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# 1 AI-Driven Project Management Transformation: Strengthening Saudi Arabia's Construction Sector as a Catalyst for Economic Diversification

## Abstract

This study investigated the transformative impact of Artificial Intelligence (AI) on project management within Saudi Arabia's construction sector, examining its role as a catalyst for economic diversification under Vision 2030. A qualitative research approach was adopted, utilizing case studies of three flagship projects; NEOM, Qiddiya, and Red Sea Global. The analysis demonstrated that AI integration enhances project planning, risk management, performance monitoring, sustainability optimization, and workforce transformation. Findings reveal that AI-driven practices improve efficiency, reduce cost overruns, strengthen environmental compliance, and facilitate high-skill workforce development, aligning operational outcomes with national strategic objectives. At the macroeconomic level, AI adoption contributes to non-oil GDP growth, industrial diversification, and the creation of knowledge-intensive employment opportunities. Challenges such as digital readiness disparities, high infrastructure costs, and evolving regulatory frameworks remain, underscoring the need for policy intervention and capacity building initiatives. The study concludes that AI is not merely a technological enhancement but a strategic enabler, positioning Saudi Arabia's construction sector as a key driver of Vision 2030's innovation-led, sustainable, and economically diversified future.

Keywords: Artificial Intelligence; Project Management; Construction Industry; Vision 2030; Economic Diversification; Saudi Arabia; Sustainability

## 2 Introduction

The Saudi Arabian Vision 2030 is a transformative national roadmap that was designed to shift dependence of the Kingdom on oil towards a diversified, knowledge based model [1]. The vision 2030 of Saudi Arabia focused on different sectors for national development and growing economy, and construction sector is amongst them which is kept at the centre of vision for becoming a vital contributor in shifting to non-oil economy in the region. The influence of vision 2030 can be observed in the Kingdom's large scale infrastructure programmes which includes the projects like

NEOM, The Line, Diriyah Gate, Qiddiya and the Red Sea Development [2]. These projects represent the physical and economic alignment with the goals and outcomes of the vision 2030, where each project require complicated and sophisticated planning, cost management and execution framework for meeting global standards, sustainability and technological advancements along with efficiency. However, due to complications in planning and designing of these projects, the construction sector face challenges like increase in costs, time delays, inefficiencies in resources and management systems due to which productivity and long-term contribution in economic diversification is impacted. On the other hand, emergence of Artificial Intelligence (AI) has brought opportunities for enhancing the outcomes of these projects while reducing inefficiencies and turning them into strategic advantages. It is because AI based project management has increased automation of processes while providing predictive analytics and enhancing decision making by analyzing data at every stage of the project delivery. In this regard, Liu and Hao [3] stated that machine learning algorithms have the ability to make forecasting deviation in schedule while detecting any inconsistencies in project designing and management. Similarly, Jain et al.[4] also noted that machine learning algorithms are supporting construction industry by optimizing procurement and logistics processes. In addition to machine learning algorithms, Building Information Modeling (BIM) with AI integration has been enhancing the coordination between design and construction teams and supporting in reducing delays and reworking. As a result, with AI, ability of project managers has enhanced due to intelligent resource management tools which allow them to allocate labour, materials, and equipment based on real time data. Thus, with the technological advancements an adaptive and efficient project management ecosystem is created that aligns the construction project with the Kingdom's transformation objectives defined in Vision 2030.

3 The construction industry of Saudi Arabia is estimated $74.11 billion and it is expected to grow by $96.26 bullion by 2030 fueled by vision 2030 [5]. Since, Saudi Arabian

construction sector operates in a broader economic transformation, Vision 2030 has brought several projects worth $1.5 trillion where construction industry alone is likely to acquire $950 billion of this total [5]. The Saudi Arabian Vision 2030 is based on three key pillars, thriving economy, vibrant society and an ambitious nation. Therefore, AI driven project management has the potential to support these three key pillars of the Vision 2030 by enhancing the productivity, reducing risks and enhancing innovation in the projects. It is because AI driven project management tools are increasing the ability of construction project managers for efficient utilization of resources and capital while accelerating project completions, and improving costs control, leading to higher returns on investments of construction industry. According to Bhattacharya and Chatterjee [6], technological integration in construction projects supports strengthening of construction supply chain, creating employment opportunities and developing local expertise in digital engineering and analytics. However, the macroeconomic relevance of the transformation due to Kingdom’s Vision 2030, is beyond, operational efficiency, because construction industry acts as a multiplier for connected sectors like transportation, logistics, finance and manufacturing [7]. Therefore, improvements in the construction management with AI adoption can contribute in wider economic growth, employment creating and increased participation of private sector in the diversification of Saudi economy. Despite, Vision 2030 promising these developments, the implementation of AI is the infrastructural construction projects of Saudi construction industry is in its early stage [8]. It is because the industry demonstrated different levels of digital readiness, where many firms in the industry are still relying on the conventional project management practices. At the same time, there are several barriers that are hindering adoption of AI in construction projects such as limited technical expertise, resistance to change, regulatory ambiguity, and data fragmentation. Thus, addressing these challenges need coordinated policies, institutional capacity building and investments in digital infrastructure for which professional bodies need to integrate AI driven project management competencies into engineering and management education and skills development to ensure future workforce has required digital and analytical skills.

