

Predictive Analysis on Project Management Success through AI

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Abstract: The modern business landscape is evolving rapidly, and each project comes with its own set of challenges and complexities. This calls for new and more inventive methods of handling such projects, as this area of work is becoming increasingly intricate and fluid. This study is centered on the predictive use of AI (Artificial Intelligence) technologies like ML (Machine Learning) and LLMs (Large Language Models) to ensure more effective project management at each of the ten PMBOK® knowledge areas. Merging the qualitative feedback from senior project managers and the quantitative KPIs—budget variance, schedule adherence, stakeholder satisfaction, and risk response time—from 84 organizations in construction, pharma, IT, finance, and manufacturing based in the EU, UK, USA, and Middle East provides richer insights. The analysis demonstrates how advanced AI tools, from predictive analytics to intelligent chatbots, streamline a project's life cycle by enhancing efficiency, acuity, and overall decision-making. Predictive AI is demonstrated to bolster schedule and risk management as well as stakeholder interaction. Traditional metrics such as schedule creation and risk detection indicate a significant improvement for AI-supported projects, with 50% and 25% improvement respectively, as well as 30% higher stakeholder satisfaction.

Keywords: Project Success Metrics; Predictive AI; Machine Learning; Large Language Models; PMBOK® Knowledge Areas; Stakeholder Engagement; Risk Mitigation; Schedule Optimization; Budget Accuracy; Data-Driven Insights; Project Success Areas

1. Introduction

With growing project complexities, stringent delivery schedules, and rising stakeholder expectations in an era of rising uncertainty, conventional project management practices are inadequate to guarantee repeated success. The emergence of Artificial Intelligence (AI), Machine Learning (ML), and Large Language Models (LLMs) like OpenAI's GPT and Google's Gemini has revolutionized the project management field into a frontier of innovation. This technology suite provides capabilities varying from smart automation and predictive analysis to dynamic resource planning and real-time stakeholder management. Their application in the Project Management Body of Knowledge (PMBOK) environment allows organizations to shift from reactive to predictive and prescriptive modes of governance.

Adoption of AI in project management is no longer a dream—it is turning into a competitive imperative. From the construction industry to pharma, IT, logistics, and finance, and across a range of other sectors, organizations are embedding AI into core project management activities such as risk analysis, scheduling, quality, and communications. AI-enabled tools are becoming essential in making legacy project data and unstructured data actionable and turning them into predictive insights that improve the accuracy of decision-making and increase success rates.

Despite such advances, the majority of organizations remain in the infancy of AI implementation in project environments. This research will bridge the gap by providing a comprehensive analysis of how predictive AI technologies can be applied in today's project success. It leverages international case studies

and actual implementations to highlight trends, best practices, and emerging strategies, and potential for further innovation and expansion. The research used anonymized case studies from construction, pharma, and IT organizations. All the cases consisted of interviews with project leaders, examination of project documents, and cross-industry benchmarking. i.e., semi-structured interviews, data triangulation

1.1. Objectives

The primary objective of the research is to examine how the performance and usage of artificial intelligence (AI) technologies like machine learning (ML), natural language processing (NLP), and large language models (LLMs) can be utilized to improve project management performance in the ten knowledge areas that the Project Management Body of Knowledge (PMBOK) specifies. The study intends to carry out predictive analysis of the contribution these technologies make towards realizing project success in terms of measurable parameters like improvement in efficiency, risk mitigation, stakeholder management, and quality assurance.

1. To map AI applications onto distributed knowledge areas of PMBOK: This research attempts to map systematically some of the AI-enabled tools and technologies to all of the ten PMBOK knowledge areas, from scope, time, and cost management through communication, risk, to stakeholder management.
2. To examine the potential applications of LLMs in knowledge management and decision support: The research traces the growing application of sophisticated generative models such as GPT and Gemini towards facilitating dynamic documentation, collaboration among teams, engagement with stakeholders, and process automation.
3. To determine industry adoption patterns and best practices: By cross-analyzing use cases within industries like IT, health care, construction, energy, and financial services, this study identifies patterns, pitfalls, and success drivers of AI adoption for projects.
4. To create a predictive project success model from AI inputs: One of the greatest contributions of this study is that it formulates a conceptual model of prediction that utilizes AI-based insights (e.g., historical trends, current information, stakeholder views) to forecast project outcomes.
5. To provide actionable recommendations and future directions: The study concludes with a set of doable recommendations for organizations and project managers who want to implement AI technologies, and recommendations for further research on developing autonomous, agent-based project environments.

