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The impact of using artificial intelligence (AI) tools on achieving construction project management goals in construction companies in Riyadh, KSA

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ABSTRACT:

This study explores how AI tools solutions are being gradually introduced into project management within the construction sector in Riyadh, Saudi Arabia. As businesses are under increasing pressure to meet shorter delivery times, cost control, quality preservation, and better communication with stakeholders, there is already a tendency to embrace new technologies. Saudi Vision 2030 even stimulated this trend by paying more attention to the function of modernization and digital transformation, in particular, infrastructure-based sectors.

The research focuses on how certain artificial intelligence tools, contribute to improving core project objectives. These include staying on schedule, keeping expenses within planned limits, ensuring the quality of work, and enhancing communication with parties involved. The methodology involved collecting input from (149) individuals working in the construction field—ranging from engineers to project leaders—using a structured questionnaire. Statistical evaluation was carried out using SPSS to identify links between the use of these tools and the effectiveness of project outcomes. While better monitoring of progress, earlier detection of risk, and coordination with the stakeholders have been observed, challenges remained, nonetheless. Resistance to change, inexperience with the computer, and compatibility with currently implemented systems were also among the significant challenges that were present. In summary, the research concludes that, to the extent that there is promise in computer research, more widespread use will only follow with planning strategies as well as the elimination of current limitations.

CHAPTER ONE: INTRODUCTION

1.1. Introduction:

The construction sector lies at the heart of economic development, but still struggles with issues like cost overruns, schedule slippage, and inconsistencies in quality, while in Riyadh, these are amplified by the scope and speed of the ongoing Vision 2030 mega projects. Classic project management techniques are no longer adequate to cope with the intricacy of contemporary construction projects, while AI tools, through the possibility of analysing vast datasets, automating processes, and providing predictive insights, create new prospects of broadening the scope of project management practices. So, this research examines the infusion of AI tools into the field of project management, concentrating on their influence in the achievement of project cost, time, quality, and stakeholder objectives in the construction industry of Riyadh keeping things on track with project time, cost, and quality, and therefore requires strong project management. In cities like Riyadh, where growth is fast and Vision 2030 is pushing for major changes, companies are under pressure to deliver better results (Hashfi & Raharjo, 2023). This has led many firms to start using modern tools to deal with common problems like delays and going over budget. Traditional methods alone are no longer enough. Managers need systems that help them make quicker decisions and adjust plans as work moves forward. One option that's getting more attention is artificial intelligence (AI), which may help enhance how projects are handled in the construction field.

Finally, in bringing the deployment of AI tools to the practice of project performance, there needs to be investment in technology with equally organizational readiness. That requires the upskilling of the project workforce, the streamlining of workflows, and the involvement of leadership in the digitalization strategy. Where in Riyadh's construction sector fast growth and great pressure to innovate coexist, organizations must marry technological advances to organizational and cultural maturity. The focus of the research, therefore, is not only on the technical impact of the implementation of AI tools on project performance but also on how it can complement performance to meet strategic targets. With a focus on construction companies located in Riyadh, the research attempts to generate practical knowledge to inform policy, guide implementation, and eventually contribute to the success of the nation's overall developmental agenda (Baduge.et.al, 2022).

1.2. Research Problem Statement:

Construction projects in Saudi Arabia are plagued by missed deadlines, cost overruns, and patchy quality. AI solutions are usually touted, but nobody knows if they are of any benefit. Fears are about possible disruptions of legacy infrastructure and expense. Construction projects are slow to adopt AI solutions, and project managers are looking for clearer guidance about their impact on calendars, budgets, and holding the consensus intact.

1.3. Research Variable:

Independent Variable: Utilization of AI Tools

Dependent Variable: Project management goal achievement, measured by:

- Cost Management (budget adherence, cost optimization).
- Time Management (schedule adherence, project delays).
- Quality Management (defect reduction, process improvement).
- Stakeholder Satisfaction (related to improved communication, reduced conflicts, related to improved decision-making).