4 The aim of this study is to examine the strategic role of AI in transformation of project management for strengthening Saudi Arabian construction sector as a key influencer for economic diversification under Vision 2030. For this purpose, the study exploresthe potential of AI for enhancing project performance, and support sustainable development and contributes in macroeconomic transformation of the Kingdom. The findings of this study aim to inform decision makers, policy makers and industry leaders on the opportunities framework that connects technological innovation with the Kingdom's long term developmental agenda. The study addresses four research questions that guide analysis and findings: 1. What methods are used to integrate Artificial Intelligence techniques into project management practices within major Saudi construction megaprojects, including NEOM, Qiddiya, and Red Sea Global? 2. What measurable project-level outcomes arise from AI-driven project management, with attention to planning accuracy, cost control, risk mitigation, and sustainability performance? 3. Which organizational and institutional enablers and barriers determine scale and pace of AI adoption across Saudi construction firms? 4. In what ways do AI-driven project management transformations contribute to macroeconomic objectives associated with Vision 2030, including non-oil economic growth, local capability development, and sustainable development? Research Contributions The study offers several contributions for the project management especially for the construction industry. Firstly, it provides a synthesis of AI applications in project management within three nationally significant construction programs. Further, it develops a conceptual pathway that links AI adoption at project level to sectoral and macroeconomic outcomes relevant to Vision 2030. Additionally, the study delivers focused policy and managerial recommendations aimed at accelerating equitable AI diffusion across the national construction sector, covering data governance, workforce capability development,

procurement practice, and digital infrastructure priorities. Literature Review Conceptual Foundation of Project Management in Construction

5 Project management is considered an important aspect of effective construction delivery, ensuring alignment between design, planning, resource utilization, and objectives defined by the client. In the construction sector, project management is integrated with scope, time, cost, quality, safety, and stakeholder expectations in a structured framework which enables predictability and accountability in a project [9]. In addition, [10] and [11]have emphasized that construction projects differ from other industrial projects due to their large scale, complexity, and dynamic stakeholder interactions. Similarly, success of project management depends on systematic planning, real-time monitoring, and adaptive mechanisms that respond to uncertainties observed in construction processes[12]. Moreover, traditional project management practices in construction have largely relied on methods like Critical Path Method (CPM), Gantt scheduling, and cost structuring [13]. Although these tools have the potential to support large infrastructure programs, they often fail to accommodate the level of uncertainty, interdependency, and data intensity present in modern construction projects [14]. At the same time, human error, ambiguous communication, and fixed decision-making models frequently result in schedule delays and cost overruns [15]. As a result, this problem becomes visible in countries like Saudi Arabia, where megaprojects under Vision 2030 operate under tight timelines and high performance expectations. It is because modern construction projects demand agile, technology-driven project management frameworks that integrate data analytics and digital intelligence to achieve desired outcomes [16]. The conceptual foundation of project management has therefore evolved from a process-oriented discipline toward a data-driven and predictive system capable of learning from prior project data [17]. In addition, Ajayi[18] highlighted the growing importance of digital ecosystems where information flows seamlessly between stakeholders through cloud-based platforms,

real-time dashboards, and integrated modeling environments. This transformation created the foundation for AI to enhance construction project management while ensuring their timely completion. However, in the Saudi context, the transition carries economic and strategic significance because Vision 2030 places strong emphasis on efficiency, sustainability, and innovation within the construction sector as a driver of economic diversification [19]. The application of advanced project management methodologies supported by AI created a mechanism to achieve these policy goals. Therefore, scholars from regional development agencies indicate that improved project management maturity directly contributes to higher investment returns and faster

6 infrastructure delivery. Consequently, redefining the conceptual framework of project management from traditional control to intelligent automation aligns both operational practice and national strategy. Evolution of Artificial Intelligence in Project Management AI has evolved from theoretical computer science into a critical enabler of decision making and automation across industries, including construction [20]. Its integration into project management represents a paradigm shift from human-centered control toward intelligent, data driven optimization to enhance outcomes of ongoing processes. According to Narne[21], AI applications such as machine learning, natural language processing, predictive analytics, and computer vision now support planning, scheduling, and resource allocation with unprecedented accuracy. These technologies transform traditional project management from reactive oversight to proactive intelligence that mitigate and reduces risks, identifies inefficiencies, and continuously improves performance of construction projects. The adoption of AI in project management has followed a structured progression over the last decade [22]. Initially, automation was limited to repetitive data tasks such as document management or schedule tracking but with the introduction of predictive algorithms, project management is now capable of forecasting project performance based on historical data.Violos et al.[23] also noted that recent advancements have moved further toward