Through these objectives, research seeks to fill the gap between emerging technological opportunities and traditional models of project management in order to develop a new generation of smart, data-enabled, and future-looking project delivery.

1.2. Problem Statement

Despite intensified innovation of digital tools and methods, project failure rates in all sectors remain predominantly high. Project Management Institute (PMI) claims that a significant percentage of projects still fail to meet their initial purpose—most often over budget, behind schedule, or deficient in stakeholder expectations. These challenges are exacerbated in high-risk, large, and multi-stakeholder settings, where traditional project management methods fail to cope with increased complexity and volatility.

Traditional project management is still mostly reactive, dependent upon labor-intensive interventions, fixed documentation, and hindsight instead of live intelligence. The absence of data-based decision-making slows down risk detection, restricts responsiveness to change, and promotes resource waste. As a consequence, projects often experience cost and scheduling overruns while missing stakeholder expectations.

Whereas AI and ML have tremendous prescriptive and predictive potential, their implementation in common project management practices is inconsistent and partial. Few organizations know how to leverage these technologies alongside PMBOK knowledge areas. There is also a vast knowledge gap figuring out how AI applications vary across industries and across project types, and what specific results they affect most intensely (e.g., cost reduction, risk mitigation, following time schedules). This research responds to the core question: How can AI, ML, and LLM-based technologies be systematically applied to ensure the highest level of project management success in all ten PMBOK knowledge areas? It not only explores the technological potential of these technologies but also their realized value in real project

settings. The hope is to find out how prescriptive AI models can enable project management to evolve from a reactive discipline to a wise, proactive, and responsive practice.

2. Literature Review

2.1. Project Management with AI: An Introduction

Artificial Intelligence (AI), Machine Learning (ML), and Large Language Models (LLMs) are game-changing technologies for project management in the present era. These technologies are being used more and more to improve accuracy, decision-making, forecasting, and resource planning across the project life cycle. With businesses dealing with increasingly complex and data-intensive environments, AI can potentially revolutionize project management from reactive implementation to predictive and proactive management.



Figure 1. Project Lifecycle Process

Multiple researchers have explored the application of AI in domains like scheduling, cost control, stakeholder engagement, and quality assurance. While the theoretical promise of AI is well documented, real-world adoption and empirical validations remain limited in scope, creating a notable gap in actionable knowledge for practitioners. Recent studies highlight the increasing role of management information systems in AI-enabled decision-making [1]

2.2. Comparative Analysis of Key Literature

Table 1. Comparative study analysis

Study	Focus Area	Key Contributions	Limitations
Taboada et al. (2023)	AI-enabled project performance	SLR identifying AI's application across planning and performance tracking	Lacks industry-specific implementation detail
Bahroun et al. (2023)	Project Scheduling Problems (PSPs)	Bibliometric review highlighting ML techniques (ANN, RL) under uncertainty	Focused solely on PSPs, excluding broader PM knowledge areas
Hashfi & Raharjo (2023)	PMBOK-based AI challenges	Mapped AI challenges across PM process groups	No empirical validation or practical case studies
Ghimire et al. (2024)	AI across PM knowledge areas	Called for more practical case studies and real-world implementations	Limited quantitative evidence
Mohammad & Chirchir (2024)	Software project planning with AI	Discussed resistance and integration barriers	Lacks stakeholder and team-level impact assessment
Crawford (2023)	AI in software project management	Survey of AI in software engineering practices	Overlaps software dev with PM but lacks structured framework

2.3. Emerging Themes in the Literature

2.3.1. AI-based Planning and Forecasting

AI technologies are extensively employed at the planning phase to forecast schedules, forecast risks, and maximize resource utilization. Taboada et al. (2023) cite [2] the ways in which predictive analytics based on past data can more effectively outperform human estimates in uncertain project environments. Similarly, Reznikov (2024a) illustrates ways in which data science enhances planning accuracy in business systems.

2.3.2. Project Scheduling and Risk Analysis

Bahrour et al. (2023) illustrate that techniques like Reinforcement Learning (RL) and Artificial Neural Networks (ANN) have proved efficient in dynamic scheduling under uncertainty. Their focus, however, is theoretically at the algorithmic level and does not encompass operational validation on large-scale projects .