Demographic variables:

(Age, Gender, Years of experience, Engineering Sector, Career level).

1.4. Research Virtual Model:

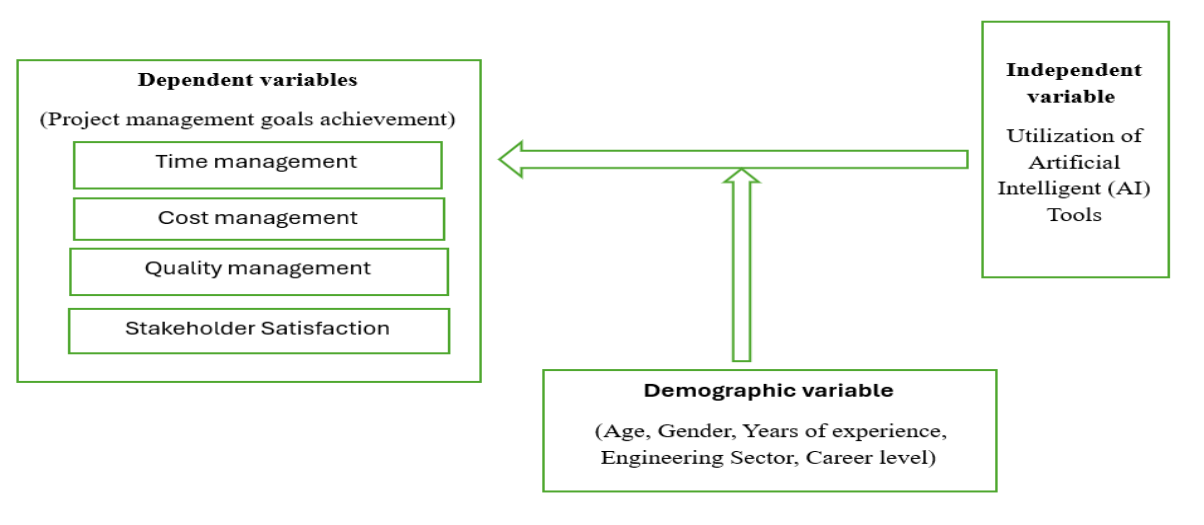

Figure 1: Virtual Model

1.5. Research Hypotheses:

• **Hypothesis 1 (H1):** Using AI tools enhances the effectiveness of time management, cost, and quality of construction projects in construction firms in Riyadh-KSA, enhancing conformity with the construction project schedule, limiting budget overrun and lowering defects and improving process for construction projects in Riyadh-KSA when compared to construction projects with no AI tools.

• **Hypothesis 2 (H2):** Artificial intelligence-based collaboration tools considerably enhance the inter-stakeholder communication within construction projects in Riyadh-KSA which reduces instances of miscommunication and improving decision-making.

1.6. Research Questions:

To answer the objective of the research, the following research questions are proposed:

• What are the approaches construction firms use to apply the life cycle concept to construction projects?

• How is construction information visualization perceived as enhancing the performance and efficiency of stakeholders involved in construction activities?

•To what extent does the utilization of AI tools help in attaining project management objectives with respect to time, budgetary control, and quality?

•What are the essential barriers (technological, financial, and organizational) for the adoption of construction project management with the help of AI tools, and how are they overcome?

1.7. Research Objectives:

Research objectives for the effect of the implementation of AI tools on reaching objectives for construction projects of construction firms in Riyadh are as follows:

•To assess the effectiveness of artificial intelligence-based tools for on time management in construction projects.

• To assess the association between artificial intelligence-based tools and construction project cost management practices.

•To investigate the applications of AI tools in enhance the level of quality management in construction sites.

•To examine the association between the use of AI tools and the effectiveness of project stakeholders' communication.