cognitive systems that reflects human judgment 163 and optimize real-time decision-making. For construction projects, where uncertainty, 164 complexity, and scale dominate, AI-driven project management has the potential to offer 165 adaptive models capable of analyzing large data sets from sensors, drones, and BIM systems to 166 support instantaneous adjustments in scope, budget, and timelines in the project. 167 Globally, integration of AI into project management is now aligned with broader digital 168 transformation initiatives for optimizing processes and completing projects on time and within 169 defined scope. Paul et al. [24] indicate that organizations implementing AI-supported project 170 systems experience higher efficiency, better cost control, and improved safety outcomes. Despite 171 potential benefits of AI, construction industry is relatively slower in adopting digital 172 technologies, but has started leveraging AI through platforms that integrate predictive modeling, 173 image recognition, and automated reporting [25]. For instance, construction industry is 174 leveraging AI-enabled systems for detecting deviations in construction progress through site 175 imagery, predict potential delays, and recommending corrective actions before performance is 176

7 impacted. However, in Saudi Arabia, the evolution of AI within project management is gaining 177 policy-level recognition where establishment of the Saudi Data and AI Authority (SDAIA) and 178 the National Strategy for Data and Artificial Intelligence (NSDAI) underscores the government’s 179 commitment to embedding AI within key economic sectors, including construction. At the same 180 time, Vision 2030 emphasizes digital transformation as a strategic enabler of national 181 competitiveness and the evolution of AI in project management serves both operational and 182 macroeconomic purposes. While enhancing construction performance while fostering 183 innovation, knowledge transfer, and high-value employment. The Kingdom’s approach positions 184 AI not merely as a technological tool but as a catalyst for systemic efficiency and sustainable 185 economic diversification. 186 AI Applications in Construction Management 187 The application of AI in construction management is extended across multiple project 188

phases, while enhancing accuracy, efficiency, and control in the project. According to Van 189 Hoang[26], AI tools integrate with BIM, Internet of Things (IoT) devices, and predictive 190 analytics platforms to create intelligent ecosystems that continuously monitor project variables 191 and adjust strategies accordingly. At the same time,in design and planning, AI algorithms 192 process large quantities of architectural and engineering data to optimize layouts, detect design 193 conflicts, and evaluate constructability [27]. Thus through generative design, AI systems explore 194 different configurations to identify solutions for balancing cost, performance, and sustainability, 195 capabilities particularly relevant to Saudi Arabia's sustainability-driven Vision 2030 initiatives. 196 In project scheduling and cost estimation, AI enhances forecasting precision so that project 197 remains under predefined measures [28]. Machine learning models trained on historical project 198 data predict potential time and budget deviations with greater reliability than traditional methods 199 [29]. In addition,predictive analytics platforms identify early warning indicators of schedule 200 slippage or cost escalation, allowing project managers to intervene before critical thresholds are 201 reached. These capabilities have the ability to reduce uncertainty and strengthen accountability in 202 large-scale projects such as NEOM or Qiddiya, where even minor inefficiencies can lead to 203 substantial economic consequences. 204 Moreover, risk management is an important area in construction project management 205 where integration of AI is significantly influencing by analyzing patterns in the project 206 documentation, performance of project and teams, and real time data for reducing the impacts of 207

8 potential risks [30]. This proactive approach enables construction managers to implement 208 preventive measures, thereby reducing safety incidents and operational disruptions. At the same 209 time, AI is also supporting predictive maintenance of equipment and infrastructure, optimizing 210 lifecycle costs and minimizing unplanned disturbance in the construction projects [31]. In 211 construction execution and monitoring, AI utilizes computer vision and drone-based imaging for 212 progress tracking and site

safety inspections. Due to which systems automatically compare on site visuals with BIM data to detect deviations, material shortages, or non-compliance. Whereas, natural language processing facilitates intelligent document control and stakeholder communication through automated reporting and contract analysis. According to Qudus[32], AI based resource management platforms integrate labor, materials, and machinery data to enhance allocation efficiency, reducing waste and delays.

