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Digital Project Controls and Data-Driven Decision-Making for Land Use and Built Environment Development in Saudi Mega Projects

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Abstract- The development of mega projects in Saudi Arabia is changing the national built environment through integration of various components of urban infrastructure such as tourism facilities, urban planning, real estate, mobility, public space, utilities, and digital governance in the Vision 2030. The scale of these projects creates a complex delivery environment. Traditional project controls often become ineffective because of land use decisions, design modifications, schedule logic, cost estimation, permits, and stakeholder commitments are interdependent. This review paper aims to explore how digital project controls and evidence-based decision-making help in optimizing the land use and built environment development through Saudi Arabia mega projects. By analysing current literature on topics such as smart construction, BIM, GIS, PMIS, digital twins, earned value management, risk analysis and urban governance, the research proposes a framework that integrates geographic information on land use with real time performance data at the project control level. This paper argues that the best project controls approach is not just the reporting tool, but it is the decision-making system, which translates isolated project information into prompt action for planners, engineers, designers, consultants, developers, and public authorities.

Keywords: Digital Project Controls, Data-Driven Decision-Making; Land Use, Built Environment, Saudi Mega Projects, BIM, GIS, PMIS, Vision 2030, Urban Planning.

I. INTRODUCTION

The Kingdom of Saudi Arabia is executing one of the biggest urban transformation programs in the world. Projects such as NEOM, Qiddiya, Diriyah, Red Sea Global, ROSHN, King Salman Park, Sports Boulevard, and New Murabba seek to achieve economic diversification, increase tourist infrastructure, enhance quality of life, and create urbanism templates.

However, such mega projects differ from normal construction programs since they are not simply focused on building facilities. Instead, such programs encompass land use planning, infrastructure corridors, mobility networks, utilities, residential housing, hospitality developments, cultural assets, environmental sustainability and conservation, and business development through multi-decade periods of time. Hence, they require more effective project controls for delivery.

The choice of the topic is motivated by the high sensitivity of land use planning and built environment development programs to delays, increased costs, scope changes, and poor information management.

For example, any decision made related to zoning, plot phasing, utility planning, road alignment, drainage, public realm design, and even building massing will impact the project's schedule, budget, risk, sustainability performance, procurement process, etc.

Since this information is traditionally kept separate from project controls data in delivery systems, such impacts are often recognized too late when project reports must describe costly problems that were caused by such delays. Digital project controls solve this issue by providing comprehensive integration of all this data. This topic aligns well with the current state of research on smart cities.

Specifically, the model-based engineering approach proposed by Gbran and Alzamil (2025) considers urban systems as interconnected networks. Digital modelling, analytics, and infrastructure systems together with the Vision 2030 goals form an integral part of their research approach. Following them, this paper explores ways to apply digital technologies in project controls and discusses how they can positively impact planning and execution of Saudi mega projects' land use and built environment components. Unlike them, however, this paper examines digital project controls as a governance activity.

Complex nature of Saudi Arabia mega projects makes this approach particularly beneficial. To start with, it involves numerous stakeholders including authorities, master developers, consultants, contractors, utility companies, investors, operators, and communities. Then, these projects have to be responsive to quick changes in government policies yet at the same time feasible from both technical and economic points of view.

Finally, they are required to offer benefits beyond simple facility delivery, i.e. they have to provide sustainability, quality of life and global competitiveness. Many Saudi mega projects are executed in unique geographic contexts like desert environment, coastlines, heritage districts, or urban sprawl.

The goal of this paper is to investigate the ways digital project controls can contribute to data-driven decision making regarding Saudi mega projects' land use and built environment components.

The paper aims to: explore relationship between project controls and urban planning decisions; highlight key digital tools employed in mega-project delivery; propose an integrated framework combining BIM, GIS, PMIS, dashboards, earned value analysis, risk analytics, and change control tools; and discuss implications for Vision 2030 projects. Contribution of this paper will be in viewing project controls from the strategic planning perspective rather than project management alone.

