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Original Research Article

AI-Powered Oracle Primavera Cloud Solutions for Construction Performance Optimization in Saudi Mega Projects

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Abstract: Project control is among the processes that can be applied to the development pipeline of the mega projects in Saudi Arabia due to its capability to cope with project size, quick development cycles, global supply chain management, relationships with multiple stakeholders, and sustainability. In the current review paper, the focus will be made on examining how Oracle Primavera Cloud with artificial intelligence capabilities can increase efficiency when building mega projects in Saudi Arabia by combining information related to scheduling, costs, risks, resources, safety, and sustainability in a decision-making tool. Methodological approach that will be used to carry out literature review within the present study is a structured narrative literature review approach that will assist in identifying articles that focus on topics such as the role of artificial intelligence in construction management, cloud-based solutions in project controls, digital twins, predictive analytics techniques, and requirements of Saudi Arabia's Vision 2030 program between 2020 and 2025. Key findings obtained from the review of literature will provide information that can assist in developing a conceptual framework for AI-enabled Oracle Primavera Cloud application with respect to forecasting, risk analysis, scenario analysis, resources management, and executives' reporting dashboard in mega projects of Saudi Arabia. Benefits of applying artificial intelligence can include improvements in schedule efficiency, warning system accuracy, cost monitoring, claim preparation, safety management, procurement of materials, and governance processes.

Keywords: Artificial Intelligence, Oracle Primavera Cloud, Saudi Mega Projects, Construction Performance, Predictive Analytics, Project Controls, Vision 2030.

1. INTRODUCTION

As for the Saudi Vision 2030 initiative, construction has become an advanced instrument for achieving diversification of the economy, re-urbanization, tourism development, and industrialization. Some examples would be such programs as NEOM, Diriyah, Red Sea, Qiddiya, King Salman Park, as well as various initiatives of Riyadh development. Those projects had quite challenging goals to create integrated cities, smart districts, mobility facilities and sustainable infrastructure under tight deadlines. It means that project performance should not be reduced to completion of the work as compared to the initial schedule of activities. In order to succeed, it is necessary for project managers to maintain total control over time, cost, risks, safety, carbon footprint, interfaces, and contracts. At that point, the size and complexity of those programs have unveiled the inefficiency of traditional unconnected and obsolete processes of

planning and reporting, which are based on spreadsheets with many calculations. As per scientific articles regarding AI impact on construction, there is a possibility of improved forecasting, risk detection, allocation of resources and safety management through the use of such technologies as machine learning, computer vision, natural language processing, and optimization with reliable data (Abioye *et al*., 2021; Pan and Zhang, 2021; Rane, 2023). Such software solutions like Oracle Primavera Cloud integrate project planning, scheduling, resource allocation, risk management and portfolio management in a single cloud platform. The Oracle platform provides a way to connect with the analytics and intelligence services, gathering information from several sources, including Primavera, Unifier, Aconex, and other tools. Making decisions on the basis of thorough analyses of project issues will lead to better business results (Oracle, 2024a; Oracle, 2024b).

2. RESEARCH AIM AND OBJECTIVES

The main purpose of the current review is to assess how the Oracle Primavera Cloud system enhanced by artificial intelligence (AI) could contribute to maximizing the performance in mega construction projects in Saudi Arabia. In contrast to many other reviews that tend to follow the case study approach, the present literature review will be conducted independently from a case study because the scope of research questions is much broader than any technical and managerial concerns. Namely, it seeks to achieve several objectives: first, synthesize available information about the use of AI in construction project management; second, identify the current capacity of the Oracle Primavera Cloud system and its opportunities for optimization via predicting analytics, machine learning, and dashboards; third, specify important performance areas in the context of Saudi mega projects; fourth, develop a conceptual framework for the stakeholders working on such mega projects; and fifth, tackle the challenges and gaps.