Benefits and Measurable Outcomes of AI Integration

With the integration of AI in construction project management has generated several measureable improvements in performance, efficiency and sustainability. Sanusi[33] also noted that AI has significantly reduced cost increase, project delays and enhanced quality of construction projects due to data driven decision making. Moreover, AI enhances productivity by automating repetitive administrative and analytical tasks that traditionally consume large portions of project time. Whereas, AI-supported automation can improve labor productivity by 20–30% across complex construction programs [34]. In addition, intelligent scheduling and resource optimization tools reduce idle time for labor and equipment, leading to significant cost savings and profit maximization. These improvements directly influence project performance indicators such as earned value, cost performance index (CPI), and schedule performance index (SPI), translating operational efficiency into measurable financial gains for the investors in construction projects. Beyond operational performance, AI contributes to enhanced safety and sustainability outcomes where its image recognition systems monitor site conditions and detect safety hazards in real time, preventing incidents and reducing liability exposure [35]. At the same time, predictive maintenance powered by AI extends the lifespan of machinery and infrastructure assets, lowering total lifecycle costs and minimizing environmental impact. These outcomes align with Vision 2030’s environmental and sustainability objectives, emphasizing reduced waste and energy-efficient construction practices.

Barriers to AI Adoption in Construction

Despite its transformative potential, AI adoption within the construction industry faces a series of persistent barriers that hinder its effective implementation in construction projects [36]. These challenges include technical, organizational, economic, and regulatory domains, particularly within emerging markets such as Saudi Arabia. Similarly, fragmented nature of the construction industry, due to involvement of multiple subcontractors, complex supply chains, and project-specific contracts, often leads to data inconsistency and limited interoperability between digital systems [37]. Therefore, absence of standardized data frameworks restricts the ability of AI algorithms to process information efficiently, reducing predictive accuracy and limiting automation outcomes. Moreover, technical challenges emerge from the quality available data because AI relies on extensive, clean datasets for model training and continuous learning [38]. At the same time, construction projects suffer from incomplete, unstructured, or inconsistent data collected through manual processes. This deficiency weakens the reliability of predictive models and complicates their integration with existing BIM and enterprise resource systems. Additionally, the lack of digital infrastructure in smaller construction firms constrains their ability to implement advanced AI solutions, reinforcing inequality in technological adoption across the sector. Moreover, organizational barriers represent another significant constraint for integration of AI in construction projects where resistance to change, inadequate digital skills, and limited management commitment often reduces the process of AI integration. According to Piras et al. [39], many project managers perceive AI as a complex or non-essential investment rather than a strategic necessity. The construction workforce traditionally values experiential decision-making, making cultural adaptation toward data-driven management difficult. Moreover, the shortage of trained professionals capable of operating and maintaining AI systems intensifies the dependency on foreign expertise, which conflicts with Saudi Arabia’s Vision 2030 target of enhancing national workforce competency. In addition to these barriers, economic barriers also hinder the process of AI integration in the projects because its integration requires high initial costs for obtaining software licenses, hardware acquisition, and staff training. These economic challenges particularly impact on small and medium sized organisations which are a major element of Saudi construction market and lack sufficient financial resources for this type of transformation [40]. Similarly, regulatory and ethical challenges further complicate the adoption process where issues like data ownership, cybersecurity and accountability is still


underdeveloped in construction governance frameworks [41]. However, in Saudi Arabia, SDAIA has initiated national data governance standards but its translation into industry specific protocols is still in the process. Therefore, ensuring compliance, privacy protection, and clear liability allocation for AI-driven decisions are critical prerequisites for scaling adoption.

## Research Gaps

Current studies in the Saudi context emphasize digital readiness and technical feasibility but rarely examine the intersection between AI-driven project management and national economic objectives. There is limited empirical evidence evaluating AI integration and its influences on macro-level outcomes such as GDP contribution, job creation in high-technology fields, and local capability development [42]. Similarly, few frameworks exist that link micro level construction project performance with macroeconomic indicators of Vision 2030. This gap highlights the need for an integrated analytical model that captures both the project-level and national-level implications of AI-driven transformation. Furthermore, AI-related construction researches relies on theoretical models developed in Western or industrialized economies, which may not fully capture the socio-economic and institutional realities of Saudi Arabia. There is a need to contextualize existing adoption theories such as Resource Based View within the unique policy environment, labor structure, and cultural dynamics of the Kingdom's construction industry.

## Methodology

The research adopted qualitative methodology to explore the transformative influence of AI on project management within Saudi Arabia's construction sector and its contribution to economic diversification under Vision 2030. From the available methodological approaches like 291 quantitative, mixed methods, and qualitative, the qualitative approach was most suitable because 292 the study seeks to interpret, understand, and explain complex socio-technical interactions rather 293 than quantify relationships. On the other hand, quantitative methods, although useful for 294 measuring relationship between variables, was likely to fail to capture the dynamic institutional, 295 cultural, and strategic factors that shape AI adoption in the Saudi construction context. A mixed296 method approach was also considered but as the study's objectives emphasize conceptual depth, 297 policy alignment, and contextual understanding rather than numerical generalization, it was not 298 selected by the author. Moreover, multiple research strategies such as ethnography, grounded 299 theory, phenomenology, and case study design were evaluated. The case study approach was 300

