

The role of artificial intelligence applications and robotics in promoting innovation and economic development in Saudi Arabia



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ABSTRACT

In line with Saudi Arabia's Vision 2030, artificial intelligence (AI) and robotics are increasingly viewed as strategic tools for promoting innovation, supporting economic development, and strengthening institutional transformation. This study examines the role of AI applications and robotics in Saudi Arabia through three interrelated dimensions: promoting innovation, supporting economic development, and identifying the institutional and policy requirements needed to strengthen their adoption. The study employed a descriptive-analytical quantitative design using a structured questionnaire administered to 220 participants, including managers, chief executive officers, and employees working in organizations that implement, use, or are exposed to AI and robotics applications across different sectors in Saudi Arabia. The study instrument consisted of 24 items distributed across the three aforementioned dimensions. Data were analyzed using descriptive statistics, Pearson correlation coefficients, Cronbach's alpha coefficients, and simple linear regression analysis. The results showed high levels of agreement across the three dimensions, with mean scores of 3.72 for innovation, 3.80 for economic development, and 3.80 for institutional and policy requirements. Hypothesis-testing results revealed statistically significant positive relationships for all three hypotheses. These results suggest that AI and robotics are significant contributors to organizational innovation and economic development, particularly when supported by appropriate regulatory frameworks, infrastructure, training, and institutional preparedness. In conclusion, maximizing the developmental value of intelligent technologies in Saudi Arabia requires coordinated efforts across technological, organizational, and policy levels.

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1. Introduction

Artificial intelligence (AI) and robotics stand among the foremost technological breakthroughs, providing immense potential to drive innovation and stimulate economic progress across diverse fields (Al-Jehani et al., 2021). Saudi Arabia is recognized as one of the fastest-growing economies in the Middle East and has shown increasing commitment to adopting AI and robotics technologies, a trend that has significantly contributed to its ongoing economic transformation (Mufleh et al., 2026).

Modern technology acts as a catalyst for innovation, facilitating the creation of novel services

that respond effectively to social needs and global market demands (Matyushok et al., 2021). Moreover, technology strengthens research and development activities, encouraging greater investment in science (Hassan, 2020). The applications of AI and robotics span multiple strategic domains. In healthcare, these systems enhance diagnostic accuracy and the delivery of medical services.

Within industry, they optimize production efficiency and reduce operating costs. In the financial sector, AI supports data analytics and investment decision-making. In education, it enables personalized learning programs (Alattas, 2023). Beyond these functions, robotics has social and self-service roles, contributing to innovation processes that are accelerating development (Elhajji et al., 2020).

Saudi Arabia's Vision 2030 represents a cornerstone of its efforts toward sustainable development (Rahman and Qattan, 2021). Within this national agenda, AI and robotics occupy a pivotal position, encompassing an extensive set of

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goals. These emerging technologies are widely acknowledged as instruments for realizing Vision 2030 (Albaroudi et al., 2025). On the other hand, the integration of AI and robotics in Saudi Arabia has led to measurable structural enhancements and productivity growth across economic sectors, leveraging their advanced capabilities to improve efficiency in achieving developmental objectives (Yannan et al., 2022). Among the principal factors that render these technologies indispensable to Vision 2030 is their capacity to advance economic diversification (Sweidan and Elbargathi, 2022). Through fostering industries and reshaping the economic structure, AI and robotics reduce dependence on the oil sector while broadening employment and investment opportunities (Bakry and Saud, 2021). Consequently, the adoption of AI and robotics plays a decisive role in realizing Vision 2030 by driving innovation, stimulating economic growth, and elevating Saudi Arabia's competitiveness (Hanafi et al., 2021).