II. LITERATURE REVIEW

The literature on digital project controls has grown as construction programs have become larger, faster, and more data-driven. Project controls include such functions as schedule management, cost control, risk management, change control, progress measurement, procurement management, and reporting.

In the context of mega projects, however, all of these functions should be linked to land use and design decisions because physical planning defines program delivery results. A road alignment, a utility reserve, a station placement, a parcel release schedule, or a public realm interface could influence a critical path, affect quantities, introduce permit dependencies, and shape urban performance in the long run.

Building Information Modelling has become one of the key technologies of digital project delivery due to the fact that it allows for providing organized asset information. BIM enables clash detection, quantity take off, 4D schedule simulation, 5D cost planning, and asset management.

In case of land use and built environment development, BIM is useful but insufficient if employed independently since it describes assets on the building or infrastructure object level. Geographic Information Systems can help to represent such elements as parcels, topography, zoning, mobility networks, environmental restrictions, utility corridors, and spatial relationships on regional scale. Thus, the integration of BIM and GIS would be highly applicable to mega projects because managers require understanding both of assets and territory.

Another important component is represented by the project management information system. Maturity of PMIS involves the ability to link such items as baselines, work breakdown structure, contract packages, design documents, risk register, document control, procurement milestones, claims, and change requests. In the case when PMIS is linked to BIM and GIS, it would be possible to build spatially enabled project controls.

As an example, a dashboard would allow seeing in what districts there are delays, where there are unresolved design interfaces, what utility corridors hamper construction access, and what work packages cause cost variances. Such visibility is crucial for mega projects that require clear information from their executive committees. Research related to data-driven decision-making proves that making a decision improves as an organization uses reliable and contextual data rather than intuition.

For Saudi mega projects, data-driven controls could facilitate scenario planning, early warning systems, trend analysis, and predictive forecasting. Earned value management would allow determination of whether the project is consistent with cost and schedule baselines that were defined during its approval.

Risk analytics would enable to identify probability-impact patterns and escalations. Change analytics would allow differentiating unavoidable technical changes and unnecessary scope instability. Spatial analytics would illustrate the impact of land use sequencing on infrastructure delivery. Also, the need for system integration was highlighted in studies focused on smart cities and sustainable construction.

According to Gbran and Alzamil (2025), sustainable urban development presupposes the integration of modelling techniques, renewables, transport network, affordable housing, governance, and sustainability indicators. It has particular importance for project controls since mega projects in Saudi Arabia also presuppose governance in technical and social terms.

Built environment encompasses mobility, public realm, utilities, energy infrastructure, tourism facilities, community services, ecology, and other elements. Consequently, digital project controls should include various indicators to ensure both effective delivery and performance. Some literature studies mention some challenges related to the implementation of digital project controls.

First, data silos occur when consultants, contractors, and authorities employ different software solutions and coding techniques. Second, baselines in cost, schedule, design, and land use might be inconsistent. Third, dashboards might look beautiful and attractive but still not contain appropriate data or lack governance discipline.

Fourth, teams might gather significant amounts of data but do not define decision rights and escalation thresholds for this information. Finally, the failure of digitalization can occur due to the absence of appropriate human workflow adjustment.

Thus, technology alone cannot help make better decisions. In summary, contemporary literature suggests that Saudi mega projects require using a hybrid approach that combines technical modelling, project controls, urban planning, and governance.

The problem of the existing literature is that there are many works on BIM, smart cities, or project management separately. Fewer publications address the question of digital project controls that could directly enhance land use and built environment decisions.

The goal of this paper is to address this research gap through developing a conceptual framework where project controls become an evidence-based interface between intention and delivery.

III. METHODOLOGY

A review methodology with a framework development will be adopted in this paper. The review is an appropriate methodology considering the need for integrating aspects of urban planning, project controls, construction management, digital engineering, and strategic governance. The objective is not measurement of one completed project using site data but synthesis of available knowledge and conversion to a practical model applicable to mega projects in the Saudi Arabia context.