11  selected as the most appropriate strategy because it enabled examination of AI-driven project 301 management transformation through real-world examples that reflect Saudi Arabia's ongoing 302 national projects. This approach supported contextual exploration of implementation of AI tools 303 in complex, high-value construction environments, and their influence on managerial decisions, 304 productivity, and macroeconomic objectives. The case study design provided an opportunity to 305 analyze data from existing projects such as NEOM, Qiddiya, and Red Sea Global, that have the 306 principles of Vision 2030 through digital innovation and advanced project governance. 307 The study relied on secondary data, gathered from scholarly publications, policy reports, 308 industry analyses, and official documents published between 2019 and 2025. Primary data 309 collection through interviews or surveys was not considered because of the availability of 310 credible secondary sources that has documented AI integration in Saudi Arabia's construction 311 sector. Thus, secondary data allowed broader coverage across different megaprojects and policy 312 frameworks, which was essential for capturing the macroeconomic implications of digital 313 transformation. For data analysis, content

analysis technique was applied to extract, organize, 314 and interpret recurring patterns and relationships from the collected data. Due to this method, 315 systematic identification of themes such as digital capability development, AI-enabled project 316 control, risk prediction, and sustainability performance, was made. 317

12 318 Figure 1 Conceptual Framework Linking AI-Driven Project Management to Vision 2030 319 Outcomes 320 Figure 1 illustrates the analytical pathway connecting AI technologies to project-management 321 transformations, project-level performance improvements, sectoral productivity gains, and 322 macroeconomic diversification outcomes aligned with Vision 2030. 323 Findings and Analysis 324 Overview of Case Studies 325 The findings of this study are based on secondary data derived from three strategic 326 megaprojects that represent Saudi Arabia's construction transformation under Vision 2030, 327 NEOM, Qiddiya, and Red Sea Global. These projects were selected using purposive criteria, 328 focusing on their scale, digital maturity, and direct alignment with national economic 329 diversification goals. At the same time, each project functions as a construction venture and 330 experimentation for digital integration, sustainability innovation, and AI-enabled project 331 management practices that symbolize Saudi Arabia's transition toward a knowledge-based 332 economy. 333

13 NEOM, a major project and reflection of Kingdom's Vision 2030, is a $500 billion 334 futuristic smart city initiative designed to embody AI-driven governance and cognitive urbanism 335 [43]. The project's digital core relies on advanced construction management systems integrating 336 AI, BIM, and IoT technologies for real-time coordination and predictive analytics. Its cognitive 337 city framework is likely to demonstrates AI-based tools can automate infrastructure design, 338 simulate construction outcomes, and optimize resource efficiency. NEOM project provides an 339 exemplary case of showing that AI is redefining project planning, control, and sustainability in 340 large-scale construction. 341 Similarly, Qiddiya, envisioned as Saudi Arabia's capital of entertainment

and culture, is a 342 different and complementary aspect of AI-enabled project delivery [44]. The project's 343 implementation strategy emphasizes AI-supported schedule optimization, supply chain 344 management, and safety monitoring. AI platforms have been integrated to assess construction 345 sequence impacts, reduce logistical bottlenecks, and monitor workforce productivity through 346 digital dashboards. The project's scale and diversity make it an ideal case for understanding 347 contribution of AI to organizational coordination and adaptive management practices within 348 complex multi-stakeholder environments. 349 In addition, Red Sea Global serves as a benchmark for sustainable and environmentally 350 conscious construction supported by AI. The project utilizes predictive algorithms to minimize 351 ecological disturbance and optimize material use while maintaining high-quality standards. 352 Through AI-driven sustainability analytics, the project monitors energy consumption, water use, 353 and carbon emissions across construction phases. It demonstrates contribution and influence of 354 AI in achieving Vision 2030's sustainability objectives while ensuring operational excellence. 355 These three projects illustrate distinct yet interconnected facets of AI integration in project 356 management becuase NEOM focuses on digital urbanism, Qiddiya on organizational efficiency, 357 and Red Sea Global on sustainability and environmental intelligence. Their selection ensures 358 comprehensive representation of the major dimensions of project management such as 359 technological, managerial, and economic, through which AI-driven project management 360 transformation supports Saudi Arabia's economic diversification and innovation goals.  361 Table 1 Summary of AI Integration across Saudi Vision 2030 Construction Megaprojects 362 Project Primary AI Applications Observed Level of Digital Documented or Reported Outcomes