3. METHODOLOGY

To align with the reference paper that focused on literature reviews, qualitative analysis, and thematic coding, a systematic review was conducted. It entailed conducting a literature review of materials found in scholarly and professional journals related to AI in construction, digital project controls, cloud-based collaboration, BIM, predictive analysis, risk management, and delivery of mega projects in Saudi Arabia between 2020 and 2025. Some of the search keywords included artificial intelligence for construction scheduling, predictive project control, Primavera Cloud, construction intelligence, digital twin technology, safety analytics, resource optimization, and Vision 2030 infrastructure project delivery. Selection criteria included relevance to construction management and mentioning either an application of AI in construction or digital project control and being published between 2020 and 2025. On the other hand, exclusion criteria involved publications that made generic references to AI or generic applications of project controls without mention of performance impact. Coding was done by using five themes during the process of evidence extraction including schedule and resource optimization, cost and risk forecasting, collaboration and governance, safety, and sustainability monitoring. Using these five themes, we were able to come up with both a theoretical framework and phased approach in adopting AI. The approach adopted for Primavera Cloud adoption is appropriate due to the nature of Primavera Cloud, where it is necessary to understand the technology in relation to organizational processes, data flow process, contracting relationships, and the construction environment in Saudi Arabia (Brunetti *et al*., 2020; Abioye *et al*., 2021).

4. Oracle Primavera Cloud as a Project Controls Platform

In order to get quality results out of artificial intelligence in the construction project performance, it would be helpful to have a reliable digital platform like Primavera Cloud. The reason for that lies in the fact that the main functions of Primavera are planning, scheduling, management of resources and risks. Collaboration provided by Primavera allows to plan a project together when both office and field staff share their schedules, tasks, resources and risks in one environment (Oracle, 2024a). Main advantages of this software concerning capital projects include its possibilities for performing work breakdown structure, critical path scheduling, resources planning, baseline planning, risk analysis and portfolio reporting. As soon as Oracle Primavera is integrated with Oracle Construction and Engineering Analytics, all collected information in Primavera can be accessed via Analytics to perform visualization and AI analysis (Oracle, 2024b). Oracle Construction and Engineering Analytics solution will be very handy for Saudi mega projects because there is a wide variety of activities and documents to manage using different software tools. Thus, cloud technology will help to save the time required for reporting, to use templates consistently and to create an official history of decisions made. Finally, the adoption of AI will give an opportunity to interpret project data to make predictions. In this regard, delayed activities, unusual progress analysis, zone-based productivity comparison, weather effect prediction, and risk analysis according to their probability and impact will come handy. Considering risk management features of Primavera Cloud described by Oracle, one can assess risks according to uncertain factors

related to costs and durations and weather can also influence on their evolution (Oracle, 2025). Thus, Oracle Primavera Cloud can serve as a nervous system of projects' performance supported by AI and governance.

