs through multiple operational dimensions, indicating a multi-path relationship.

Measurement Scale

Perceptions and responses of respondents were measured using a five-point Likert scale. Scale was between 1 (Strongly Disagree) to 5 (Strongly Agree). It was found that this scale was suitable to measure attitudes, opinions, and experiences in terms of AI-based PM tools.

Data Analysis Techniques

Data gathered were analyzed statistically. Demographic variables and distributions of variables were summarized by descriptive statistics. Correlation between variables was analyzed using Pearson correlation analysis. Effect of using AI tools on performance of engineering projects was calculated through multiple regression analysis. Moreover, mediation analysis was also considered to investigate indirect effects using efficiency, cost control and quality.

Reliability and Validity

Cronbach's Alpha was used to measure reliability of instrument with a value of 0.7 or higher accepted as being acceptable. Expert review was done to ensure content validity, that is, questionnaire items are relevant and clear. Construct validity was also considered to make sure that instrument had been able to measure targeted variables (Rabbani & Sarmad, 2019).

Results and Discussion

Demographic Analysis

Table 1
Demographic Profile

Variable	Category	Frequency	%
Age	Below 25	30	20%
	26–35	68	45.3%
	36–45	37	24.7%
	46 & above	15	10%
Gender	Male	105	70%
	Female	45	30%
Experience (years)	Less than 3	30	20%
	3–7	60	40%
	8–12	38	25.3%
	13+	22	14.7%
Role	Project Manager	45	30%
	Engineer	75	50%
	IT Professional	30	20%

Demographic findings show that most of respondents (45.3) are between ages of 26 and 35 years old, which implies a relatively young and dynamic engineering workforce. Most of respondents were male (70 percent), which is gender balance in engineering professions. Most respondents were moderately professionally exposed with 3-7 years of experience (40%). Biggest group (50 percent) were engineers, which guarantees good technical representation.

Table 2
Descriptive Statistics

Variable	Mean	Std. Dev.
ATA	3.81	0.61

DME	3.89	0.57
EPP	3.93	0.59

Mean values indicate that respondents generally perceived a high level of ATA, DME, and EPP. Highest mean score was observed for EPP ($M = 3.93$), indicating positive perceptions regarding project outcomes.

Table 3
Pearson Correlation Matrix

Variables	1	2	3
1. ATA	1		
2.DME	.69**	1	
3. EPP	.64**	.73**	1

Note. $p < .01$

Results demonstrate significant positive relationships among all study variables. ATA showed a strong positive correlation with DME ($r = .69$, $p < .01$) and EPP ($r = .64$, $p < .01$). DME was strongly associated with EPP ($r = .73$, $p < .01$).

Regression Analysis

Model 1

ATA → DME

Table 4
Model Summary

Model	R	R ²	Adjusted R ²	F	Sig.
1	.69	.48	.47	136.45	.000

ATA explained 48% of variance in DME.

Table 5
Regression Coefficients

Variables	B	T	Sig.
ATA	.69	11.68	.000

Results indicate that ATA significantly and positively predicts DME ($\beta = .69$, $p < .001$).

Model 2

ATA and DME → EPP

Table 6
Model Summary

R	R ²	Adjusted R ²	F	Sig.
.78	.61	.60	114.92	.000

Model explained 61% of variance in EPP.

Table 7
Regression Coefficients

Predictor	β	t	Sig.
ATA	.26	3.81	.000
DME	.56	8.12	.000

DME emerged as strongest predictor of EPP.

Mediation Analysis

(PROCESS Macro Model 4)

Table 8
Indirect Effect of ATA on EPP through DME

Effect	Boot SE	LLCI	ULCI
.39	.07	.26	.54

Indirect effect was significant because 95% bootstrap confidence interval did not include zero. Therefore, DME significantly mediates relationship between ATA and EPP.

Hypothesis Testing

Table 9
Summary of Hypothesis Testing Results

Hypothesis	Statement	Result
H1	ATA positively affects DME	Accepted
H2	DME positively affects EPP	Accepted
H3	ATA positively affects EPP	Accepted
H4	DME mediates relationship between ATA and EPP	Accepted

Each hypothesis is accepted, and it is already proved that AI-based PM tools have a great impact on performance of engineering projects through improvement in project efficiency, cost control, and quality.

These findings suggest that ATA positively affects EPP significantly. Greatest impacts are realized in quality and projects efficiency. Conceptual framework is supported by correlation and regression analyses, which prove theoretical expectations of study.

Discussion

Interpretation of Results

This research has shown that ATA can have a strong impact on engineering projects performance, which is positive (Piras et al., 2024; Savaş, 2025). Regression model showed that ATA is a significant predictor of EPP ($\beta = .28$, $p = 0.001$), which accounts for 58 percent variance ($R^2 = .58$). This proves that AI tools are relevant in improving results of engineering projects in terms of efficiency, cost management, and quality (Zaheer et al., 2025; Keshireddy, 2023).

Initial goal was to analyze ATA effects on EPP. Findings substantiated existence of a strong positive correlation, which implies that more AI tools are adopted, higher overall EPP (Elfirjani et al., 2025; Lumbanraja et al., 2024). Second aim was no correlation between ATA and project efficiency, cost control, and quality. Correlation outcomes revealed that there were strong positive correlations especially between ATA and project efficiency ($r = .62$), cost control ($r = .55$), and quality ($r = .60$) (Hossain et al., 2024; Sanusi et al., 2020). Third goal was a measure of effectiveness and regression scores proved that AI-based systems contribute to EPP significantly, with project quality ($\beta = +0.34$) being best predictor (Alhasan and Alawadhi, 2024; Reznikov, 2025). The centrality of decision quality observed here is consistent with findings from leadership research, where the manner in which decisions are made under pressure has been shown to shape downstream behavioural and performance outcomes, including counterproductive responses when psychological resources are depleted (Qayyum et al., 2020).