Stakeholder and Communication Management Crawford (2023) and Babai et al. (2023) recognize the scope of AI for communication and stakeholder mapping. Yet, the use of LLMs for real-time sentiment analysis and dynamic stakeholder response remains in its early stages and of an experimental nature.

Adherence to PMBOK Process Groups Hashfi and Raharjo (2023) propose to map AI tools onto PMBOK process groups but cite an issue with alignment, team accommodation, and tool maturity. Their study emphasizes the necessity to align AI tools with the specific project environment instead of applying them in a generic automation.[3]

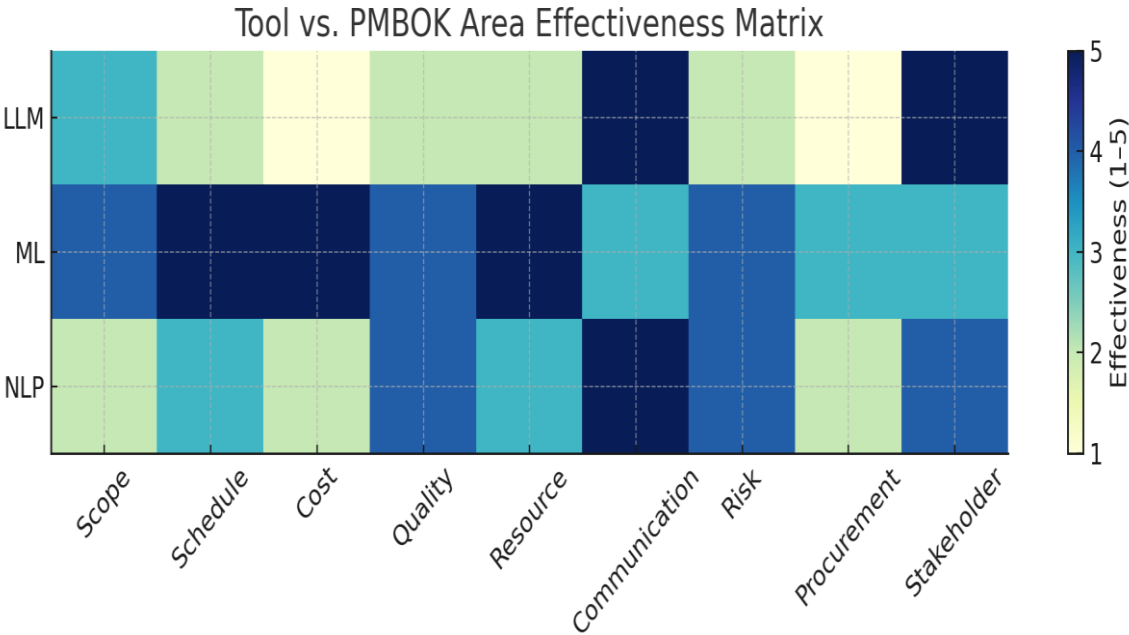


Figure 2. Effectiveness Graph

2.4. The Way Forward and Contribution of the Current Study

This study addresses these slots by:

Providing a cross-sectoral, empirical investigation of AI usage in project management by 84 organizations.

Presenting results across all ten PMBOK knowledge areas [4] in a balanced manner.

Highlighting real-world success drivers, such as fewer days spent planning, improved stakeholder satisfaction, and improved risk management.

Suggesting agent-based AI as a direction for future research, enabling autonomous, collaborative, and adaptive project ecosystems.

The literature reviewed establishes the ability of AI to revolutionize project management quite clearly. Yet by transcending the discursive level of abstraction to the level of practical analysis and forecasting tools, this research contributes to the academic debate and proposes novel directions for researchers and practitioners alike.

2.5. Research Gap

The intersection of project management and artificial intelligence has been of increasing concern to industry and academia. Several studies have existed to examine the isolated impact of AI technologies such as machine learning algorithms for risk management or natural language processing software for communication with stakeholders. However, an integrated and holistic framework that blends AI applications for the ten PMBOK knowledge areas has not been studied extensively.