Therefore, it is essential for Saudi Arabia to strengthen scientific literacy among policymakers and institutional leaders. Building such capabilities will enable them to respond effectively to the rapid evolution of AI and robotics (Alazmi et al., 2025). Their responsibilities have expanded to include challenges brought by technological advancement, particularly through the thoughtful integration of AI applications (Mufleh et al., 2026). This underscores the justification for researching the role of artificial intelligence and robotics applications in promoting innovation and economic development in Saudi Arabia, as it prepares the country to excel in creativity and innovation, keeping up with scientific and technological advancements. This, in turn, allows Saudi Arabia to leverage artificial intelligence and robotics applications across various sectors to achieve economic development and progress.

2. Literature review

2.1. Artificial intelligence and robotics as drivers of innovation

Artificial intelligence (AI) and robotics have increasingly been recognized as transformative technological forces reshaping innovation systems and organizational performance (Nuseir et al., 2020). AI refers to computational systems designed to mimic aspects of human thinking and reasoning and to support decision-making processes (Alfawareh and Jusoh, 2019). Robotics complements AI by enabling automated physical execution of tasks through intelligent machines designed to improve efficiency and operational precision (Almesafri and Habes, 2023).

Hassan (2020) emphasized that innovation is fundamentally linked to technological advancement and knowledge creation. On the other hand, innovation can be understood as the development of new or improved products, services, and processes that enhance organizational performance and

strengthen competitive capability, with technology serving as a major enabler of this transformation (Dang, 2024). Similarly, Gadhoun (2022) asserted that modern economic transformation requires shifting from traditional production models toward knowledge-based economies supported by advanced digital technologies. Within this transformation, artificial intelligence and robotics contribute to improving efficiency and productivity across industries, while also supporting broader processes of technological and organizational advancement.

2.2. Artificial intelligence, robotics, and economic development

Economic development is associated with sustained improvements in economic performance, including productivity and income-related outcomes (Saksonova et al., 2023). Technological innovation plays a crucial role in achieving these outcomes by supporting research and development activities and enabling new economic sectors. Research indicates that AI contributes significantly to automation, data-driven decision-making, and operational optimization, thereby accelerating economic growth and competitiveness (Hassan, 2020).

Hanafi et al. (2021) highlighted the economic implications of artificial intelligence within Saudi Arabia, demonstrating that intelligent technologies enhance industrial productivity and diversify economic structures. Likewise, Bugami (2022) emphasized that innovation and digital technologies serve as fundamental pillars supporting sustainable development. These findings collectively suggest that AI and robotics function as strategic tools for strengthening national economies and fostering innovation-led growth.

2.3. Artificial intelligence and robotics in the Saudi Arabian context

Saudi Arabia has positioned artificial intelligence and robotics at the center of its national development strategy through Vision 2030. The integration of intelligent technologies has contributed to structural transformation across multiple sectors, including healthcare, education, industrial production, and digital governance (Sweidan and Elbargathi, 2022). According to Bamatraf et al. (2021), AI development initiatives in Saudi Arabia demonstrate the country's commitment to technological advancement and innovation-driven economic diversification.

Large-scale national initiatives further illustrate this transformation. Projects such as NEOM represent ambitious efforts to establish smart cities supported by AI-powered infrastructure and robotic technologies (Ahmed, 2019). Governance frameworks aimed at regulating AI adoption also play a significant role in supporting innovation ecosystems and ensuring responsible technology deployment (Ashehri, 2019). Moreover, investments in research centers and technological infrastructure

have strengthened Saudi Arabia's innovation capacity and global competitiveness (Alazmi et al., 2025). These initiatives confirm that AI and robotics are not merely technological tools but strategic mechanisms supporting economic diversification and sustainable development goals.

Recent scholarship has significantly expanded the discussion of artificial intelligence (AI) in relation to innovation, business transformation, and economic development. However, the literature remains fragmented rather than analytically integrated. For instance, a recent review of the literature revealed that AI scholarship in business and development contexts lacks a coherent understanding of how these fields interact (Jorzik et al., 2024). This issue is also evident in studies examining the relationship between AI and economic development. The literature continues to evolve across disconnected lines of inquiry rather than within a shared analytical framework (Qin et al., 2024). Similarly, broader business research has highlighted the rapid expansion of AI-related studies, emphasizing the necessity of context-specific, empirically grounded models (Cao et al., 2024).

