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Research paper

AI-Driven Organizational Capabilities and The Innovation Environment: Examining The Drivers of R&D Transformation in Saudi Arabian Start-Ups

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Abstract

Artificial Intelligence is transforming how start-up companies conduct research and development (R&D) and generate value through innovation. This research investigates the impact of AI-based organizational capabilities on decision-making, problem-solving, productivity, customer satisfaction, and technology infrastructure. It also examines how these capabilities foster an innovative climate, enabling innovation in Saudi Arabian start-ups. Using a quantitative cross-sectional research approach that draws on the Technology–Organization–Environment (TOE) and Unified Theory of Acceptance and Use of Technology (UTAUT) frameworks, the present study analyzes survey data from 384 start-ups using Partial Least Squares structural equation modeling (PLS–SEM). As presented in the results section, all five AI-powered capabilities are positively and significantly related to the innovation ecosystem ($R^2 = 0.685$); further, technology infrastructure and decision-making have the most significant effect on the innovation ecosystem, and these results underline the importance of AI-aided organizational capabilities in preparing Saudi start-ups to innovate and collaborate in an ecosystem. The research extends the body of theoretical knowledge on AI adoption and guides how entrepreneurs and policymakers can strengthen the Kingdom's innovation ecosystem in line with Vision 2030.

Keywords: *Artificial Intelligence, Innovation Environment, Decision Making, Problem-Solving, Technology Infrastructure, Kingdom of Saudi Arabia*

1. Introduction

The Kingdom of Saudi Arabia (KSA) has acknowledged the potential of Artificial Intelligence (AI) in transforming the Kingdom by enhancing innovation With Vision 2030, elevating research, and diversifying the economy By creating the Research Development & Innovation Authority (RDIA) and the Supreme Committee for RDI, Saudi Arabia aims to institutionalize R&D and innovation as a key enabler of sustainable development. With the advent of AI, an additional 10–15% contribution to national productivity is expected. This will primarily result from increased automation, data-driven decision-making, and productivity gains in innovation across various sectors, including technology, healthcare, and manufacturing, among others. Start-up firms are essential in this transformation to promote both innovation and job creation, as they are the most dynamic agents in the economy that need to be knowledge-based and competitive; however, on a national level, a lot of Saudi start-ups experience challenges in properly incorporating AI into their Research & Development (R&D) processes. Despite these national workshops, the broader ability to leverage AI technologies for innovation and competitiveness has been hampered by limited funding opportunities, a shortage of skilled AI professionals, and poor alignment between the academic and industrial sectors (SDAIA, 2020; Alshamrani, 2022).

Although previous studies have proven thorough examination of AI adoption in advanced economies, however there remains narrow empirical evidence from emerging markets, particularly amongst Saudi Arabia entrepreneurial ecosystem (Bresciani et al., 2021; Hadchity, 2025); Saudi Arabia: Start-ups in Saudi Arabia still have limited tech infrastructure and a strategic framework that can help them in operationalizing AI in their R&D processes. Consequently, there is a significant knowledge gap regarding organizational capabilities, as the use of AI (decision-making, problem-solving, productivity, customer satisfaction, and technology infrastructure) shapes the innovation context and, in turn, affects the performance of a start-up enterprise. This is crucial to understand, as the Saudi AI market alone is expected to reach $ 14 billion by 2030, growing at a compound annual growth rate of 43.1%. Still, only 15% of the start-ups realized they have adequate AI funding. To clarify these potential outcomes from a systematic academic perspective, aiding policymakers and practitioners, we have identified a lack of empirical frameworks that describe exactly how AI promotes innovation outcomes.

Therefore, this study examines the impact of AI integration on the performance of start-up enterprises within Saudi Arabia's innovation ecosystem, utilizing the Innovation Environment (IE) framework. More specifically, it aims to investigate the relationship between AI-enhanced Organizational Capabilities (AIOC) in decision-making, problem-solving, productivity, customer satisfaction, and technology infrastructure, and their impact on the Innovation Environment.

1.1 Research Objectives

1. Assess the impact of AI-driven decision-making on the development of the innovation environment in Saudi start-ups.
2. Examine the effect of AI-enabled problem-solving on fostering an innovation-oriented culture.
3. Evaluate the role of AI-based productivity in enhancing R&D-driven innovation practices.
4. Investigate how AI-supported customer satisfaction contributes to the creation of a collaborative and innovative ecosystem.
5. Analyse the impact of technology infrastructure readiness on strengthening the innovation environment within start-ups.