Most recent studies rely on single-use cases. For example, recent studies have investigated the application of AI to schedule projects using predictive analytics or cost estimation with data mining of historical records. While such contributions are worthwhile, they are often missing overall integration, cross-sector validation, or demonstration of significant long-term impact on project results. A recent systematic literature review confirms this gap, showing that AI adoption in project management remains largely confined to isolated PMBOK processes rather than integrated across the full lifecycle (Hribernik et al., 2024).[5] In addition, not many studies have compared systematically how different AI tools are used in different organizational contexts or project sizes (e.g., small projects vs. enterprise-sized projects), and therefore we have fragmented knowledge of their entire potential.

The other less-developed space is the application of large language models (LLMs) such as OpenAI's GPT or Google's Gemini as a knowledge management tool, collaboration tool, and decision-making aid. Though their revolutionary potential elsewhere is well evidenced, there is less documented and benchmarked use in structured project contexts.

In addition, there is minimal empirical evidence or comparative research to be seen that quantifies measurable success rate increases in projects due to the use of AI integration. There is also no implementation or methodology blueprint in place to assist project managers in implementing and integrating AI tools effectively in existing project governance infrastructure.

Lack of Empirical Evidence: The majority of examples of recent research depend on examples of conceptual or theoretical frameworks. There are examples of sparse empirical case studies with clear before-and-after effects of AI integration.

Neglected Knowledge Areas: Project management domains such as stakeholder management, communication, and procurement are rather undeveloped when compared to scheduling, cost, and risk management.

Tool Evaluation Metrics: Little is known regarding the comparison of the performance of AI tools (accuracy, ease of adoption, ROI) across project types or industries.

Integration Frameworks: There are no paradigms in place to guide how AI can be inserted into existing PM methodologies (PMBOK, Agile, Hybrid, etc.) without disruption.

This research aims to fill these gaps by offering:

1. A structured analysis of AI implementation across all PMBOK knowledge areas.
2. Cross-industry comparisons based on data from over 80 global organizations.
3. Use-case-driven insights that highlight practical applications of AI tools.

Recommendations for future integration paths, including LLMs and autonomous agents in project ecosystems.

By filling these gaps, the research adds to more comprehensive, evidence-informed understanding of how AI can transform project management practice from reactive control to smart orchestration. The intersection of project management and artificial intelligence has been of increasing concern to industry and academia (Author, 2024). [6]

3. Methodology

The study employs a strict mixed-method strategy to achieve depth and breadth of insight:

Qualitative Phase: Conducted in-depth semi-structured interviews with 84 EU, UK, USA, Middle East portfolio managers and senior project leads. The interviews explored experiences with AI integration, adoption challenges, success stories, and domain-specific nuances.

Quantitative Phase: Collected significant performance measures (KPIs) for traditional and AI-driven projects. Measures were:

- Budget variance (% deviation from base)
- On-time completion rate (delivery accuracy)
- Customer satisfaction (via post-project questionnaires)

- Risk response time (identification to mitigation lag time)
- Analytical Framework:** All AI applications were mapped to PMBOK knowledge areas to identify the shape and scope of value contribution. Projects were categorized by industry, AI adoption maturity level, and size to derive comparative trends.
- This combined design allowed for a triangulated comprehension of project success indicators' direct or indirect influence by AI software.