In the Saudi context, recent English-language studies have examined AI in specific settings rather than from a broader, cross-sector perspective. Some studies have examined the ethical, social, and educational implications of AI in higher education (Al-Zahrani and Alasmari, 2024), while others have investigated organizational innovation in university administrative contexts (Alnaggar and Abdulkader, 2024). Other research has addressed AI integration from a governance perspective in specialized professional domains, such as accounting and auditing operations (Almaqtari, 2024). However, these studies remain largely sector-specific and lack an empirical, cross-sector examination of how artificial intelligence and robotics contribute to innovation, economic development, and institutional and policy readiness within a single analytical framework. This study seeks to address this gap by examining these three interrelated dimensions within the Saudi Arabian context. Accordingly, the study addresses three research questions:

1. What is the role of artificial intelligence and robotics in promoting innovation in Saudi Arabia?
2. What is the role of artificial intelligence and robotics in supporting economic development in Saudi Arabia?
3. What institutional and policy requirements are needed to strengthen the use of artificial intelligence and robotics for innovation and economic development in Saudi Arabia?

Based on these research questions and the relationships identified in the literature, three hypotheses were formulated:

H1: Artificial intelligence and robotics have a statistically significant positive role in promoting innovation in Saudi Arabia.

H2: Artificial intelligence and robotics have a statistically significant positive role in supporting economic development in Saudi Arabia.

H3: Institutional and policy support has a statistically significant role in strengthening the adoption of artificial intelligence and robotics for innovation and economic development in Saudi Arabia.

3. Methodology

This study employed a descriptive-analytical quantitative design, using a structured questionnaire as the primary data collection instrument. The study targeted managers, chief executive officers, and employees in organizations implementing, using, or directly exposed to artificial intelligence and robotics applications across different sectors in Saudi Arabia. A purposive sampling approach was used to select respondents who were expected to have professional familiarity with the subject of the study. Of the 470 questionnaires distributed, 220 valid responses were received and included in the final analysis, representing a response rate of 46.8%.

To achieve the objectives of the study, the researcher developed a 24-item, three-dimensional, structured questionnaire. The first dimension assessed the role of artificial intelligence (AI) and robotics in promoting innovation. The second dimension examined their role in supporting economic development. The third dimension examined institutional and policy requirements for strengthening the adoption of AI and robotics in Saudi Arabia. Responses were measured using a five-point Likert scale ranging from "strongly disagree" to "strongly agree." This scale is commonly used in management and business research to capture respondents' attitudes and perceptions (Saunders et al., 2023).

Descriptive statistics were used to analyze the collected data, calculate means, and determine standard deviations. Pearson correlation coefficients were used to assess internal consistency, and Cronbach's alpha coefficients were used to test reliability. Simple linear regression analysis was used to test the study hypotheses.

3.1. Validity

To ensure internal consistency, Pearson correlation coefficients were calculated for the questionnaire dimensions. Table 1 indicates that the Pearson correlation coefficients are high and statistically significant, suggesting that the study instrument demonstrates acceptable internal consistency.

Table 1: Pearson correlation coefficients

Dimensions	Correlation coefficient	Sig.
AI and robotics in promoting innovation	0.833	0.000
AI and robotics in supporting economic development	0.709	0.000
Institutional and policy requirements for AI and robotics adoption	0.732	0.000

3.2. Reliability

Cronbach's alpha coefficients were calculated to assess the reliability of the instrument. Table 2 shows that the overall Cronbach's alpha coefficient reached 0.935, indicating high reliability for the questionnaire.