The methodology is following a narrative review approach applied in most of the existing smart construction papers combining literature, case context, technology themes, and implementation challenges in forming a framework.

The review will cover all literature and professional materials between 2020 and 2025 on such themes as BIM, GIS, digital twins, PMIS, earned value management, risk analytics, smart cities, infrastructure governance, and Saudi Vision 2030 delivery.

This paper uses the attached Springer model paper in terms of structure because it shows how an article can integrate such elements as Vision 2030 context, research gap, objectives, methodology, figures/tables, implementation challenges, and future directions.

However, the current paper uses a different aim, objectives, and analytical focus, namely, digital project controls for land use and built environment delivery. The methodology includes five steps. The first step is identification of the delivery problem as fragmented decision making in mega-scale urban projects.

The second step is identification of digital control domains which include spatial planning data, BIM asset data, schedule-cost integration, risk and change management, and executive dashboards. In the third step, the control domains are mapped to urban land use and built environment decisions such as parcel phase, infrastructure readiness, public realm coordination, utility interfaces, and district delivery sequence.

The fourth step is framework development showing how the data flow from planning input to governance output. Finally, there will be discussion of implications, limitations, and further research directions of the framework. For increasing the analytical rigor of the paper, thematic analysis will be conducted.

Themes in the review were not selected randomly but identified as recurrent problems in mega projects in terms of delay visibility, cost escalation, design change, coordination complexity, stakeholder alignment, data quality, and sustainability reporting. Moreover, each theme will be reviewed in relation to digital controls and urban planning. Implementation barriers should be considered since a framework without reference to governance, skills, and adoption issues will not be operational.

The methodological limitation is in that the paper is just a review and not measured data from one completed project in the context of confidentiality. The paper proposes a conceptual and practical framework which should be tested in subsequent empirical work. Such studies may involve expert interviews of project controls directors, planners, BIM managers, PMO leaders, and public sector stakeholders on Saudi mega projects.

Quantitative validation might consider schedule variance, cost variance, request for information trend, change order rate, design approval cycle time, and land package readiness score.

IV. RESULTS AND FRAMEWORK DEVELOPMENT

The findings indicate that digital project controls are capable of optimizing land use and built environment development due to five related competencies, which include: integration, visibility, prediction, governance, and learning. Integration constitutes the first competency. The absence of a linked data model means there will be no insight regarding implications of every change in the master plan on schedule, costs, procurements, risks, and stakeholder engagement.

Ideally, the connected data environment is expected to link information starting from master plan and including all of the following: GIS layer, BIM model, WBS, cost breakdown structure, schedule activities, risk register, document control, and approvals workflow. Note that the above does not refer to consolidation of software platforms but to harmonized data definition.

The second competency is visibility. Decision makers and stakeholders should be provided with informative dashboards displaying different parameters pertaining to progress in districts, packages, assets, and interfaces. Apart from showing percentage of completed works, such dashboard should display health of milestones, pressure on schedule, cost variances, unresolved designs, land access limitations, utilities interface state, environmental approval, permit dependency, and effects of change orders.

It should be noted that the above dashboard would be spatial in case of land-use projects since location is important in terms of identifying problematic bridges, utility corridors, substations, and access roads that affect entire districts and decrease their value. Prediction is another competency required of project controls.

In particular, project controls should assist teams identify potential problems leading to schedule slippages and claim disputes. Trend analysis would allow highlighting repetitive failure in delivery of designs.

Risk analytics could single out critical interfaces involving infrastructure/vertical component interactions. Cost forecasts would be used to assess consequences of inflation, design changes, and procurement plans. Schedule simulations would be used to compare effects of different phasing options.

Scenario models would show if there is a need to develop a district in one phase or sequence works according to infrastructure maturity levels. These predictive capabilities are essential for Saudi mega projects that operate under tight schedule constrained by national priorities.