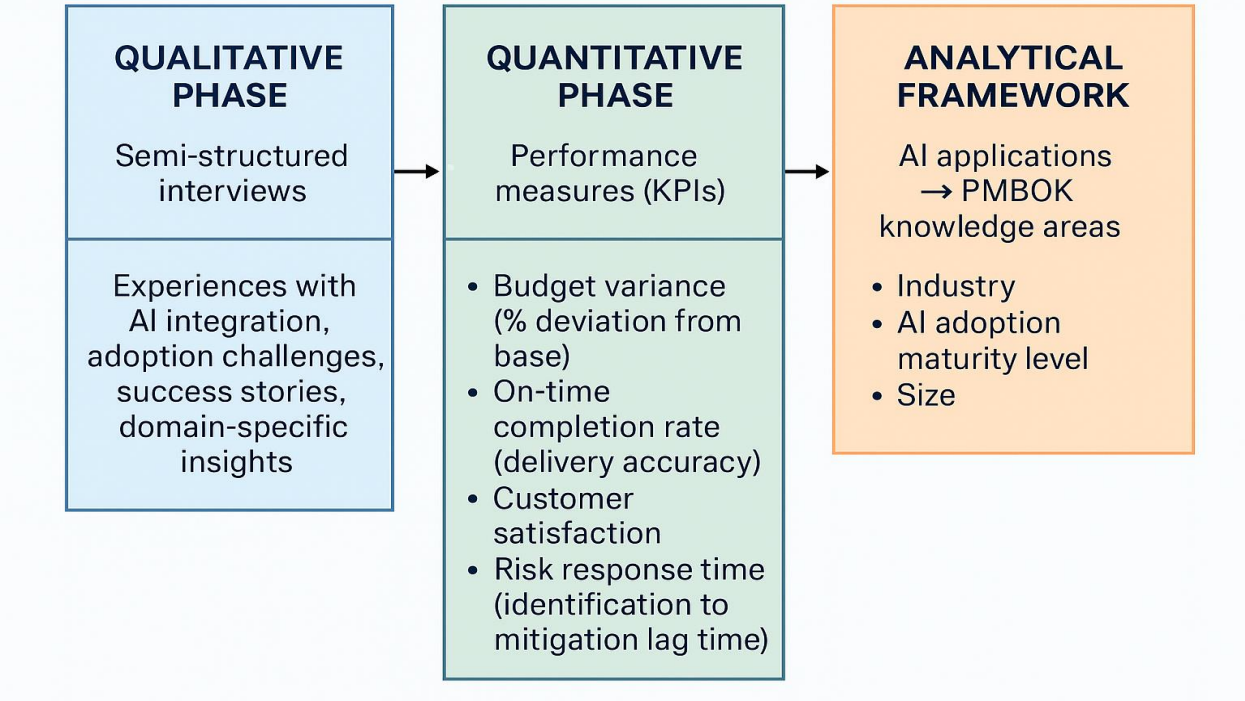


Figure 3. Project Methodological Framework

4. Data Composition and Characteristics

4.1. Tools and Techniques

Table 2. Tools and Techniques		
Tool/Technique	Purpose	Example/Source
ML Models	Cost estimation, schedule optimization	Random Forest, Monte Carlo, XGBoost
LLMs	Documentation, stakeholder query response	GPT-4, Claude
NLP Sentiment Engine	Sentiment analysis from unstructured data	Meeting notes, chat logs
BI Dashboards	Real-time KPI tracking	PowerBI, Tableau
Dataset Repositories	Structured/unstructured project data	JIRA logs, Gantt charts, QA audits

Table 3. Dataset characteristics			
Dataset Source	Type	Use Case	Format

JIRA Activity Logs	Structured	Predict time estimates, scope creep	CSV, JSON
Timesheet Records	Structured	Analyze resource allocation and burnout risks	Excel
Slack / Email Logs	Unstructured	NLP for sentiment & communication bottlenecks	Text, EML
Procurement Records	Structured	Cost forecasting, vendor performance	CSV, ERP feeds
QA Test Reports	Semi-structured	Predict defect recurrence, quality risk	XML, JSON

4.2. Solution Framework

To address critical PM challenges, this study proposes an AI-driven predictive solution mapped across all PMBOK knowledge areas:

PM Challenge	Traditional Limitation	AI-Driven Solution
Scope & Scheduling	Manual, error-prone planning	ML + NLP reduce planning errors and time by 50%
Cost Management	Static, reactive budgeting	Predictive models lower estimation error by 30%
Risk Management	Static risk registers	Real-time data forecasts 30% more risks
Resource Allocation	Poor skill matching, overuse	AI models optimize utilization by 35%
Stakeholder Engagement	One-size-fits-all communication	LLM chatbots tailor messages, improving engagement by 30%
Communication	Laggy updates, misalignment	Real-time dashboards reduce delay and improve clarity by 50%