1.8. Research Importance:

Understanding the conceptual and practical implications of research on how the role of AI tools aids the achievement of project targets for construction projects is necessary for outlining the implications of research.

Theoretical Contribution

- The Evolution of Project Management Theory.
- Integration of Technology into Construction Projects.
- Testing Existing Theories.

Practical Contribution

- Enhanced Project Success.
- Cost Savings and Operational Efficiency.
- Risk Mitigation and Stakeholder Satisfaction.
- Strategic Decision-maker.
- Competitive Advantage.

1.9. Key Definitions:

- Artificial Intelligence (AI): The process of simulating the human thinking process by computers, particularly by computer systems.

- AI tools are a branch of the science of computers that is concerned with the construction of programs that can execute functions that would normally involve human intelligence. These tasks include reasoning, learning, visual perception, understanding natural language, interaction, and adaptation to complex environments. AI tools seek to create systems that can function autonomously or semi-autonomously, processing information and making decisions in a similar way to human intelligence (Negnvitsky, 2011).

Project objectives are specific, quantifiable outcomes that a project will deliver within a defined period. These objectives define desired results or accomplishments to be obtained through teamwork by the project team, sponsors, and stakeholders. Project objectives instill focus and direction into planning, executing, and monitoring activities within the project. They are typically associated with an organization's overarching strategic objectives and serve as metrics to evaluate project success or effectiveness after project execution. Project objectives include, among other aspects, reaching predetermined levels of quality or customer satisfaction, producing goods or services within time and cost, or implementing new processes or systems to help expand output. Also, delivering goods or services on schedule and within budget, or implementing new processes or systems to boost output.

CHAPTER TWO: LITERATURE REVIEW

The emergence of generative AI software and applications is also one of the historic points of the Exponential Age, which characterizes the era of great acceleration of technologies and changing organizational behaviors. The future of project management lies in greater flexibility, so they are changing agents and leaders into the use of AI tools in their processes (PMI, 2020). The transformation is broad-based by which AI, formerly a specialty technology, has gone mainstream and become an instrument used to transform industries, such as the practice of project management, manufacturing, and the arts (Manh, 2024).

The construction building sector, which previously held back from accepting digital innovations, now utilizes AI solutions as a means of enhancing construction productivity, saving construction wastage, and meeting construction schedule requirements (Alaloul et al., 2020). AI solutions, beyond automation, incorporate extensive databases of previous projects and real-time construction site conditions to optimize construction plans and site coordination. Construction managers are therefore in a better position to steer clear of construction issues, adapt construction schedules, and control construction risks (Al-reshidi et al., 2018).

AI technologies are also equally critical in the management of construction projects in the present-day construction industry, particularly when it comes to predictive analysis and schedule improvement. By analyzing historical data, AI algorithms can identify patterns which may not be recognized by human analysts, and can predict potential construction delays and suggest remedial actions (Zhang et al., 2013). In addition, AI-driven Building Information Modeling (BIM) technologies are capable of simulating construction sequences, and through this, they can identify potential construction conflicts even before they happen in the field (Davis, 1989).

Furthermore, AI technologies allow enhanced resource allocation by way of automated control of equipment, material, and manpower through real-time data. The combination of IoT sensor and drone technologies presents ongoing input of data, which AI can use to refine resource flows and manpower efficiency (Liu & Wang, 2021). Apart from enhancement of the effectiveness of projects, this also provides for the sustainability of the environment through the achievement of minimized wastage (Cao et al., 2021).

While the application of AI tools has its own set of advantages, its introduction into the management of construction projects occurs unevenly and with considerable regional differences. In the Saudi contexts, the traditional decision-making and the conventional management of projects are deterrents to the application of AI tools (Al-reshidi et al., 2018). Cost, and especially by small and medium-sized enterprises, presents an added challenge, since the installation cost of AI, in some instances, may be exorbitantly high (Pan & Zhang, 2021).