The fourth competency is governance. Project controls information becomes irrelevant if there is no action after report review. Therefore, dashboards should be associated with information on rights to make a decision, escalation limits, and responsibilities.

For example, red light on a dashboard should indicate the package affected by problem, its cause, responsible for addressing it, appropriate action, and deadline. Thus, the task of reporting would become proactive and provide transparency since executives would be able to judge if an issue is under control or postponed to the future date. The fifth competency refers to learning.

Data generated by mega projects can lead to a number of lessons learned about districts and individual work packages. If analysed properly, the data would reveal patterns associated with delays, design interface problems, procurement issues, land transfer problems, permits, and cost escalation.

The above insights can form a basis for optimization in subsequent project phases and in other Vision 2030 projects. This competency appears to be highly relevant to Saudi Arabia since multiple mega projects operate simultaneously, and therefore mistakes made in one district can be avoided elsewhere. Figure 1 represents the proposed digital project controls framework.

It begins with land-use and built environment data such as GIS layers, BIM models, utility corridors, environmental constraints, district master plan phasing, and stakeholder requirements. The information above feeds project controls engine represented by baseline schedule, cost plan, risk register, procurement plan, and change log.

Analytics will transform the input into earned value trends, scenario models, cost forecasts, and early warnings. Finally, governance will use analytics output to implement land use alignments, scope management, funding priority, stakeholder communication, and corrective actions.

As seen from Table 1, the interaction between digital controls and decision needs of land-use project can be summarized as follows: digital project controls can be viewed as planning intelligence system aimed at determining why there are discrepancies in built environment and how these can be addressed through making decisions.

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Figure 1. Digital Project Controls Framework for Saudi Mega Projects. Source: Author.

Table 1. Digital Controls and Land-Use Decision Needs

Control Domain	Key Data Inputs	Decision Supported	Built Environment Value
BIM-based asset data	Models, quantities, design maturity	Constructability and package readiness	Reduces clashes and rework
GIS and land-use data	Parcels, corridors, zoning, constraints	Phasing and spatial prioritization	Improves district sequencing
Schedule-cost integration	WBS, CBS, earned value, baselines	Budget and time control	Improves executive confidence
Risk and change analytics	Risk register, trends, change logs	Escalation and mitigation	Reduces late surprises
PMIS dashboards	Milestones, approvals, actions	Governance and accountability	Improves transparency

V. DISCUSSION

This discussion clearly indicates that digital project controls become truly powerful only when they link technical delivery to strategic urban outcomes. In many infrastructure programs, project controls are seen as a technical reporting discipline. This narrow perception does not work well in mega projects in Saudi Arabia because the goal is not just to deliver standalone assets but to create functional destinations, districts, communities, tourism areas, and public spaces.

Districts can be technically sophisticated but not operational if road connectivity, utilities, landscaping, permits, digital assets, and mobility integration are not ready to go at the same time. Data-driven controls solve this problem because they measure readiness in terms of the whole system.

One of the main implications is the need to have common coding for land use planning and project controls. Parcels, district zoning, asset codes, WBS elements, cost codes, and schedule activities must all match one another.

It means that a decision maker can click on a particular geographic area and get an overview of relevant design packages, contracts, costs, progress, risks, and approvals. In cases when these two functions are disconnected, project teams can provide various reports which are individually correct but overall confusing.

In mega projects, the lack of coding creates a misleading sense of progress as physical works advance while interface problems stay unsolved. Another important implication is the development of decision-quality dashboards. Too often, dashboards fail to serve their purpose because they focus on aesthetics but not management needs. A properly developed PMIS dashboard must have three layers.

First, it should include an executive summary showing current status and exceptions. Second, it must be capable of analytical drill-down providing explanations to causes and trends. Third, it should track actions showing who made what decision, when it should be done, and what consequences can be expected.