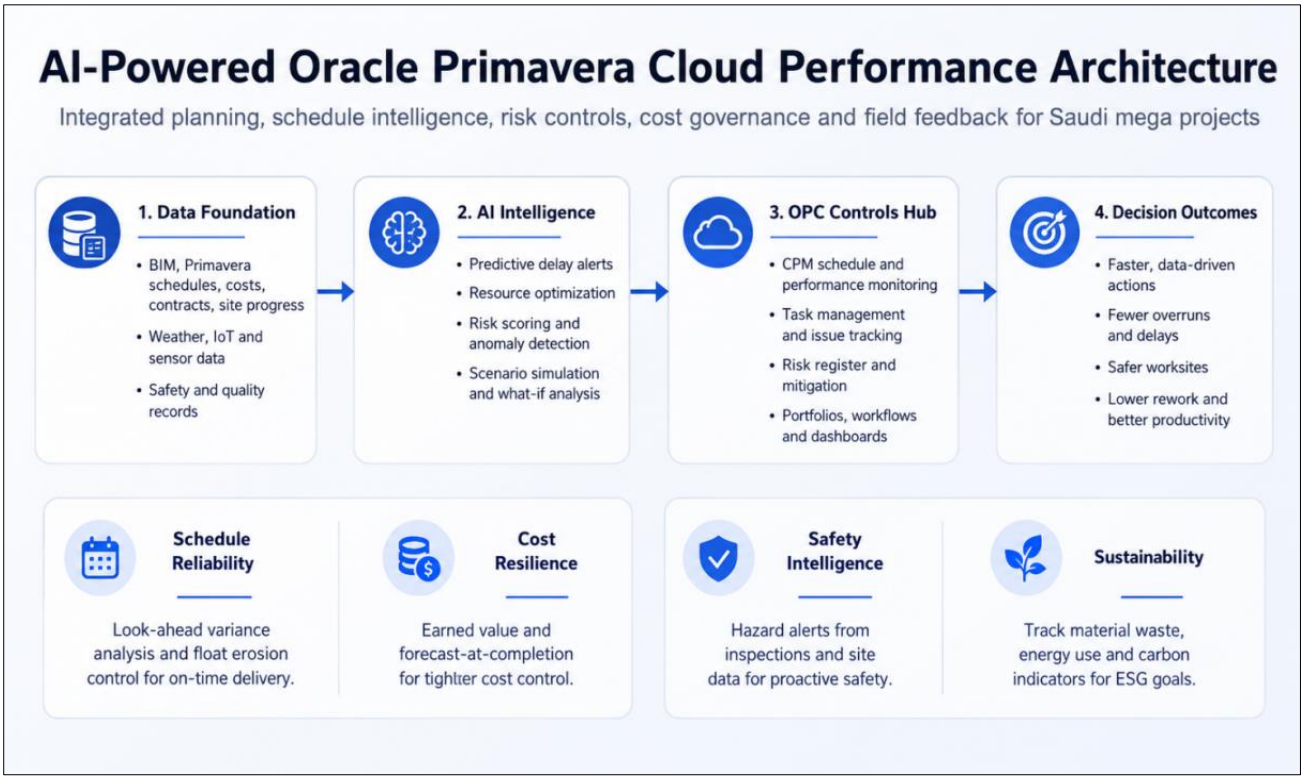

Figure 1: AI-powered Oracle Primavera Cloud performance architecture for Saudi mega projects

6. Performance Optimization Dimensions

Firstly, AI-based Primavera Cloud solutions have the opportunity to optimize the performance of mega projects in Saudi Arabia regarding several interconnected dimensions. Firstly, this refers to schedule reliability. Thanks to machine learning, differences between performance and baseline, productivity curves, and constraints can be used for timely estimating the loss of float. Secondly, cost control is also an important aspect. Integrating schedule performance data with cost and change management as well as procurement information will improve the ability to interpret earned value, make forecasts at completion, and identify the budget risks. Thirdly, resource productivity is another area where Primavera solutions can benefit from using algorithms to evaluate crew availability, equipment productivity, material supply, and workplace efficiency. Fourthly, AI can significantly improve risk management by allowing dynamic analyses of factors that impact the progress and, therefore, updating the rankings. Finally, the last important dimension is the safety and sustainability. By analyzing inspections through visual recognition technology, one will be able to spot unsafe practices, work packages producing significant waste, and carbon-intensive operations. These dimensions are related: accidents disrupt essential procedures, procurement problems raise costs, and inefficiency with material results in waste. In other words, optimizing performance needs comprehensive analyses of all the aspects rather than KPIs considered separately. In fact, one prediction is quite useful; however, the main contribution is in processing multiple weak signals.

Table 1: AI-powered Primavera Cloud performance optimization matrix

Performance area	AI-enabled OPC function	Saudi mega-project value	Indicative KPI
Schedule	Delay prediction, float erosion alerts, scenario simulation	Earlier recovery action across packages	Schedule performance index; critical path variance
Cost	Forecast-at-completion analytics and cost anomaly detection	Better budget visibility and change control	Cost performance index; estimate at completion variance
Risk	Dynamic risk scoring linked to activities and impacts	Prioritized mitigation before escalation	Risk closure time; high-risk activity count

Performance area	AI-enabled OPC function	Saudi mega-project value	Indicative KPI
Resources	Crew, plant and material optimization	Reduced idle time and improved productivity	Resource utilization; productivity variance
Safety and sustainability	Inspection analytics, waste indicators and environmental dashboards	Safer sites and reduced environmental footprint	TRIR; waste intensity; carbon intensity