The global trend of digitalization and the scalability of cloud-based AI technologies also offer the construction industry a window of opportunity to adopt the technologies. Such strategies like Vision 2030 of Saudi Arabia aim to develop innovations and modernization and allow the access of AI tools to be competitive and meet the stakeholders' expectations .AI technologies also related to improve the cost, time, and achievement of quality in construction projects. The traditional "iron triangle" of the management of projects, which holds time, cost, and quality in equal balance, has been reconfigured by the AI capability of examining vast databases and establishing risks early in the lifetime of the project (Rogers et al., 2014). AI technologies are also able to provide predictive reporting of cost, which permits early budgeting and reducing the risks of overrun (Hashfi & Raharjo, 2023). Quality control technologies powered by AI are also able to perform automatic inspections, which identify abnormalities and verify the achievement of the design specification (Sacks et al., 2020).

Nonetheless, AI solutions successful implementation relies on varied organizational and contextual factors. Many construction organizations lack infrastructural support, digital literacy, and organizational adaptability in AI solutions implementation (Regona et al., 2022). Resistance to change, particularly in traditional markets, presents a challenging task to implementation (Kerzner, 2025).

For better stakeholder communication, AI technologies can facilitate collaboration from diverse stakeholders in a project. By facilitating the automation of the distribution of data and issuance of reports in real-time, AI-powered platforms are better equipped to facilitate transparency and responsibility (Abioye et al., 2021). Natural language processing (NLP) capabilities facilitate the analysis of unstructured communication data, through which misunderstandings are identified and may be corrected, and stakeholder relationships may be fortified (Fazli et al., 2020).

Nonetheless, AI communication solutions success relies on the organizational culture and the workforce preparedness. In areas such as Saudi Arabia, which comes under the domain of the hierarchical approach, AI communication success

involves considering the delicacy of culture and the digital literacy of the stakeholders (Regona et al., 2024).

AI technologies also facilitate better decision-making while managing projects through data-driven insights and automation. Predictive analytics and machine learning facilitate the project manager in analyzing the enormous databases, recognizing the patterns, and making the best decisions (Afzal et al., 2019). Software such as the Microsoft Project utilizes machine learning in revising the strategies of the projects, therefore, making the estimation of the time frame and the resource distribution even better (Auth et al., 2019).

While AI technologies hold much promise, various challenges need to be addressed first before they can be implemented in the construction sector (Regona et al., 2022). Cost concerns are key deterrents, particularly among small and medium-sized enterprises (Regona et al., 2022). In addition to hampering AI implementations, tech challenges such as aging infrastructure and inadequate data management also hinder (Omar et al., 2022).

Cultural resistance appears to be one of the major inhibitions to innovation. Execution of innovative technology may be hampered by the reality of the construction environment having traditional practices and hierarchical decision-making (Na et al., 2023). In reaction to job displacement fears, cultural inhibitions of this nature must be overcome by transparency in portraying the benefit of AI technologies and involving stakeholders through consultative processes (Bianco, 2021).

In sum, while there exists massive AI tool potential to revolutionize construction project management, successful integration requires surmounting financial, technological, and cultural challenges. The construction sector can actualize AI tool potential for enhanced stakeholder engagement and construction project performance through the development of an enabling digital transformation environment and theoretical frameworks of guidance toward implementation. Research and empirical investigation will continually feature in determining the performance of AI tools under different conditions of practice, especially in the rapidly changing sectors such as those in Saudi Arabia (Shoushtari.et.al, 2024).

The use of artificial intelligence technology in construction projects can be conceptually modeled using existing technology adoption models. Some of the relevant technology models used to interpret construction projects and AI tool applications include the Technology Acceptance, UTAUT, and Diffusion of Innovation. The importance of adopting these models in constructing a basis for understanding AI tool adoption includes the identification of critical factors

incorporated within the technology adoption process. Some of these factors include perceived usefulness and ease of use, social factors, and perceived compatibility. Based on these factors, the thesis is informed by the chosen theoretical perspectives.