Figure 2 illustrates this approach to dashboards through a schematic executive model with three layers including data inputs, validation, analytics, decision gates, and actions. Data-driven project controls also allow integrating sustainability into decision-making processes. Land-use and built-environment decisions impact carbon emissions, mobility, energy consumption, water systems, the public realm, and social access.

When sustainability indicators are embedded in project controls, decision makers can evaluate various delivery options not only in terms of costs and schedules but also in terms of environmental and social performance. For instance, changing a road alignment will influence costs, schedule, tree retention, pedestrian comfort, and future mobility performance.

The data-driven framework allows evaluating all these factors at once. The framework can help in improving risk governance. Mega projects are subject to uncertainty related to design maturity, regulatory approvals, market capacity, supply chains, stakeholder requirements, and interface problems.

A live risk register connected to schedule and spatial data can help to identify concentrations of risks and areas of intervention. This will facilitate executive prioritization because the executives will know where to direct their attention to achieve maximum results both in terms of completion and urban performance.

Nonetheless, implementation will be possible only when the organization is mature enough. Data-driven project controls depend on data quality, disciplined updating, and trust among various teams. In case of poor quality of progress data submitted by contractors, frequent changes of baselines without governance, and infrequent updating by design teams, the whole system will generate suboptimal decisions.

That is why Saudi mega projects should invest in information management standards, data quality, platform interoperability, and training for planners and controls professionals. The human process matters as much as technology.

Table 2 provides an implementation roadmap. It suggests that a digital transformation should start with governance and data standards, not with dashboards. After creating codes, setting baselines, defining responsibilities, and developing validation rules, PMIS and visual analytics can produce valuable outputs. The final step is to implement predictive controls with support of historical and live data.

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Figure 2. Executive PMIS Dashboard Logic for Built Environment Delivery. Source: Author.

Table 2. Implementation Roadmap for Saudi Mega Projects

Phase	Main Action	Responsible Actors	Digital Output	Expected Benefit
1. Governance setup	Define codes, baselines, data ownership	Client, PMO, authorities	Information management plan	Reliable control foundation
2. System integration	Connect BIM, GIS, PMIS and document control	Digital delivery team	Common data environment	Reduced silos
3. Dashboard design	Build executive and technical dashboards	Controls and analytics teams	Performance dashboards	Faster decisions
4. Predictive controls	Use trends, risk models and scenarios	PMO and planners	Early warning system	Proactive mitigation
5. Learning loop	Capture lessons and benchmark packages	Client and consultants	Knowledge repository	Improved future phases

VI. PRACTICAL IMPLICATIONS

The practical implications of this review are pertinent to master developers, project management consultants, urban planners, contractors, regulators, and public authorities. Firstly, project controls practitioners should be involved from the master planning phase and not wait until the construction process starts.

Being involved early gives an opportunity for controls professionals to check the feasibility of land use phasing, utility corridors, procurement packages, and approval sequencing. Secondly, giga projects should set up a common data environment that becomes obligatory for all major players. Such an environment would specify naming conventions, data ownership, submission schedule, approvals, and audits.

Thirdly, digital project controls should contain indicators of spatial readiness. For each district or land parcel, the system will track design maturity, land access, permissions, utilities, mobility access, procurement progress, critical risks, and intended handover date.

Such an approach will allow understanding whether an area is really ready for construction. Fourthly, Saudi mega projects should utilize 4D and 5D BIM combined with GIS dashboards. The 4D model will show how construction sequence aligns with time while 5D will link quantities to cost. GIS will provide the territorial dimension that is crucial for land use.

Finally, the governance process should be exception based. Decision makers must not be flooded with trivial information. The dashboards will highlight material deviations, decision bottlenecks, and critical risks.

Each exception should have such components as root cause, recommendation, decision maker, deadline, and consequence. Such an approach builds the culture of action rather than reporting. From the policy perspective, Vision 2030 projects are supposed to produce public value and not only private returns. Digital project controls may contribute to public accountability by increasing transparency of progress, risk and sustainability performance.