Comparison with Literature

Results of current research align with literature findings (Taboada et al., 2023; Adebayo et al., 2025). Close connection between ATA and project efficiency is in line with Hossain et al. (2024) who observed that AI enhances schedule accuracy and minimizes delays in engineering projects. Likewise, Rana (2025) also found that AI-based systems boost resource optimization, which corroborates current study regarding efficiency increase ($\beta = .30$).

Regarding cost control, findings are consistent with Zaheer et al. (2025), who have shown that AI predictive analytics can enhance budget estimation and decrease financial risks (Kausar & Qayyum, 2018; Shabeer et al., 2024). Another significant yet relatively smaller impact of AI on cost control (β

=.18) was also identified in current study, which shows that financial optimization benefits are present, but not so significant compared to efficiency and quality improvements (Sanusi et al., 2020; Shamim et al., 2025).

On project quality, results are in a strong agreement with Alhasan and Alawadhi (2024) who discovered that AI-based monitoring systems are linked to a lower number of errors and higher adherence to engineering standards. In present research, most significant predictor of performance was project quality ($\beta = .34$, $r = .73$), which proved to be highly important in project success (Elfirjani et al., 2025; Masih et al., 2026). Nevertheless, some researchers such as Al-Arafat et al. (2025) identified cost and resistance to change as some of barriers to implementation, which could lead to differences in rate of ATA in practice (Shah et al., 2025).

Implications

Theoretically, research can be justified by TAM because it proves that perceived usefulness of AI tools is an important factor that can influence their ATA and efficiency (Davis, TAM foundation; conceptually supported in Adebayo et al., 2025). It is also consistent with IDT, where findings show that AI technologies augment performance over time with organizational adoption growth and integration (Taboada et al., 2023).

In practice, results indicate that engineering companies need to focus on ATA to enhance performance results (Kozhakhmetova et al., 2024; Khan et al., 2025). Greatest AI influence on projects quality and efficiency suggests that companies gain more successful projects due to attention to these spheres (Rana, 2025; Ram et al., 2025). Also, employee competence level in AI tools should be improved through training programs implementation since AI tools successfully lead to project improvement results (Hossain et al., 2024; Daniel et al., 2025). Research indicates that AI use in quality assurance and scheduling systems can greatly contribute to engineering projects success (Wang, 2023; Choi et al., 2021).

Summary of Findings

This paper explored AI-powered PM tools implementation and their impact on performance of engineering projects through quantitative approach. Results of studies are consistent in showing that AI use can positively and substantially affect essential aspects of project success, such as efficiency, cost control, and quality.

Descriptive and inferential findings revealed that there are mostly positive perceptions of AI tools among engineering professionals. It was also identified using correlation analysis that there were strong correlations between ATA and EPP ($r = .68$), and with efficiency ($r = .62$), cost control ($r = .55$), and quality ($r = .60$). Out of these, strongest relationship was observed between project quality and overall performance ($r = .73$), which shows its central position in project success determination.

These results were further reinforced using regression analysis, which was used to explain 58% of variance in EPP ($R^2 = .58$). Each predictor was significant, with project quality being most significant ($\beta = .34$), then efficiency ($\beta = .30$), and cost control ($\beta = .18$). This means that AI-based tools have greatest impact on enhancing quality standards and operational efficiency, as well as aid in financial control and budgeting operations.

Hypothesis test proved that all hypotheses proposed were accepted and supported notion that ATA has a positive influence on engineering projects' outcomes. These findings coincide with current literature, which has repeatedly emphasized AI importance in enhancing planning accuracy, resources optimization, and decision-making in complex engineering systems (Aurangzeb & Uddin, 2025).

Conclusion

This study examined ATA effect on EPP and investigated DME mediating role. Findings revealed that AI-based PM tools significantly enhance DME among engineering professionals and

contribute directly to improved EPP. Results further demonstrated that DME serves as an important mechanism through which ATA influences engineering project outcomes. Organizations that effectively integrate AI technologies into PM processes are better positioned to make timely, accurate, and data-driven decisions, resulting in improved project execution and overall performance. Study provides empirical evidence supporting TAM and IDT application in explaining ATA within engineering project environments. Overall, findings suggest that AI-enabled PM tools are becoming strategic resources that enhance managerial capabilities and support engineering projects successful delivery in increasingly complex and dynamic environments (Shah et al., 2025).

Recommendations

Based on findings, engineering organizations should promote ATA to improve EPP and decision-making quality. Organizations should invest in training and capacity-building programs to enhance employees' ability to effectively utilize AI-driven systems and interpret AI-generated insights. Project managers should integrate AI tools into planning, monitoring, scheduling, risk assessment, and resource allocation processes to support evidence-based decision-making. Senior management should establish supportive policies, technological infrastructure, and data governance mechanisms that facilitate successful AI implementation. Furthermore, organizations should encourage a culture of innovation and continuous learning to maximize AI technologies benefits (Mir et al., 2021). Future researchers are encouraged to examine additional mediating and moderating variables, such as organizational support, digital competence, and project complexity, to further understand the relationship between ATA and EPP across different industrial contexts (Urooj et al., 2025).

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