Although there are many studies that have discussed the potential applications of artificial intelligence and BIM in the management of projects in the construction industry, many studies are descriptive in many ways. Although it was focused on the potential of technology, they do not critically discuss the challenges associated with adoption and the organizational issues that need to be addressed. There is also limited literature on the relationship between the use of artificial intelligence and the level of communication and the performance outcomes for projects in the construction industry in developing markets.

CHAPTER THREE: METHODOLOGY

3.1. Study Design:

This study aims to understand the use of artificial intelligence (AI) tools in improving project results within Saudi Arabian construction firms in Riyadh City. The research is grounded in a quantitative design, allowing for objective measurement of variables and statistics-guided data interpretation. The study uses both exploratory and confirmatory dimensions to achieve a holistic perception of the issue.

3.2. Research Methodology:

The research approach involves an exploratory and confirmatory aspect, which caters to the theoretical foundations and practical conditions uniquely applicable to the Riyadh construction industry. The quantitative approach, through the aspect of measurability and comparability of data, and the combination of the descriptive and analytical approach is used to grasp the state of AI tools' adoption in the different firms.

3.3. Research Instrument:

Pre-designed questionnaires are used to gather in-depth information from construction practitioners in Riyadh. The questionnaire has Likert-scale and closed-ended questions for standardized responses also it has been constructed from literature and pilot-tested questionnaires. Also, it will be relevant, easy to answer, and in accordance with the research objectives and will be piloted to test clarity and validity before large-scale administration. The standardized

questionnaire allows the gathering of data from various job levels and various firms.

3.4. Limitations of the Study:

Despite careful preparation, this study is not exempt from limitations that need to be taken into consideration. The most significant limitation is with self-reported data, which will be affected by social bias or individual perception of questions posed. The respondents will tend to overstate familiarity with AI tools or understate challenges to meet perceived mandates within sectors. Such issues can distort data gathered and render them less objective. Also, by being a cross-sectional study, causality is limited as responses are taken at one time, as compared to being gathered at a later point in time.

Another limitation is the sectoral and geographical scope of the study. Given that the study is confined to only those construction firms with headquarters at Riyadh, its findings may not be generalizable to other sectors and places within Saudi Arabia, let alone internationally. The quite modest sample size, though statistically significant, may not capture fully the diversity of perceptions and practices that exist within the sector. In a practical sense, such limitations are mitigated by purposive sampling of skilled professionals as well as by using designed instruments aimed at eliciting data reliability and richness to the maximum extent possible.

3.5. Data Collection Methods:

Both data collection methods of primary and secondary are incorporated within this research to develop an overall image of AI tools adoption within Saudi Arabia’s construction industry, specifically within Riyadh. Primary data are collected via structured questionnaires that are completed by professionals who are currently working within the industry. The questionnaires are distributed both physically and digitally to promote response rates and gain broad-based participation. The data obtained via such tools provides first-hand insights regarding current practices, challenges, and beliefs regarding AI tools implementation.

Data collection from secondary sources complements the primary data by providing contextual within theoretical premises. The latter encompasses rigorous peer-reviewed article reviews, whitepapers from all sectors of construction, case studies, reports of AI technology instruments deployed within project management in the construction sector.

They aid in determining the popularity of mainstream themes, informing the development of questionnaires, with in creating an analytical framework to unravel results. After combining the two data sets, the researcher can make evidence-informed decisions that are sustainable within a contextual foundation.

3.6. Reliability and Validity of the Research:

The researcher covers the principles of validity and reliability in the study to be comprehensive and significant. The test of validity requires the data to be relevant to the phenomenon or subject under examination and to what it was designed to measure. The study also consists of the hypotheses from qualitative research and upheld by illustrations and reliable settings.