Besides, improved cross ministry coordination and coordination between various public bodies, developers, and infrastructure companies is essential. Especially, this is the case with tourism infrastructure where visitor experience depends on the coordinated delivery of mobility, hospitality, utilities, public space, safety, and digital services.

this topic shows the high degree of alignment with urban planning, built environment development, and mega project delivery. At the same time, the discussion reveals the importance of digital project controls as a key strategic capability to boost construction productivity, efficiency, and quality in Saudi Arabia.

VII. LIMITATIONS AND FUTURE RESEARCH

Nevertheless, there are some restrictions to the study. Firstly, as a review paper, the current research does not offer any confidential information concerning project data and performance results within the context of a specific Saudi mega project. Thus, the proposed framework is conceptual and practical but lacks statistical evidence. Secondly, the literature on smart cities, BIM, digital twin, and project management is often independent, so combining these fields is interpretative.

Thirdly, there are considerable variations among Saudi mega projects concerning their scale, governance, geographic location, business model, and maturity of project controls. Thus, the framework relevant for the coast tourism project may be inappropriate for an urban park, historic area, entertainment city, or infrastructure corridor.

The future research would consist of case study analysis and interviews with project managers and practitioners. The possible sources of information could be planners, heads of PMO, project controls managers, BIM coordinators, GIS specialists, and representatives of clients.

The potential indicators might be scheduling variance, cost variance, frequency of change orders, response time for RFI, time to get permits, design maturity index, district readiness index. Another research direction could be comparison of projects with integrated digital controls versus projects with emphasis on conventional reporting.

Development of the maturity model of project controls for Saudi mega-projects ranging from basic reporting to predictive and spatially integrated decision-making is another option for further research.

VIII. CONCLUSION

The present review paper has examined digital project controls and data-driven decision-making concerning land use and built environment development in Saudi Arabia mega projects. It has been identified that mega projects require integrated project controls as decisions related to urban development are linked spatially, temporally, financially, and in terms of risks, sustainability, and governance.

Traditional reporting is not sufficient for mega projects that involve large districts, various stakeholders, infrastructure interfaces and national transformational objectives. A framework has been suggested that integrates land and built environment data with project controls, analytics and governance decision-making.

This approach will position building information modelling (BIM), geographic information systems (GIS), program management information systems (PMIS), earned value, risk analytics, change management and dashboards as parts of a unified decision-making system. The main objective is to support problem identification, alternatives evaluation, resource allocation and master planning alignment.

The value of this approach in Saudi Arabia is enormous. Digital project controls can greatly contribute to Vision 2030 in terms of enhanced transparency, elimination of wastage, stakeholder coordination, sustainability and increase in confidence regarding mega projects delivery.

The findings suggest that further development of project controls in Saudi Arabia should be focused on shifting from retrospective reporting to predictive, spatial and actionable decision making. Another professional implication of the study is that the significance of treating digital project controls as a common language should be recognized. In any complex program, all disciplines generate their progress reports.

Planners communicate using drawings and zoning logic, engineers – using technical packages, commercial teams – using budgets and executives – using milestone commitment. If such views do not interact, top-level decisions may be made on insufficient data.

Therefore, in a Saudi Arabia mega-project control environment, the ability of discipline-specific data translation into indicators allowing answering simple yet critical questions should be provided. Those are: which district is ready; which interface is blocking value; which decision is overdue; which risk can affect the public opening date; and which change will affect the approved urban vision.

The latter is especially significant for tourism infrastructure development. The visitor experience depends on the simultaneous readiness of access roads, utilities, hotels, public spaces, digital systems and safety measures. Furthermore, this approach will make it possible to improve investment discipline.

Significant capital investments are required for delivery of mega projects and decision makers should balance ambition and affordability. Digital project controls will promote capital efficiency through visual demonstration of how design changes, market factors, procurement timing and land release strategies affect whole-life value.