7. Conceptual Framework

The suggested framework incorporates Oracle Primavera Cloud as the hub and the AI layer over the integrated project data. In the proposed model, first is the data layer consisting of baseline schedules, BIM quantities, cost estimate, procurement, contracts, submittals, risk register, weather data, site report, safety observation, and IoT signals. Then follows standardization through work breakdown structure, cost breakdown structure, location breakdown structure, and responsibility matrix. Next is the cloud integration layer whereby the Primavera Cloud integrates schedule, task, resource, and risk information while other systems provide documents, commercial, and field information. Fourth is the AI analytics layer including the use of AI to predict delays, detect cost anomalies, cluster risks, benchmark productivity, forecast material demands, and simulate scenarios. Fifth is the decision governance layer whereby dashboards, alerts, and recommendations are analysed by planners, project managers, commercial team, and executives. Last is the performance learning layer where results are incorporated back to models and organizational processes. The proposed framework represents the approach in the reference paper that evaluates AI implementation in mega construction not through technologies but through its benefits and challenges as well as strategies for implementation (Allouzi and Aljaafreh, 2024).

8. Implementation Strategy for Saudi Mega Projects

Implementation has to be phased as megaprojects cannot go immediately from traditional accounting practices to AI-enabled controls. First comes a readiness assessment where owners and program managers assess project schedule maturity, coding consistency, data ownership, integration architecture, cyber security needs and staffing ability. Next is pilot implementation where, for example, a chosen package including enabling works, utility networks, rail connection and building complex can be used to pilot Primavera Cloud workflow and predictive dashboarding capabilities before broader implementation. Third is integration expansion where BIM, ERP, procurement, document management, health & safety systems and field applications are integrated into Primavera structures. Fourth is predictive model governance where AI models have to be validated, explainability criteria set, bias monitored and responsibilities established for taking action. Fifth is portfolio scaling as learning experiences from pilot initiatives can become part of SOPs, templates and executive dashboards for more projects. In Saudi Arabia, adoption considerations would include Arabic-English reporting needs, capability of local subcontractors, weather challenges, public sector governance issues and Vision 2030 performance expectations. Training becomes paramount. Project planners need training in understanding AI-based predictions. Site managers will need training in using field inputs to make predictive modelling more accurate. Executives will need to realize that algorithms alone are not the source of truths. A human in the loop approach is thus necessary to marry AI efficiency with professional judgment (Brooks *et al*., 2020; Brunetti *et al*., 2020).