14  Maturity NEOM Predictive analytics for planning, digital twin integration, autonomous site monitoring, AIdriven design coordination, and sustainability modeling High Increased project schedule accuracy, proactive risk identification, improved interdepartmental coordination, enhanced carbon and energy modeling accuracy Qiddiya Machine-learning

scheduling systems, computer-vision safety compliance, AI-assisted procurement analytics, IoT-based asset monitoring Medium– High Reduction in work delays, higher safety compliance rate, supplychain optimization, improved material traceability Red Sea Global Environmental impact prediction through AI, real-time energyefficiency optimization, autonomous drone inspection, and predictive maintenance of utilities Medium– High Reduction of material waste by more than 20%, energy cost savings, enhanced environmental compliance, improved maintenance scheduling Table 1 presents comparative evidence of AI adoption across NEOM, Qiddiya, and Red 363 Sea Global, illustrating varying maturity levels, implementation domains, and measurable 364 outcomes aligned with Vision 2030 objectives. 365 AI Integration in Project Planning and Control 366 The adoption of AI in project planning and control within Saudi Arabia's construction 367 megaprojects has become a defining feature of the country's technological transformation under 368 Vision 2030. Across NEOM, Qiddiya, and Red Sea Global, AI systems are used to enhance 369 predictive planning accuracy, automate scheduling, optimize resource utilization, and improve 370 coordination among multiple stakeholders. At NEOM, AI is embedded within the project's 371 digital management infrastructure through predictive analytics platforms and BIM integration. 372 The NEOM project's Cognitive Digital Twin framework allows real-time visualization of 373 construction progress, enabling project managers to simulate potential delays, budget 374 fluctuations, and risk scenarios before they materialize. In addition, AI algorithms analyze 375

15 millions of construction variables to recommend optimized scheduling and procurement 376 sequences, ensuring that critical path activities are executed efficiently [45]. These AI 377 capabilities align directly with Vision 2030's digital governance objective, emphasizing 378 transparency, automation, and intelligent decision-making in infrastructure development. On the 379 other hand, Qiddiya demonstrates AI's role in multi-stakeholder project coordination and 380 control. AI-powered dashboards and scheduling algorithms manage interdependencies between 381 contractors, monitor resource allocation, and

provide dynamic progress forecasting. The project 382 employs machine learning systems to predict schedule deviations and automatically generate 383 corrective action plans. Such practices have significantly reduced project rework and idle time 384 while enhancing synchronization between design, procurement, and on-site construction 385 activities. While the literature on AI in project management confirms that predictive control 386 models enhance planning reliability and minimize uncertainty by continuously analyzing 387 historical and live project data [30].Similarly, Red Sea Global has implemented AI-driven 388 systems for integrated project delivery because AI platforms are managing workforce 389 deployment, logistics scheduling, and environmental compliance, ensuring real-time control 390 across geographically dispersed project sites. Data from AI sensors and drones feed into 391 centralized control centers that track project milestones and flag anomalies. This aligns with the 392 findings of Obiuto et al. [46], who emphasized that AI-based predictive monitoring enhances 393 cost control and schedule adherence in large-scale construction projects. Through these 394 applications, Red Sea Global is likely to demonstrate the synergy between digital technology, 395 project governance, and sustainable development practices. The use of AI in planning and 396 control across these projects reveals a consistent pattern: data-driven automation improves 397 accuracy, accountability, and performance visibility. Thus, showing that AI is likely to become 398 an essential enabler of project governance and strategic efficiency within the Kingdom's 399 construction sector. 400 AI-Driven Risk and Performance Management 401 Risk and performance management represent two of the most critical dimensions of 402 project success in Saudi Arabia's construction megaprojects, and AI has become instrumental in 403 reshaping the ways these functions are executed. In traditional project environments, risk 404 monitoring depended on static assessments and manual reporting, which often failed to anticipate 405 interconnected threats. Through AI, risk management has evolved into a predictive, continuous, 406

 and data-responsive discipline. The integration of machine learning and advanced analytics 407 across NEOM, Qiddiya, and Red Sea Global illustrates AI systems have the potential to 408 transform uncertainty into measurable, manageable parameters that directly enhance project 409 performance and accountability. In NEOM project, AI-driven analytics form the strength of its 410 risk governance framework where predictive algorithms model external and internal variables, 411 ranging from supply chain disruptions to workforce productivity fluctuations, produce early412 warning signals for project managers. These predictive insights enable proactive mitigation 413 rather than reactive correction, minimizing time and cost overruns. Therefore, predictive 414 modeling exemplifies the transition from traditional deterministic planning to dynamic 415 probabilistic forecasting, reinforcing managerial confidence and decision precision. In Qiddiya, 416 AI applications focus on operational and safety risk management in which the project uses 417 computer vision and real-time monitoring tools to assess on-site safety compliance, identify 418 unsafe behaviors, and automatically trigger alerts to supervisors [47]. Machine learning models 419 analyze incident patterns to predict high-risk zones, contributing to a significant reduction in 420 workplace accidents. These AI systems are coupled with performance dashboards that 421 consolidate key metrics like cost variance, progress deviation, and quality index while providing 422 a comprehensive view of project health [48]. On the other hand, Red Sea Global employs AI to 423 manage environmental and operational risks simultaneously in which predictive performance 424 models forecast potential disruptions due to environmental variables such as temperature, 425 humidity, or material transport delays. The Red Sea Global’s integrated AI platform quantifies 426 sustainability performance by tracking energy use, emission levels, and material efficiency, 427 aligning directly with Vision 2030’s environmental stewardship goals. These AI tools ensure that 428 sustainability objectives are not isolated from project delivery performance but embedded within 429 it, representing a dual-benefit model where risk reduction and sustainability optimization 430 reinforce one another. Across all three projects, a consistent trend emerges that is AI is 431 redefining performance measurement through precision, transparency, and continuous learning. 432 The integration of AI with existing project management information systems (PMIS) allows for automated evaluation of cost, schedule, and quality parameters, reducing human bias and improving accountability.