For example, acceleration of one district may be appealing from the perspective of branding, however, analytics may show that another district has greater infrastructure readiness, less interface risks and more revenue potential. In this way, project controls can become the tool for prioritization of investments and protection of public and private interests while keeping the master plan. Another practical advantage is increased stakeholder confidence.

Mega projects involve multiple parties including government agencies, developers, consultants, contractors, future operators, investors and communities. A clear digital control system can minimize disagreements as all parties can discuss on equal basis based on shared evidence rather than narratives.

That is particularly relevant in case of changes. The question is not whether changes will occur, but whether they will be analysed in time, correctly priced, properly scheduled and approved in terms of governance. Good digital controls will help to identify design development and scope drift.

In addition, the suggested framework will contribute to interface management. Development of the built environment involves thousands of interfaces among roads, bridges, utilities, landscaping, buildings, technology systems, transport services and public realm assets.

Failure of interfaces is the usual reason for delays in large scale programs because one package seems to be finished while the other cannot start. Spatially enabled dashboards can show interface ownership, deadlines, constraints and impact on district readiness.

This will help to control handovers between packages rather than solve interface-related issues during construction. Human capability aspect should also be considered. Digital transformation does not mean the end of professional judgment, but generation of new evidence for professionals. Planners, project controls professionals, engineers, BIM managers, GIS experts, commercial managers, and risk professionals should be educated in interpreting integrated data.

It is especially important that they are able not only to work with software, but to formulate questions, test hypotheses, and deliver conclusions to decision makers. Dashboards are efficient when professionals can explain the story behind numbers. In relation to Saudi Arabia, such skills will build a national learning community.

There are plenty of mega and giga projects delivered simultaneously, and each of them creates lessons in procurement, phasing, land release, design coordination, permits, risks, and stakeholder management.

Those lessons can be collected in a unified project controls structure and then applied to further project development, avoiding repetitions. This will help to build local expertise and improve the maturity of the construction and urban planning sectors.

Finally, the framework will improve the long-term sustainability of urban assets. Decisions related to land use during delivery determine mobility patterns, utility efficiency, public space quality, environmental performance, and operation costs in the years ahead.

Data-driven project controls will make it possible to ensure that short-term pressure does not jeopardize long-term urban value. Through linkage of schedule, cost, risks, sustainability, and spatial readiness, Saudi Arabia can build a delivery model that becomes faster, more transparent, more accountable, and aligned with Vision 2030.

This will assist in the creation of disciplined, accountable, and sustainable urban delivery through integrated digital governance. This will assist

REFERENCES

[1] Abuhussain M., Alzahrani A., Alotaibi R. (2025) Integrating BIM, machine learning, and PMBOK for green building project management in Riyadh. Buildings 15(17): 3031.

[2] Alaloul W.S., Liew M.S., Zawawi N.A.W.A., Mohammed B.S. (2020) Industry 4.0 in construction: A systematic review of opportunities and challenges. Ain Shams Eng J 11(1): 225–240

[3] Alotaibi R., Alshahrani S., Akintoye A. (2025) Modelling project control system effectiveness in Saudi construction projects. Buildings 15(18): 3426

[4] Alshihri, S., & Al-Gahtani, K. (2023). Construction project performance and digital transformation in Saudi Arabia. International Journal of Construction Management, 23(12): 2081-2094.

[5] Azhar, S., & Kassem, M. (2021). Building information modelling for infrastructure delivery: Digital integration and project controls. Automation in Construction, 129: 103798.

[6] Bibri, S. E. (2021). Data-driven smart sustainable cities of the future: An evidence synthesis approach. Sustainable Cities and Society 75: 103317.

[7] Boje, C., Guerriero, A., Kubicki, S., & Rezgui, Y. (2020). Towards a semantic construction digital twin: Directions for future research. Automation in Construction, 114: 103179.