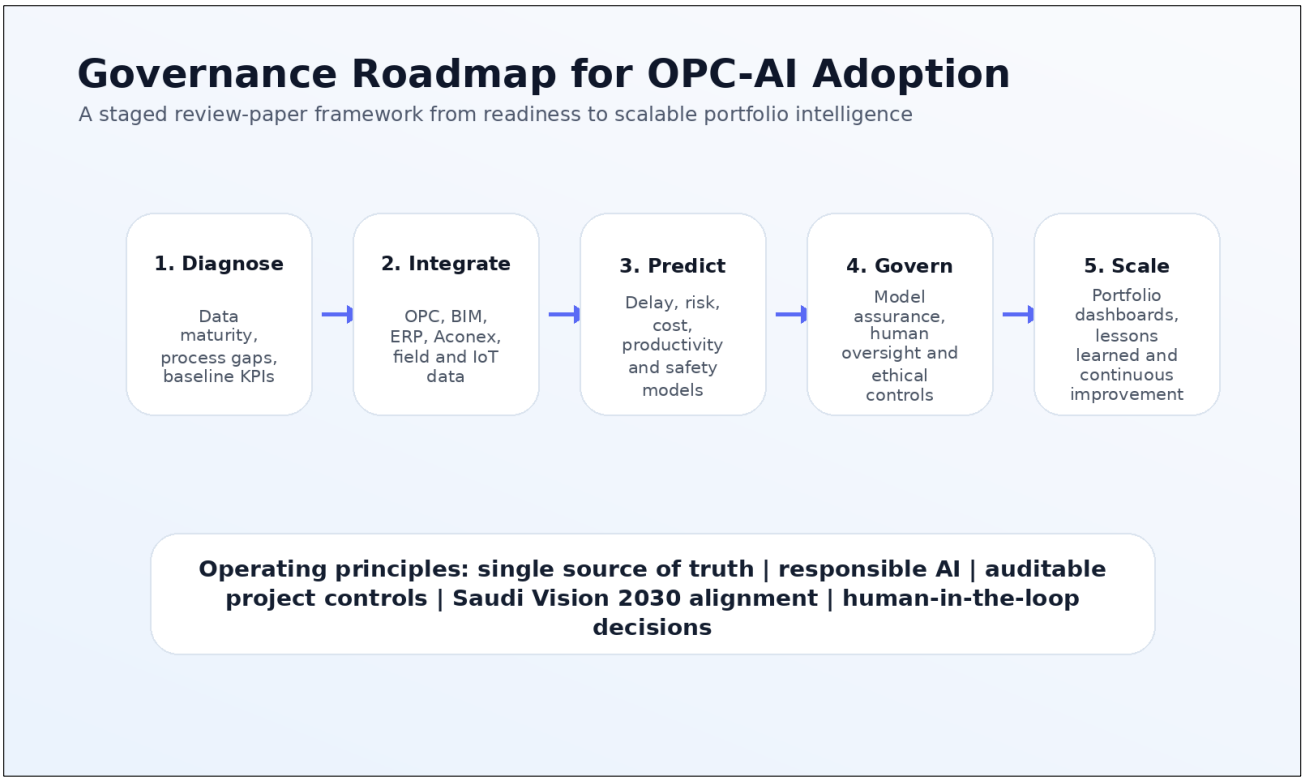

Figure 2: Governance roadmap for OPC-AI adoption in Saudi mega projects

9. Benefits, Challenges and Governance Considerations

The advantages of the AI-Enabled Primavera Cloud depend on certain conditions. For instance, AI could help reduce reporting times, create better early warning systems, plan schedule recovery operations more effectively, facilitate contractor collaboration, improve cash flow prediction, lower the need for rework, provide more reliable basis for claims and increase transparency for sponsors. Small gains in reducing delays and improving resource management would yield considerable benefits in such complex projects. Moreover, AI could help achieve greater sustainability in mega projects by detecting activities prone to generate waste, optimize material delivery processes and connect environmental measures with construction packages (Pan and Zhang, 2023). At the same time, several obstacles could arise. First of all, data quality matters. Inaccurate or untimely progress reports, inconsistent activity codes, unrealistic baseline schedules would lead to inaccurate predictions from AI models. Additionally, integration would require a lot of effort due to the variety of platforms and other technical resources used in mega projects. The confidentiality of information and cybersecurity are vital, since project data include designs, contract terms, cost estimates and other sensitive information. Moreover, there are ethical concerns related to the biases in algorithms, lack of explanations for AI-driven decisions and accountability. Therefore, the process of governance needs to include data standards, access controls, audits, monitoring and clear communication about the role of AI forecasts in decision making.

Table 2: Implementation risks and control responses for AI-powered OPC adoption

Risk area	Typical issue	Governance control	Responsible owner
Data quality	Late updates, inconsistent coding, weak baselines	Common WBS/CBS/LBS standards and data audits	PMO and project controls lead
Model reliability	Opaque forecasts or unvalidated outputs	Human-in-the-loop review and model validation logs	Digital PMO and planning manager
Cybersecurity	Sensitive schedules, contracts and costs exposed	Role-based access, encryption and audit trails	IT security and program director
Contractual use	AI forecasts misused as formal determinations	Clear protocol for notices, claims and approvals	Commercial manager and legal counsel
Adoption capability	Resistance from planners or site teams	Training, pilots and change champions	Executive sponsor and HR learning lead