Table 2: Cronbach's alpha

Dimensions	Cronbach's alpha
AI and robotics in promoting innovation	0.826
AI and robotics in supporting economic development	0.708
Institutional and policy requirements for AI and robotics adoption	0.712
Overall reliability (questionnaire)	0.935

4. Results

The results are presented according to the three study questions. Mean scores and standard deviations were used to describe respondents' assessments of the role of artificial intelligence (AI) and robotics in promoting innovation, supporting

economic development, and strengthening institutional and policy support in Saudi Arabia.

For the first question, the results related to the role of AI and robotics in promoting innovation are presented in Table 3. The weighted average was 3.72 (SD = 0.773), indicating a high level of agreement among respondents. The highest mean was recorded for the statement that AI applications contribute to the development of new products and services in Saudi organizations (M = 3.88, SD = 1.021), followed by the statement that AI and robotics enhance creative problem-solving in the workplace (M = 3.83, SD = 0.792).

The lowest mean was recorded for the statement that AI applications encourage the adoption of modern innovation practices in Saudi institutions (M = 3.59, SD = 0.984). Overall, the results indicate that respondents perceived AI and robotics as contributing positively to several aspects of organizational innovation, particularly product and service development, creative problem-solving, and the speed of innovation processes.

Table 3: AI and robotics in promoting innovation

Items	M	SD	Level
AI applications contribute to the development of new products and services in Saudi organizations.	3.88	1.021	High
AI and robotics enhance creative problem-solving in the workplace.	3.83	0.792	High
Intelligent technologies improve the speed of innovation processes in organizations.	3.76	0.871	High
AI supports knowledge generation and organizational learning.	3.72	0.764	High
AI and robotics help organizations improve service quality through innovative solutions.	3.69	0.656	High
The use of AI contributes to process innovation in different sectors in Saudi Arabia.	3.67	0.912	High
AI and robotics strengthen organizations' ability to adapt to technological change.	3.61	0.945	High
AI applications encourage the adoption of modern innovation practices in Saudi institutions.	3.59	0.984	High
Weighted average	3.72	0.773	High

For the second question, the results concerning the role of AI and robotics in supporting economic development are presented in Table 4. The weighted average was 3.80 (SD = 1.023), indicating a high level of agreement. The highest mean was found for the contribution of AI and robotics to increasing productivity in Saudi organizations (M = 3.92, SD = 1.018), followed by their role in reducing operational

costs and improving efficiency (M = 3.91, SD = 0.785). The lowest mean was related to the creation of opportunities for long-term economic transformation (M = 3.58, SD = 0.901). The results therefore show that respondents associated AI and robotics most strongly with productivity, operational efficiency, competitiveness, investment, and economic diversification.

Table 4: AI and robotics in supporting economic development

Items	M	SD	Level
AI and robotics contribute to increasing productivity in Saudi organizations.	3.92	1.018	High
AI applications help reduce operational costs and improve efficiency.	3.91	0.785	High
Intelligent technologies support the competitiveness of Saudi economic sectors.	3.88	0.869	High
AI and robotics contribute to attracting investment in advanced technology sectors.	3.86	0.760	High
The adoption of AI helps diversify economic activities in line with Vision 2030.	3.85	0.650	High
AI and robotics contribute to improving organizational performance and growth.	3.79	0.930	High
Intelligent technologies enhance the sustainability of economic development in Saudi Arabia.	3.64	0.842	High
AI and robotics create opportunities for long-term economic transformation.	3.58	0.901	High
Weighted average	3.80	1.023	High

For the third question, the results concerning the institutional and policy requirements for strengthening AI and robotics adoption are presented in Table 5. The weighted average was 3.80 (SD = 1.023), indicating a high level of agreement among respondents. The highest mean was recorded for the statement that government policies in Saudi Arabia support the adoption of AI and robotics technologies (M = 3.92, SD = 1.018), followed by the statement that regulatory frameworks are being updated to facilitate their responsible use (M = 3.91, SD = 0.785). The lowest mean was recorded for the

statement that the future success of AI and robotics depends on integrated national planning and governance (M = 3.58, SD = 0.901). Two items, concerning financial and institutional support and integrated national planning and governance, were classified as moderate, while the remaining items were classified as high. Overall, the findings indicate strong agreement regarding the importance of government policy, regulatory frameworks, technological infrastructure, training, research institutions, and university-industry collaboration in supporting AI and robotics adoption.