## AI and Sustainability Optimization

17 Sustainability has emerged as a defining benchmark for project excellence within Saudi Arabia's Vision 2030 framework, and Artificial Intelligence (AI) now plays a decisive role in achieving this transformation across the Kingdom's major construction initiatives. The national focus on green development and efficient resource utilization has compelled project stakeholders to adopt intelligent systems that integrate sustainability objectives into every stage of construction management. AI enables predictive evaluation, adaptive control, and optimization of environmental and operational parameters, ensuring that large-scale developments meet both economic and ecological goals. Scholarly evidence supports these industry practices, demonstrating that AI-enabled sustainability analytics can reduce material waste by up to 25 percent and energy consumption by 15–20 percent in large-scale construction [49]. Such outcomes directly align with Vision 2030's Environmental Sustainability and Circular Economy programs, reinforcing the Kingdom's leadership in sustainable development. AI-driven sustainability frameworks not only improve project-level environmental performance but also enhance long-term national resilience by conserving natural resources and reducing dependency on imported materials. In addition, AI-enabled sustainability optimization represents the practical realization of Vision 2030's integrated development philosophy while balancing economic growth, environmental preservation, and technological innovation. Through projects such as NEOM, Qiddiya, and Red Sea Global, Saudi Arabia is not only constructing physical infrastructure but also building the foundation for a digitally intelligent and ecologically responsible national economy.

## Macroeconomic Linkage to Vision 2030

The integration of AI into Saudi Arabia's construction sector transcends operational efficiency, functioning as a strategic enabler of macroeconomic transformation under

Vision 2030. While the preceding case analyses illustrate project-level benefits in terms of planning, risk management, and workforce development, the broader implication lies in showing that these advancements collectively contribute to national economic diversification, productivity enhancement, and technological sovereignty. The cumulative evidence from NEOM, Qiddiya, and Red Sea Global reveals that AI-driven project management practices are shaping a digitally empowered construction economy, one that aligns with the strategic pillars of Vision 2030: a thriving economy, an ambitious nation, and a vibrant society. AI adoption in construction directly supports non-oil GDP expansion by improving project delivery efficiency and reducing



cost overruns, AI enhances capital productivity and infrastructure output. According to Akeiber[50], projects with digital transformation across construction could contribute up to 4.5 percent to national GDP growth over the next decade, with AI-enabled process automation accounting for a significant portion of that increase. As projects such as NEOM and Qiddiya deploy intelligent planning systems, their operational models serve as prototypes for future infrastructure programs, setting a national standard for digital performance benchmarking [51]. These systemic gains foster investor confidence, attract foreign direct investment, and stimulate private-sector growth, all of which are fundamental to Vision 2030's diversification agenda. The economic impact also extends to labor market transformation, through AI-enabled workforce localization and digital upskilling, the construction sector is transitioning from a dependency on expatriate labor toward a high-skill, knowledge-intensive employment base. Initiatives within Red Sea Global and NEOM have already demonstrated the feasibility of integrating Saudi professionals into advanced roles such as data analysts, AI system operators, and sustainability engineers. The alignment between AI adoption and national employment objectives strengthens the Kingdom's long-term socio-economic resilience. The macroeconomic impact of AI in construction extends beyond immediate project outcomes because it establishes a sustainable cycle of innovation, productivity, and diversification [52]. At the same time, AI-driven project management strengthens the operational stance of Vision 2030 by improving efficiency, enhancing human capital, stimulating domestic industries, and reinforcing environmental stewardship. Collectively, these effects demonstrate that the digital transformation of Saudi Arabia's construction sector is not an isolated modernization initiative but a foundational component of the Kingdom's transition toward a diversified, knowledge-based economy.