10. DISCUSSION

From the review, it emerges that the greatest strength of artificial intelligence-driven Oracle Primavera Cloud is its capacity for integration. Artificial intelligence tools have value if they are linked to structured project data and applied through systematic management practices. Primavera Cloud can provide the latter, and artificial intelligence analytics can turn project data into foresight. That is why it is highly relevant for Saudi Arabia, where mega projects are fast-track, global in scope, characterized by lofty ambitions related to sustainability, and highly visible. Furthermore, the review has shown that tool adoption is not enough; what companies and organizations need is data governance, capable users, executive support and improvement mechanisms. The framework proposed above may help both private and governmental institutions go beyond simple use of technologies towards better project management results. It has also indicated another crucial area in terms of research: the necessity to collect evidence from the Saudi setting. Future researchers should evaluate Primavera Cloud-based artificial intelligence adoption in real-life settings and its contribution to variance of schedule, cost predictability, risk closure speed, safety incidents and sustainability indicators. Comparisons of project performance under conventional controls versus artificial intelligence controls may prove to be helpful as well. In addition, there is an obvious research gap in relation to contractual acceptance of artificial intelligence. More information about the proper use of predictive analytics in delays analysis and discussion of extensions of time needs to emerge.

11. CONCLUSION

Artificial intelligence-powered Oracle Primavera Cloud solutions represent a promising route toward better performance of construction activities in Saudi mega projects. Through the convergence of scheduling, resource allocation, cost management, risk management, safety management, and sustainability management information within one platform, it may become possible to provide early warnings, improve decision-making and strengthen governance of construction projects. As this literature review shows, artificial intelligence can bring added benefits to scheduling, cost, risk, resource management, safety management, and sustainability management if integrated within a cloud-based project controls platform. However, maximum potential will be unlocked only when Primavera Cloud serves as a single version of the truth while AI works as an overlay layer that helps project managers predict and prevent issues. Of course, proper adoption is critical in this context since lack of good data, integration challenges, skill deficits, cybersecurity vulnerabilities and insufficient accountability may negate potential benefits. Therefore, Saudi mega projects need to develop a staged approach to AI-powered project controls involving readiness assessment, testing certain applications, project data integration, validation of models, training, and scaling through portfolio-level governance.

12. Practical Contribution

The present review thus contributes to practice by translating the broader promise of artificial intelligence into a concrete configuration of project controls that is feasible for delivery partners to apply. First and foremost, it contributes by clarifying conceptual foundations. Numerous analyses discuss artificial intelligence in construction technology without specifying the way these technologies relate to contractual schedules, cost accounts, risk registers, and other core features of projects. As a result, predictive analysis may become nothing but a visually pleasing dashboard sitting atop weakly evidence-based processes. The proposed framework based on Oracle Primavera Cloud, on the contrary, demonstrates that performance forecasting starts with the language that is spoken by artificial intelligence. Without well-defined activity structures, cost accounts, responsibility matrices, location codes, and governance baselines, it is impossible to speak to predictive models. Second, the present study makes a significant contribution by considering the case of Saudi mega projects. Saudi projects are known for involving challenging conditions, such as remote locations, global partnerships, difficult climatic conditions, aggressive deadlines, public investment requirements, and multiple interface interactions between different parts of infrastructure. All these factors make early warning systems particularly valuable, and AI-assisted project controls could assist planners in moving from retrospective report to early interventions in cases of potential risk, packages consuming project float, overloaded activities, and other threats. Third, the present analysis proposes a practical plan for adopting AI and implementing Oracle Primavera Cloud. Rather than rushing toward automation, the organization should start by ensuring readiness of its data management practices and running pilots to verify that forecasts are meaningful and credible to project planners. Outcomes of these pilots should be analysed using quantitative measures, such as variance of schedules, timeliness of updates, timeliness of risk closure, aging of corrective actions, resource allocation efficiency, accuracy of forecasts, and speed of management response. With these insights obtained, the organization should be ready to standardize templates, reports, and procedures among comparable packages. Fourth, the proposed framework addresses the issue of human accountability. Even though AI could generate valuable insights for decision making, it cannot