The researchers' conclusion may not be generalizable to the whole of Saudi Arabia or the whole of any other industrial fields, but they may contribute greatly to the knowledge about the construction industry's AI tools adoption.

The research centers on the precision and the credibility of the AI tools of the construction companies in Riyadh, Saudi Arabia. The reliability of the test entails confidence in the shapes of the parallel forms, the internal uniformity, and the faithfulness. The Cronbach's alpha coefficient, which captures the steadiness and the permanence of the data, lies between 0.85 and 0.73 during the research. The population of concern are the decision-makers, the engineers, and the project managers who employ the AI tools in the construction companies.

3.7. Population and Sample Size:

Target Population: Project managers, engineers, and decision-makers, AI tools users in Riyadh’s construction firms.

Sampling Technique: Purposive sampling to ensure respondents have relevant AI tools experience.

Sample size: The sample size of (149) respondents was selected with consideration to statistical sufficiency along with practical feasibility. Because this research is quantitative and this research intends to generalize findings on construction firms around the city of Riyadh, those sample sizes were found to be appropriate to yield valid and reliable results. So, as per Krejcie and Morgan (1970) outline that in a population larger than (3,000), sample (150) respondents are statistically acceptable with (±5%)margin of error at (95%) confidence level. Furthermore, purposive sampling was adapted to ensure that those who were interviewed were professionals dealing with building projects and had hands-on experience with AI tools, technologies, or computerized project management

systems. The use of (149) respondents also took into consideration logistic constraints, such as time limitations, accessibility, and availability of capable responders who were willing to cooperate. The sample size thus draws a balance between statistical rigor and practical limitations of the field.

Data analysis: Statistical tools like SPSS and Excel analysis used.

3.8. Data Analysis

Collected data undergo statistical treatment utilizing computer programs such as SPSS and Microsoft Excel. The programs employed to clean data, code, and make descriptive and inferential statistics calculations. The descriptive statistics present us with data summaries such as frequencies, means, and standard deviations to inform us of general trends as well as characteristics of the respondent pool. The preliminary analysis paves the way for further advanced statistical procedures employed to test the hypotheses of the study.

3.9. Research Ethics:

The ethical aspects were maintained in the study. Voluntary participation in the study was encouraged, and the respondents were asked for their consent after which the data was collected. The personal details were not gathered, and the answers were kept anonymous. The study didn't enquire ethical committee review as it is both non-invasive and didn't enquire any personal information.

CHAPTER FOUR: DATA ANALYSIS AND RESULTS

4.1. Respondent Profile:

The sample surveyed comprised both males and females. More than half of the sample had more than three years of working experience, which indicated a mixed level of expertise among them. Discipline-wise, a higher percentage (34.2%) belonged to civil engineering, followed by mechanical engineering (28.9%), electrical engineering (22.8%), and architectural engineering (14.1%). In terms of organizational level, a higher percentage (32.2%) held entry-level positions, while (28.9%) held middle-level, (24.8%) senior, and (14.1%) executive-level positions.

4.2. Descriptive Results of AI Tools Utilization:

The embrace of AI applications in construction projects was considered in four functional areas, namely: (1) the integration of AI applications in construction project activities, (2) the use of AI applications in planning and scheduling, (3) AI-based monitoring and control, and finally, (4) the application of AI in construction project-related communication. Generally, the views of the respondents showed a level of acceptance of AI application integration in construction project activities.

4.3. Artificial intelligence tools in project Cost Management:

From the results, it is clear that the perceived attributes of the application relate to better cost management practices. However, the results regarding the tracking of the budget in a real-time fashion appear to be moderately below the desired expectations, implying that the application of AI in managing the budget may require a level of system integration.

4.4. Artificial intelligence tools in project Time Management:

In terms of time management, the respondents indicated they viewed AI-powered tools for project scheduling and planning as being more related to project timelines and the ability to meet project schedules. However, there existed differing viewpoints on how those tools impacted project delay times and project milestones being met on a consistent basis. This indicates that the project related outcomes related to time management can be affected by other variables.