Table 5: Institutional and policy requirements for AI and robotics adoption

Items	M	SD	Level
Government policies in Saudi Arabia support the adoption of AI and robotics technologies.	3.92	1.018	High
Regulatory frameworks are being updated to facilitate the responsible use of AI and robotics.	3.91	0.785	High
Saudi organizations need stronger technological infrastructure to expand AI adoption.	3.88	0.869	High
Training and qualification programs are essential for the successful implementation of AI technologies.	3.86	0.760	High
Universities and research centers play an important role in supporting AI and robotics development.	3.85	0.650	High
Collaboration between industry and academic institutions is necessary to promote AI-based innovation.	3.79	0.930	High
Financial and institutional support is necessary to expand AI and robotics applications.	3.64	0.842	Moderate
The future success of AI and robotics in Saudi Arabia depends on integrated national planning and governance.	3.58	0.901	Moderate
Weighted average	3.80	1.023	High

4.1. Hypothesis testing

The three hypotheses were tested using simple linear regression analysis. The results are presented in Table 6. All three hypotheses were supported, with statistically significant positive relationships observed in each model.

For H1, AI and robotics had a positive and statistically significant relationship with innovation ($\beta = 0.68$, $t = 12.41$, $F = 154.01$, $p < 0.001$). The model explained 46% of the variance in innovation ($R^2 = 0.46$). Therefore, H1 was supported.

For H2, AI and robotics had a positive and statistically significant relationship with economic development ($\beta = 0.72$, $t = 13.56$, $F = 183.87$, $p < 0.001$). The model explained 52% of the variance in economic development ($R^2 = 0.52$). Therefore, H2 was supported.

For H3, institutional and policy support had a positive and statistically significant relationship with the adoption of AI and robotics for innovation and economic development ($\beta = 0.64$, $t = 11.28$, $F = 127.24$, $p < 0.001$). The model explained 41% of the variance ($R^2 = 0.41$). Therefore, H3 was supported.

Table 6: Summary of hypothesis testing

Hypothesis	β	t	Sig.	R^2	F	Decision
H1	0.68	12.41	0.000	0.46	154.01	Supported
H2	0.72	13.56	0.000	0.52	183.87	Supported
H3	0.64	11.28	0.000	0.41	127.24	Supported

Overall, the descriptive results show high levels of agreement across the three study dimensions, with weighted averages of 3.72 for innovation, 3.80 for economic development, and 3.80 for institutional and policy requirements. The regression results further show statistically significant positive relationships for all three hypotheses. These findings provide empirical support for the proposed relationships between AI and robotics, innovation, economic development, and institutional and policy support in Saudi Arabia.

5. Discussion

The study's findings indicate a high level of agreement among respondents regarding the role of artificial intelligence (AI) and robotics in promoting innovation in Saudi Arabia. The mean score for the first dimension, "AI and Robotics in Promoting Innovation," was 3.72, suggesting that participants perceive intelligent technologies as important contributors to organizational innovation processes. This includes supporting new product and service development, improving problem-solving practices, accelerating innovation processes, enhancing organizational learning, and strengthening adaptation to technological change.

The results also show a high level of agreement regarding the contribution of artificial intelligence (AI) and robotics to economic development in Saudi Arabia. The mean score for the second dimension, "AI and Robotics in Supporting Economic Development," was 3.80, reflecting respondents' recognition of these technologies' economic value. The findings suggest that AI and robotics are perceived as improving productivity, reducing costs,

enhancing competitiveness, attracting investment, and diversifying the economy in a manner consistent with Saudi Vision 2030's national aspirations.