eliminate the necessity of professionals and formal decision processes. The proposed framework, therefore, assumes human monitoring of automated forecasts. For instance, managers should verify the underlying assumptions, planners should evaluate the logic of schedule, commercial departments should distinguish forecasts from entitlements, and digital specialists should keep track of model history and data security practices. Fifth, the present review contributes to the discussion by proposing a method of integrating AI-based dashboards into the operations of project delivery process. Primavera Cloud becomes particularly useful once it is linked to BIM quantities, procurement schedule, submittals, document management system, safety monitoring, productivity records, equipment tracking and commercial management system. Such connections enable project managers to discuss why there is a delay at a particular activity, rather than where the delay happens. For instance, the reason for poor progress in concrete placement could be related to late approvals, late deliveries, overallocation of cranes, or limited hours due to hot weather. Combined together into a dashboard, all this data provides a basis for practical conversations on recovery. Sixth, the present review contributes to the discussion of sustainability. Sustainability performance of Saudi projects should include not only time and costs but also environmental impact, and AI-assisted scheduling system could support achievement of these goals. Namely, by connecting quantities, waste levels, equipment utilization, energy consumption and carbon indicators to specific activities, sustainability teams could spot high-impact packages for proactive intervention. Such a connection could also help to implement circular economy by enabling more accurate forecasting, reducing material surplus, promoting reuse, and documenting waste avoidance. In turn, when sustainability indicators are visualized alongside time and cost dashboards, environmental management becomes part of regular governance. Seventh, the present analysis offers to consider procurement as a critical element of AI-assisted governance systems. Since Saudi mega projects involve imports, long-lead equipment, port logistics, customs clearance, local manufacturing, and synchronized installations, AI should analyse procurement plans against actual needs of activities. Primavera Cloud would help to spot procurement risks for critical work, packages with free float, and opportunities for more disciplined expediting, substitution analysis, and contingency planning. Moreover, localization goals could be accomplished as well because AI would compare imported vs. local supply options based on time, cost, quality and risk criteria. Eighth, another advantage of AI-assisted project controls is improved dispute resolution. Disagreements among owners, consultants and contractors in Saudi mega projects tend to be caused by the lack of consensus regarding causality of delays, mitigation obligations, lost productivity, and impact of design changes. AI-assisted systems may help to resolve these problems if consistent data is available in Primavera schedules, risk management tools, change orders, and other sources of project performance records. AI could identify inconsistencies and establish a chronological order of events that may help to achieve agreement. Nevertheless, it is crucial to remember that AI-based analysis remains to be a source of intelligence, not formal determination. Management must comply with contractual terms, baselines and notifications. Ninth, the proposed framework contributes by addressing the issue of workforce development. Implementation of the proposed technology would require professionals capable to perform scheduling, engineering, commercial functions, and make decisions in project management. Thus, training courses would need to teach platform skills, project controls theory, data literacy, risk communication, and ethics. Saudi Arabia could launch digital project controls academies, mentoring and community programs in order to cultivate necessary talent locally, reducing dependence on external specialists. Finally, the tenth contribution lies in a suggested future research direction. To demonstrate actual benefits of AI-assisted governance system, studies in Saudi Arabia would need to use empirical datasets created from past mega projects. Researchers would collect information on schedules, risk, procurement, productivity, cost, and environmental indicators. By comparing AI forecasts and traditional project controls, they would determine whether the former reduce risk, improve schedule recovery, increase the number of interventions, decrease material waste, or facilitate decision making for executives. Moreover, they would need to consider how Arabic-English languages, subcontracting capability, weather, regulations, and other aspects of Saudi mega projects influence model performance. To summarize, the review proposes the framework that would enable organizations in Saudi Arabia to harness predictive AI technologies within cloud-based Primavera environments in order to improve foresight and project controls governance. By combining reliable data, skilled professionals, proper decision-making practices, strong governance structure, rigorous contractual agreements, cybersecurity, and continuous feedback in one project delivery lifecycle, organizations will be able to utilize artificial intelligence more effectively. While it does not mean substituting a planner or engineer, AI may help professionals to see risks earlier, coordinate activities better, and take decisions with evidence. Eleventh, AI-assisted Primavera Cloud may contribute to institutional memory through a portfolio approach to project controls. Mega projects