Table 2 Comparative Summary of This Study and Recent Reviews Study Scope and Method Key Findings Identified Gaps Contribution of Present Study Regona et al. (2022) Systematic review of global AI adoption in project management. Summarized AI tools improving cost, schedule, and quality control. Limited exploration of policy or regional application. Extends evidence to Saudi Vision 2030 context with macroeconomic linkage. Darko et al. (2020) Scientometric mapping of AI in AEC research Identified research clusters and growth Lacked applied project-level validation. Provides grounded case analysis demonstrating

19 Study Scope and Method Key Findings Identified Gaps Contribution of Present Study (2000–2019). trends. practical AI integration outcomes. Olawumi& Chan (2021) Critical review of BIM adoption for sustainable building management. Highlighted managerial and cultural barriers to digital adoption. Focused mainly on sustainability, not AI-driven transformation. Integrates sustainability and AI within national digital transformation narrative. Egwim et al. (2023) Systematic review across full construction value chain. Classified AI applications and adoption maturity. Did not connect AI use to economic or workforce impacts. Demonstrates sectoral and macroeconomic implications of AI adoption in Saudi projects. Laissy&Dakhil (2025) Pilot evaluation of AI sustainability tool. Reported energyefficiency improvement and reduced material waste. Narrow sample, no national framework integration. Expands sustainability benefits toward national Vision 2030 policy outcomes.

While earlier reviews concentrated on identifying technological enablers, managerial barriers, and operational applications, they offered limited exploration of macroeconomic or policy-level implications. The present study advances the discussion through a national lens, connecting project-level AI applications in Saudi megaprojects to economic diversification goals set under Vision 2030. The integration of empirical case evidence allows this research to bridge the gap between technical innovation and its measurable contribution to sectoral and national transformation.

## Conclusion

The study demonstrates that AI is redefining the strategic and operational foundations of Saudi Arabia's construction sector. Through evidence drawn from NEOM, Qiddiya, and Red Sea Global, the analysis confirmed that AI-driven project management has evolved from a technological tool into a transformative mechanism aligned with Vision 2030's economic diversification and sustainability objectives. The integration of AI across planning, risk



management, performance monitoring, sustainability optimization, and workforce transformation signifies a structural modernization of one of the Kingdom's most vital industries. The findings established that AI enhances project predictability, reduces inefficiencies, and supports intelligent decision-making across all management levels. Projects like NEOM illustrated that predictive analytics and cognitive systems mitigate risks and optimize scheduling accuracy, while Qiddiya demonstrates the role of AI in promoting operational efficiency and safety compliance and Red Sea Global provides further validation of AI's environmental contribution through resource optimization and sustainable design integration. These cases highlighted that AI implementation not only strengthens project-level performance but also generates macroeconomic benefits through higher productivity, resource efficiency, and industrial innovation. The findings also revealed that AI contributes directly to Vision 2030's pillars of a thriving economy and sustainable environment. The digital transformation of construction enhances domestic value creation, reduces dependency on imported expertise, and accelerates the localization of high-skill employment. The alignment between AI adoption and national development strategies illustrated that technological modernization acts as an economic 519 accelerator, enabling Saudi Arabia to transition from oil-based growth toward a knowledge520 driven, innovation-led economy. 521 However, the study also identifies structural challenges that require strategic attention. 522 These include disparities in digital readiness among small and medium-sized enterprises, the 523 high cost of AI infrastructure, and limited regulatory frameworks for data governance. Thus, 524 addressing these challenges is essential for achieving equitable and scalable digital 525 transformation across the entire construction sector.  526 Future Research  527 Future research should focus on three main areas because of their importance and 528 potential to enhance liter. First, empirical studies are needed to quantify the long-term economic 529 returns of AI integration in construction, including cost savings, productivity growth, and 530 sustainability performance. Second, comparative analyses across different Gulf Cooperation 531 Council (GCC) nations could reveal regional trends and best practices for digital construction 532 governance. Third, longitudinal studies should explore how workforce reskilling programs and 533 AI governance frameworks evolve as AI adoption matures within the Saudi construction 534 industry. 535

21  The transformation observed in this study confirms that AI is not merely enhancing 536 project management but it alsoshowedcreation of value, its distribution, and sustained within 537 Saudi Arabia’s construction economy. Through strategic integration and governance, AI-driven 538 project management will continue to serve as a cornerstone of Vision 2030, strengthening the 539 Kingdom’s global position as a leader in technologically advanced, sustainable, and 540 economically diversified development. 541 References 542 1. Al-Sulaiti, A., Hamouda, A. M., Al-Yafei, H., &Abdella, G. M. (2024). 543 Innovation-based strategic roadmap for economic sustainability and diversity in 544 hydrocarbon-driven economies: the Qatar perspective. Sustainability, 16(9), 3770. 545 https://www.mdpi.com/2071-1050/16/9/3770 546 2. Arif, M., &Aldosary, A. S. (2023). Urban spatial strategies of the Gulf 547 Cooperation Council: A comparative analysis and lessons 548 learned. Sustainability, 15(18), 13344. https://www.mdpi.com/2071549

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