4.5. Artificial intelligence in project Quality Management

Findings emerging under the quality management category show that the use of these AI tools is associated with quality practice, defect detection, and compliance checking. Even though the association is positive, the degree to which

support is offered through the use of these tools is also conditioned by the implementation context, which varies from one project to another.

4.6. Artificial intelligence in project Stakeholder Communication:

Regarding communication between stakeholders, the majority of the group was satisfied that AI-assisted platforms provide better, timelier, and more efficient communication between project stakeholders. AI-assisted tools are believed to eliminate miscommunications and enable more interactive and data-driven decision-making sessions.

4.7. Correlation Analysis:

Pearson correlation analysis is employed to investigate the relationship between the utilization of the AI tools and the four dimensions related to the project performance variables that include the management of costs, time management, quality management, and stakeholder communication. The findings suggest that a positive and statistically significant relationship exists between the utilization of the AI tools and the four dimensions related to the project management variables.

To add further strength to the validity of findings, correlation results can be considered in the context of the pattern of responses. The isomorphism between the levels of respondents' agreements and the nature of the Pearson Correlation values bears testimony to the fact that the patterns do not pertain to anomalies.

CHAPTER FIVE: DISCUSSION, CONCLUSION, AND RECOMMENDATIONS

Discussion

This paper explores the inter-relationships between the use of artificial intelligence tools and the construction project management performance measures: cost, time, quality, and communication. Discussion of findings is presented using Correlation Analysis and Descriptive Statistics, aligned to the nature of the data collected through the survey study.

The results provide evidence of positive and significant relationships between the use of AI tools and all performance measures taken. These results indicate that increased use of AI tools positively correlates with more positive perceptions of project management practices. But it should be noted that the results should not be taken as creating cause-and-effect relationships, since it is not the purpose of this research.

In the area of cost control, the results reveal a perceived correlation in the use of AI with higher accuracy in budgeting, better planning in the procurement process, and better allocation of resources. The outcomes match findings in existing bodies of knowledge in construction, demonstrating the contribution of data-driven solutions towards budget-related understanding and decision-making. However, in real-time budget control, the level of agreement among the respondents has been relatively lower.

From the efficacy perspective of time management, the application of AI had a positive correlation with the perceived usefulness of the system in terms of scheduling and early detection of timeline variances and proactive planning. However, the findings related to the delay reduction system had mixed results and revealed that despite the application of AI systems that help manage and predict delays, actual delays on the projects are actually driven by certain environmental factors such as obtaining approvals and supply chain management issues.

Regarding the quality of their project, the data shows a strong link between the use of AI and the perception of better quality-related processes, such as inspection aid services. Differences in the perceived benefits can vary based on the level of maturity of the use of AI, data, and consistency of tool use.

With regards to communication and stakeholder communication in particular, it was found that AI-based platforms correlate with more seamless and more effective communication and that AI tools help minimize instances of communication breakdowns in construction projects and other such projects where several parties might be involved.

Notwithstanding, the findings exhibited a level of positive outcomes in relation to the described patterns and results, hence building and strengthening the reliability of the findings on the constructs' stability. The findings display an implication that AI tools and successful adoption in construction management evoke a positive perception with respect to the management of construction projects. The findings have been validated through existing literature documents in construction and adoption of technologies.

Conclusion:

In particular, the impact of artificial intelligence tools on the performance of construction project management is assessed. The findings indicated that there is a significant relationship between the utilization of artificial intelligence tools and the critical parameters of construction project management, such as cost management, time management, quality, and communication with stakeholders. This finding is in line with the perceptions of the construction practitioners on the utilization of artificial intelligence tools.

It should, however, be noted that this research does not look to establish cause-and-effect, since it was carried out with data that was obtained from a cross-section questionnaire design. The implication, therefore, is that it draws attention to some key factors that highlight the relevance of AI systems, provided this adoption is carried out properly in this context, that is, within a construction context.