are often managed in terms of packages, and lessons learned in one of them may be helpful to others. Thus, a cloud-based Primavera environment will allow saving historic baselines, recovery interventions, risk closures, productivity statistics, and decisions made in interface management. Afterward, AI will compare newly started packages to similar finished packages in order to estimate constraints that may appear during the implementation. This process would be very beneficial for public mega projects involving repeated assets because each of them is expected to have a similar performance profile. Twelfth, another contribution of the proposed solution could be seen in the improved visibility of senior management. Traffic light reports that typically appear in executive briefings tend to conceal detailed information and uncertainty that underpin risks and delays. AI-assisted Primavera Cloud would provide an opportunity for senior management to understand which risks, activities, resources and documents cause high-risk status, how recovery plans look like and what decision should be taken. Such visibility will enhance accountability and encourage managers to make decisions in line with actual evidence. Thirteenth, another benefit of applying the proposed solution could be improved interface management. Since Saudi mega projects involve many interfaces, such as utilities crossings, district cooling, transport corridors, public realm works, fit-outs access, authority approvals, and commissioning dependencies, these aspects of project delivery require close attention from project controls. Primavera Cloud could help to model all these activities as constraints, risks and milestones. In addition, AI could detect patterns indicating interface inefficiencies. For instance, repetitive late handover between the same contractors, pending approvals at the same time affecting many zones, and resource bottlenecks in joint entry points are among possible triggers.

Fourteenth, AI-assisted Primavera environment could contribute by addressing uncertainty in Saudi mega projects. Since these projects operate in uncertain conditions of global logistics, regulatory, labour market, design evolution, weather, and stakeholder management, baselines are necessary but not sufficient for managing project delivery. Using the proposed technology, it will become possible to assess how projects behave in different conditions, such as delayed shipment, productivity decline, postponed approval or poor subcontractor performance. Scenario planning would help managers to consider multiple recovery options in advance and use contingency funds strategically. Fifteenth, the next contribution could be realized in the increased reliability of audit and assurance. Projects are managed as packages, and progress should be monitored across multiple packages. By analysing progress updates, Primavera environment could reveal inconsistencies, repeated overly optimistic forecasts, and activities that stay nearly finished forever. While it does not automatically mean that somebody is misleading the management, such observations would assist audits in targeting their efforts at suspicious packages. In Saudi mega project portfolio, such assurance strategy could increase confidence in reported information. Sixteenth, another value of the proposed solution would consist in responsible innovation. In some cases, workers feel uncomfortable when being monitored continuously, and construction companies tend to misinterpret predictive analytics results. A responsible adoption strategy would include communicating purpose of using data analytics, ensuring protection of confidential information, defining acceptable uses of data, and consulting with stakeholders on design of AI dashboard. At the same time, managers would need to disclose uncertainty, not to make it look like absolute prediction. This could foster confidence and motivate people to improve data quality. Seventeenth, another contribution could lie in localization. Primavera templates and models would need to incorporate particular characteristics of Saudi mega projects, such as regional calendar, heat-stress rules, prayer time, approval process, Saudization requirements, localization objectives, Arabic-English documentation, and regional logistics. This localization is necessary but does not mean abandoning global best practices. On the contrary, it will be possible to adapt them for local conditions. As a result, the framework would become applicable to actual projects. Eighteenth, the last contribution of the proposed solution would be improved managerial discipline. Technology could accelerate analysis but not necessarily improve decision making. Thus, organizations would need to appoint owners to every forecast, risk alert, recovery scenario, and dashboard indicator. Regular meetings would require providing evidence, taking decisions, establishing deadlines, and following up. Once this discipline is established, AI-assisted Primavera Cloud will transform from a flashy solution to a powerful tool of continuous improvement.

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