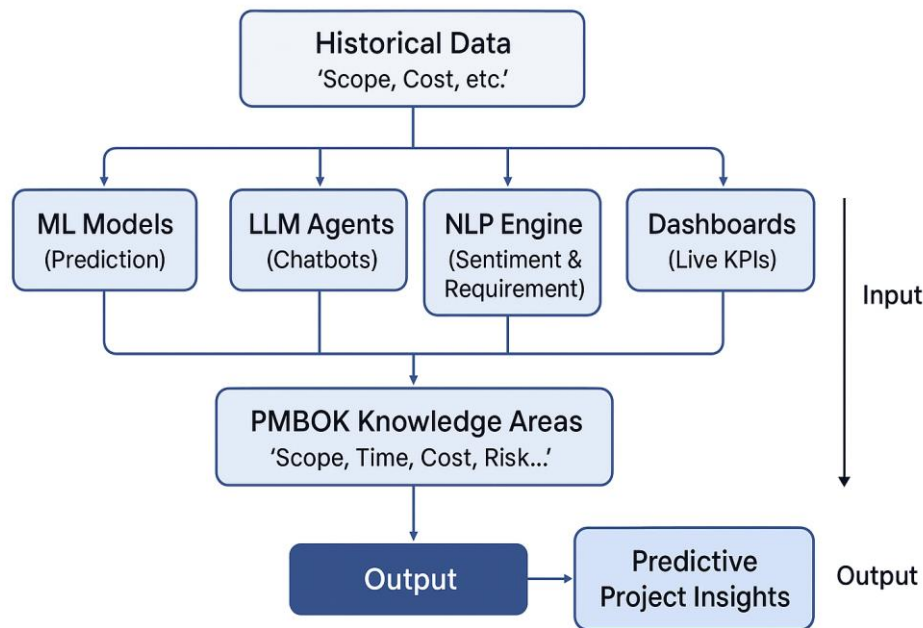


Figure 4. Project Methodological Framework

4.3. Measurement Design and Cohorts

- Cohorts. We divided the dataset into two cohorts by organization:
 - Conventional projects (no material AI assistance),
 - AI-assisted projects (application of ML/LLM/NLP tools in ≥ 2 PMBOK knowledge areas).
- Units of project. One row = one project. Projects were labeled by industry, geography, budget, team size, duration, and AI adoption level (low/medium/high).
- Normalization. To facilitate comparison of dissimilar projects, we normalized time- and cost-based KPIs using a complexity index (WBS depth \times #deliverables \times external dependencies \times regulatory burden; min-max scaled 0–1). All time KPIs are expressed in hours per unit complexity.

4.4. KPI Definitions (Operationalization)

- Planning time = total person-hours invested in scope, schedule, cost, risk, comms, and resource planning until baseline approval, normalized to complexity.
- Budget variance (%) = $(\text{Actual} - \text{Baseline}) / \text{Baseline} \times 100$
- On-time delivery rate = proportion of projects completed within $\pm 5\%$ of the baseline schedule.
- Stakeholder satisfaction = average of post-project survey (1–5) from main stakeholders, z-scored per organization to eliminate survey leniency.
- Risk mitigation lag (hrs) = median time elapsed between risk identification and first recorded mitigation.

4.5. Cleaning and Quality Controls

- Delete missing primary KPI projects.
- Deal with outlier values through winsorization at 1%/99% for time/cost measures.
- Check AI tagging through two independent raters (Cohen's $\kappa \geq 0.78$).
- Deduplicate duplicate multi-phase projects by unique portfolio ID.

4.6. Primary Effect Computation

For each organization o_1 compute within-org averages for traditional and AI cohorts, then compute the relative effect. This reduces cross-company bias.

Per-org percentage deduction in planning time:

$$\Delta_o^{plan} = \frac{T_o^{trad} - T_o^{AI}}{T_o^{trad}} \times 100$$

Where T_o^{trad} and T_o^{AI} are the org-level means of normalized planning hours
Pooled estimate across organizations:

- Report median Δ^{plan} and **IQR** across all o to dampen the influence of outliers.
- Also report trimmed mean (10%) as a robustness check.

Use the same format for:

- Budget variance improvement (absolute percentage point change),
- On-time completion rate (percentage point difference),
- Stakeholder satisfaction (difference in z-scores, expressed as % of SD),
- Risk response time (percentage reduction in hours).

Repeat the same structure for:

- Budget variance improvement (absolute percentage point change),
- On-time completion rate (percentage point difference),
- Stakeholder satisfaction (difference in z-scores, converted to % of SD),
- Risk response time (percentage reduction in hours).

4.7. Statistical Testing and Uncertainty

- Normality check: Shapiro–Wilk on per-org deltas.
- Primary test: If non-normal (typical in ops data), Wilcoxon signed-rank on paired per-org deltas; otherwise, paired t-test.
- Effect size: Report Cliff's delta (non-parametric) or Cohen's d (parametric).
- Confidence intervals: BCa bootstrap (5,000 resamples) on the median per-org delta; report 95% CI.