On a wider note, it appears that the present study has been able to add more information regarding the existing body of knowledge in the construction industry with regard to the adoption of AI with the aid of empirical evidence related to the relationship that exists between the use of AI as well as its impact related to construction project performance.

5.3. Recommendations:

1-Use of AI tools-Driven Scheduling Tools

Construction firms ought to adopt AI tools-powered schedule-related software to augment scheduling productivity, reduce delays, and make project timetables more streamlined with proactive identification of deviations.

2-Add AI-Augmented Cost Estimation Tools

It is advisable for these institutions to bring in software that utilizes artificial intelligence to enhance monetary control, make realistic budget estimates, and to mitigate the risk of overrun spending in construction work.

3-Infuse AI technologies and tools in Risk Management:

Alliance managers use AI tools to detect probable construction hazards in advance in order to provide for correction at an early point and enhance overall safety.

4-Utilize computer vision and drone technology:

Installation of AI-driven computer vision and drones should be complemented with real-time monitoring of the site, progress tracking, and safety inspections.

5-Applying Artificial Intelligence Tools and Technologies to Resource Allocation and Supply Chain Optimization:

It can be adopted to enhance the performance of supply chains and also in the allocation of resources, thereby optimizing the operations in each of the stages in the project delivery.

6-Enhance Stakeholder Communication Using AI-Powered Platforms:

Teams should make use of AI software and platforms to make collaboration better, reduce confusion, as well as ensure open documentation to all stakeholders in a project.

7-Develop Specialized Training Programs:

Professional development programs need to be implemented to enhance the skills of engineers and project managers in AI technologies and their application to construction project management's practical applications.

8-Leverage Artificial Intelligence for Predictive Maintenance:

Artificial intelligence technology should be utilized to carry out predictive maintenance of machinery and equipment, thereby cutting down downtime and extending the lifespan of assets.

9-Raise Awareness of AI tools Application for Construction:

Specific and seminars should be conducted to inform construction businesses about the worth and strategic value of applying AI tools.

10- Culminate with Research Institutions:

Such collaborations with Saudi universities and research centers should be promoted so that the establishment and indigenization of the AI tools solutions suited to the construction sector of Saudi Arabia may be achieved.

11-Synchronize AI Integration with Vision 2030 Goals:

Adoption of construction AI will have to harmonize with Saudi Vision 2030, sustainable construction, and smart construction practices.

12- Align AI Tool Adoption with Scale and Budget of Projects:

For maximum utilization of resources and further cost reduction, there should be schedules of utilization of the use of AI tools depending on size and cost of the project. In the Saudi Arabian manner of doing industry, projects can normally be classified in the following classifications:

• Smaller-scale projects (less than SAR 5 million) may take advantage of simple AI solutions like automated report systems and cloud calendar tools.

• Medium projects (SAR 5–50 million): Suitable for sophisticated applications, such as the use of predictive analytics in cost and risk factors and the creation of procurement systems with the assistance of AI tools for cost performance, the roles of AI tools in budgetary control and spending overrun areas cannot be emphasized enough.

• Large projects costing above SAR (50) million can utilize all AI tools and platforms to the maximum extent, such as drone-based tracking systems, computer vision for monitoring sites, and all-resource-utilizing systems to maximum efficiency.

By matching spending on AI tools to project scope, firms can boost scalability along with the rate of AI adoption. Subsequently, that implies technology adoption will always pay dividends, whether the project scope widens or narrows.

13-Install Certain AI Agents Discussed under Literature:

Construction enterprises are recommended to adopt found AI tools of this study-statistical data examination, machine learning capabilities, automated reporting systems, and artificial intelligence-powered monitoring platforms, due to their efficiency in fortifying project performance concerning costs, time, quality, and satisfaction of various stakeholders.

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