[8] Chen, K., Lu, W., Peng, Y., Rowlinson, S., & Huang, G. Q. (2020). Bridging BIM and

building: From a literature review to an integrated conceptual framework. International Journal of Project Management, 38(1): 1-12.

[9] Dallasega, P., Rauch, E., & Linder, C. (2020). Industry 4.0 as an enabler of proximity for construction supply chains. Computers in Industry, 118: 103228.

[10] Dodge Data & Analytics. (2021). SmartMarket report: The business value of BIM for infrastructure. Dodge Construction Network.

[11] Gbran, H., & Alzamil, W. (2025). Achieving sustainable housing in smart cities: The role of model-based engineering in developing complex systems in line with Vision 2030. Smart Construction and Sustainable Cities 3: 24. https://doi.org/10.1007/s44268-025-00062-w

[12] Government of Saudi Arabia (2024) Vision 2030 annual report.

[13] ISO. (2020). ISO 19650-3: Organization and digitization of information about buildings and civil engineering works, including building information modelling. International Organization for Standardization.

[14] Jiang, F., Ma, L., Broyd, T., & Chen, K. (2021). Digital twin and its implementations in the civil engineering sector. Automation in Construction, 130: 103838.

[15] Kassem, M., Kelly, G., Dawood, N., Serginson, M., & Lockley, S. (2021). BIM in facilities management applications: A case study of a large university complex. Built Environment Project and Asset Management, 11(4): 647-666.

[16] Love, P. E. D., Matthews, J., Simpson, I., Hill, A., & Olatunji, O. A. (2021). A benefits realization management building information modelling framework for asset owners. Automation in Construction, 124: 103591.

[17] Marzouk, M., & Enaba, M. (2021). Analyzing project data in construction: Earned value, risk indicators and decision support. Journal of Construction Engineering and Management, 147(8): 04021083.

[18] Matarneh, S. T., Danso-Amoako, M., Al-Bizri, S., Gaterell, M., & Matarneh, R. (2021). Building information modelling for facilities management: A literature review and future research directions. Journal of Building Engineering, 39: 102237.

[19] Naji, K. K., Gunduz, M., & Al-Salti, M. (2020). Assessment of delay factors in construction projects in Gulf Cooperation Council countries. International Journal of Construction Management, 20(4): 345-355.

[20] Newman P., Kenworthy J. (2021) Urban design and transport energy in sustainable city development. Urban Plan 6(3): 1–12.

[21] PMI (2021). A guide to the project management body of knowledge (PMBOK Guide) (7th ed.). Project Management Institute.

[22] Pärn, E. A., Edwards, D. J., & Sing, M. C. P. (2020). The building information modelling trajectory in facilities management: A review. Automation in Construction, 111: 103076.

[23] RICS. (2021). Digital transformation in construction and infrastructure: Cost management and project controls guidance. Royal Institution of Chartered Surveyors.

[24] Sacks, R., Brilakis, I., Pikas, E., Xie, H. S., & Girolami, M. (2020). Construction with digital twin information systems. Data-Centric Engineering, 1: e14.

[25] Saudi Data and AI Authority (2021) National strategy for data and AI. SDAIA.

[26] Shahzad, W., Mbachu, J., & Domingo, N. (2022). Digital construction and project performance: A systematic review. Engineering, Construction and Architectural Management, 29(9): 3475-3502.

[27] Singh, T., Solanki, A., Sharma, S. K., Nayyar, A., & Paul, A. (2022). A decade review on smart cities: Paradigms, challenges and opportunities. IEEE Access, 10, 68319-68364. https://doi.org/10.1109/ACCESS.2022.3184710

[28] World Economic Forum (2023) Shaping the future of construction: Digital transformation and data-driven infrastructure delivery. WEF.

[29] Zhang, L., & El-Gohary, N. (2022). Semantic information modelling and automated compliance checking for built environment planning. Advanced Engineering Informatics, 52: 101606.