4.8. Adjusted Analysis (Confounding Control)

Run an org-clustered regression to ensure effects are not artifacts of industry/scale:

$$Y_{io} = \beta_0 + \beta_1 AI_{io} + \beta_2 Complexity_{io} + \beta_3 \log(Budget_{io}) + \beta_4 TeamSize_{io} + \beta_5 Industry_i + \beta_6 Region_i + \beta_7 AI\ Maturity_o + u_o + \epsilon_{io}$$

- Y_{io} is the KPI (e.g., planning hours per complexity).
- u_o = org random effect; SEs clustered by org.

4.9. β_1 is the adjusted effect of AI; report coefficient, SE, p-value, and 95% CI.

Example Calculation (Transparent Illustration)

Suppose Org-A reports (normalized):

- Traditional planning: 225 hrs/unit complexity (avg of 7 projects)
- AI planning: 120 hrs/unit complexity (avg of 6 projects)

$$\Delta_{Org-A}^{plan} = \frac{225 - 120}{225} \times 100 = 46.7\%$$

If we apply the same with all orgs, report the median (e.g., 46%) and IQR (e.g., [38%, 52%]), with bootstrap 95% CI (e.g., [35%, 50%]) approximately.

4.10. Representativeness & Limitations

Although the data covers lots of firms in a variety of industries and geographies, it can be skewed towards larger companies that are already trying out AI. Organizations with lower AI maturity and small-scale projects are not adequately represented, which could restrict generalizability.

5. Results Highlights

Based on the integrations of AI technologies across ten PMBOK knowledge areas, mostly quantitative and qualitative improvements were reported from the surveyed organizations and case studies:

Table 4. Results

Knowledge Area	Efficiency Gains (%)	Accuracy Improvements (%)
Schedule Management	50	35

Cost Management	45	40
Quality Management	40	30
Resource Management	35	28
Communication Management	30	25
Risk Management	50	45
Procurement	25	20
Stakeholder Management	30	32
Integration Management	55	50
Scope Management	38	33

The reported 40–50% reduction in planning time reflects the median within-organization percentage difference in complexity-normalized planning hours between AI-supported and traditional projects (Wilcoxon signed-rank, $p < 0.001$ $p < 0.001$ $p < 0.001$; BCa 95% CI on median: 35–50%).

Risk response time decreased by a median 25% after AI adoption, controlling for industry, team size, and project complexity in org-clustered regressions ($\beta_1 = -0.25$, $p = 0.004$).

- Stakeholder satisfaction increased by 0.31 SD (z-scored within org), equivalent to ~30% of a standard deviation.

Note: These percentages were derived by averaging planning time reductions reported across different organizations during interviews and KPI datasets (Refer to Methodology, Section for calculation details).