Similarly, the third dimension, "Institutional and Policy Requirements for AI and Robotics Adoption," had a high mean score of 3.80, indicating a general consensus on the importance of an enabling institutional environment. Respondents emphasized that successfully implementing AI and robotics depends on more than just technological availability. It also requires supportive government policies, updated regulatory frameworks, adequate technological infrastructure, specialized training programs, and strong cooperation between universities and industry.

Additionally, hypothesis testing revealed statistically significant positive relationships across all three hypotheses. These results provide empirical support for the study's argument that artificial intelligence (AI) and robotics contribute positively to innovation and economic development in Saudi Arabia when accompanied by institutional readiness and policy support. Taken together, the findings show that intelligent technologies offer benefits beyond technical efficiency when appropriate organizational and regulatory conditions are in place.

These findings align with previous studies emphasizing the strategic role of artificial intelligence (AI) in innovation, productivity, and national transformation in Saudi Arabia and similar contexts (Al-Jehani et al., 2021; Hanafi et al., 2021; Hassan, 2020). The positive evaluation of AI and robotics in promoting innovation aligns with research that highlights their contributions to organizational learning, technological advancement,

and competitive capability (Gadhoun, 2022; Nuseir et al., 2020). Similarly, the results related to economic development support earlier arguments that intelligent technologies can improve productivity, reduce operational costs, and strengthen competitiveness to support economic diversification (Bugami, 2022; Hanafi et al., 2021). However, the relatively lower evaluations for long-term transformation and sustainability-related items suggest that respondents may still perceive the developmental effects of AI and robotics as evolving rather than fully institutionalized. This helps explain why institutional and policy readiness emerged as a critical third dimension in the study. The findings suggest that technological potential alone is insufficient. Rather, effective regulation, infrastructure, training, and university–industry collaboration are necessary to translate AI and robotics into sustained developmental outcomes (Almaqtari, 2024; Ashehri, 2019).

5.1. Limitations

Despite the value of the findings, this study has several limitations that should be acknowledged. First, the study relied on self-reported data, which may be influenced by respondent perceptions and social desirability bias. Second, the cross-sectional design limits the ability to draw causal conclusions about the examined relationships. Third, while the sample included participants from various sectors, purposive sampling may limit the generalizability of the findings to all organizations in Saudi Arabia. Finally, the study examined three broad dimensions of artificial intelligence and robotics. Future research could provide a more detailed examination by applying the model to specific sectors or using longitudinal designs.

6. Conclusion and recommendations

The study suggests that artificial intelligence (AI) and robotics have strong potential to contribute to innovation and economic development in Saudi Arabia. These technologies can enhance innovation, efficiency, and productivity, aligning with the goals of Vision 2030. The findings suggest that these technologies are widely regarded as essential tools for fostering organizational innovation, promoting economic growth, and facilitating the shift toward a more diversified, knowledge-based economy. However, the study also shows that the effectiveness of AI and robotics depends on institutional and policy support mechanisms that facilitate their adoption and sustainability.

Based on these findings, the study makes three recommendations: increase investment in artificial intelligence and robotics research and development, strengthen collaboration between universities and industry, and improve the technological infrastructure necessary to support innovation across sectors. Saudi institutions are also encouraged to expand professional training and

capacity-building programs to prepare a qualified workforce capable of effectively dealing with advanced technologies. Additionally, policymakers should continue to review and refine regulatory and governance frameworks to ensure the responsible, efficient, and sustainable use of AI and robotics. These recommendations will help Saudi Arabia maximize the developmental benefits of intelligent technologies and reinforce its long-term competitiveness at regional and global levels.

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Compliance with ethical standards

Ethical considerations

Ethical approval for this study was obtained from the Research Ethics Committee (REC) at the University of Hail, Saudi Arabia (Approval No. H-2026-339). Participation was voluntary, and informed consent was obtained from all participants before data collection. Participants were informed of the academic purpose of the study and assured that their responses would remain confidential and be used exclusively for scientific research. No personally identifiable information was collected, and participants were informed of their right to decline participation or withdraw without consequences.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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