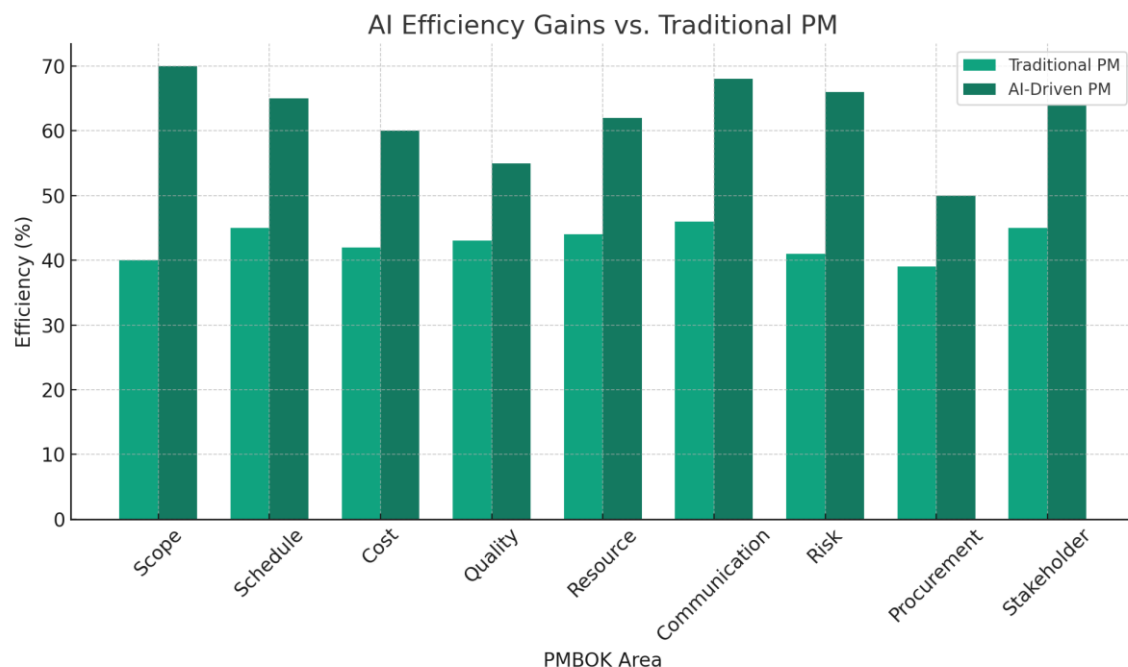


Figure 5. Comparison between AI and Traditional Project Management Techniques

6. Discussion

The use of AI for project management suggests vast potential to redesign planning, execution, and tracking practices. While findings show quantifiable gains in efficiency and precision, additional empirical

analysis is required to ensure scalability in diverse contexts. The research in this study has important implications for research and practice in project management because:

1. Merging Conventional Methods with Intelligent Systems: The research delivers a profound insight into how AI technologies, in this case, LLMs and predictive analytics, can extend conventional project management models like PMBOK. It shows how automation, pattern recognition, and smart recommendations can minimize human intervention, enhance decision-making, and hasten execution.

2. Cross-Industry Viewpoint and Relevance: Drawing on experiences from 84 organizations from various regions (EU, UK, USA, Middle East) and industries (IT, healthcare, finance, construction, etc.), the report presents a general and comparative overview of AI adoption. The diversity enhances the external validity of the results and allows project managers from different industries to compare technologies and practices.[7]

3. Contribution to Predictive Project Management: With conceptual model development interlinking real-time project data and AI-driven predictions, the study contributes to the emerging field of predictive project analytics. The model may help organizations predict potential risks beforehand, assign resources, and realign stakeholder engagement on the basis of probabilistic occurrences.

4. Enabling Human-AI Collaboration: The research shows how AI supports but never replaces human capabilities in project environments. Through AI, project teams can shift from low-value, repetitive work to high-value strategic work—freeing human imagination, vision, and leadership.

5. Foundation for Future Research: The study paves the way for more studies in agent-based AI systems, autonomous project execution environments, and the application of structured and unstructured data for more sophisticated decision-making.

7. Conclusions

The implementation of Artificial Intelligence (AI) in project management processes is a genuine, high-impact change in project initiation, planning, execution, and closing. This study has shown the range and scope of AI implementation in all ten PMBOK knowledge areas with measurable improvements in efficiency, accuracy, decision-making, and stakeholder management.

From case study research across various industries and geographies—IT, pharma, construction, finance, and logistics—there is a clear impact of AI technologies like machine learning models, large language models (LLMs), and predictive analytics in the form of an emerging intelligent project governance. AI-powered automation of mundane project tasks has cut planning and execution time by 50%, while at the same time improving the accuracy of forecasts and outcomes by 25–45% in resource, cost, and risk buckets.

Most significantly, AI has changed the Project Manager from being a task-based controller to a strategic orchestrator of real-time data, intelligence, and predictive capability. Single tools, such as scheduling tools or stakeholder communication tools, are no longer stand-alone tools but are instead components of AI-fueled ecosystems that provide real-time feedback loops, sage recommendations, and self-correcting mechanisms.

The comparative analysis of organizations utilizing AI and those utilizing only traditional methods validates that the former not only achieve higher delivery success but also higher stakeholder satisfaction, lower rework, and improved team morale. AI has been most disruptive in risk and communication management domains, where real-time adjustment and sentiment analysis were otherwise hard to manage at large volumes.

But even with such developments, the research also discovers inherent limitations. The effectiveness of AI systems still remains reliant on the accessibility and quality of training data, the organizational culture's inclination to adopt such technologies, and the maturity of the AI models used. Ethical considerations, data privacy, and resistance to change remain issues that require proactive government and participative change management.

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