2. Literature Review

The present study proposes solutions for this gap by investigating how AI-powered organizational capabilities (decision-making, problem-solving, productivity, customer satisfaction, and technology infrastructure) affect the innovation ecosystem of Saudi start-ups. This is essential, as incorporating AI in R&D is imperative for driving technical progress and economic growth in Saudi Arabia. Innovation and private enterprise are vital to realizing the goals of Saudi Vision 2030 (Saudi Vision 2030, 2021; Monshaat, 2023).

2.1 Define AI in the context of R&D and start-ups.

Artificial Intelligence (AI) refers to the creation of computer systems that can perform tasks typically requiring human intelligence, including reasoning, learning, problem-solving, and adaptation. AI, which began with a rather theoretical foundation at the Dartmouth Conference in 1956, has evolved into a branch of ML and DL that is at the core of automation, innovation, and data-driven decision-making across industries worldwide. AI accelerates data analysis, reducing experimental cycles and facilitating advanced predictive modeling, which supports faster and more informed innovation processes in research and development (R&D) (Babina et al., 2024).
In an ethical sense, we refer to the ability of digital computers or computer-controlled robots to perform tasks typically associated with human innovative thinking. One use of this term refers to projects aimed at building formal or computational systems to perform functions that humans naturally perform (e.g., logical reasoning, generalization, meaning extraction, and learning through experience) (Copeland, 2024). AI adoption presents both a strategic opportunity and a developmental challenge for start-up enterprises, particularly in emerging economies like Saudi Arabia, as successful deployment requires substantial data infrastructure, capital, and institutional support; when well-integrated, AI is a driver of innovation, pairing human intelligence with computer power to enhance competitiveness, accelerate scientific progress, and support Saudi Arabia's national development and objectives. AI-driven organizational capabilities enhance financial reporting through trend analysis, automated data processing, reduced human error, and improved real-time reporting. They also enable cost control through forecast analytics, which helps improve asset distribution and ESG disclosures by providing efficient tracking of sustainability indicators and regulatory compliance.

2.2 Dimensions of AI-Driven Organizational Capabilities

Each sub-section describes one variable (Independent Variables) and its link to innovation:
Decision-Making (DM): Many researchers argue that it is a multidimensional process that affects individual cognition and intelligence, depending on contextual factors such as technology, organizational structure, and environmental uncertainty. As a result, decision-making is one of management's primary functions, encompassing planning, organizing, motivating, and controlling. It is an essential function where every decision must be accurate and specific, as it affects the organization's performance and competitiveness (Topanica, 2025). However, effective decision-making in modern business is a data-driven activity supported by artificial intelligence, predictive analytics, and business intelligence tools that convert massive amounts of raw data into actionable insights for designing operational and strategic efficiency (Morozov, 2022). A good business decision involves leveraging modern technology and creative ideas to meet customer needs, achieve high customer satisfaction, and retain business and market competencies (Muslim et al., 2023).
Problem-Solving (PS): Problem-solving is a complicated cognitive activity that entails defining and expressing problems and considering prospects and solutions through advanced thinking ability; this highly desirable skill can benefit individuals of any age in numerous settings, whether it is in a classroom, in the office, or for practical occurrences in everyday life. Rather, problem-solving is defined broadly as some form of effortful, goal-oriented thinking that an individual, team, or other stakeholder employs to overcome a barrier or achieve a target performance level; it requires identifying a problem, generating solutions, and selecting and implementing the most effective solution (Wu et al., 2024). Problem-solving is a fundamental human skill essential for navigating and resolving conflicts in complex, dynamic settings, as noted in educational and psychological contexts (Munali et al., 2024).
Productivity (PR): Productivity is the ratio of what is produced to what is required to create it. Moreover, productivity is the output per unit of input used to produce goods and services. It also represents the ratio of output to input in the production process and in the general act of generating output, indicating the total production output gain per unit of input over a specified period. It compares the output produced with a unit of input (land, labor, capital, or management). It refers to the efficiency and effectiveness of a single individual action or, more broadly, of an entire economic activity. Productivity refers to an employee's capacity to exceed the company's expectations. For example, when an employee is assigned a job or task, human resources should ensure the employee is productive. Employee motivation plays a significant role in determining another major factor affecting employee productivity (Robin, 2023). It examines the number of services or products requested and considers only helpful resources, such as workers, tools, and finances. It also assesses how many products can be generated over a specific period to avoid expiration.
Customer Satisfaction (CS): A key metric indicating how well a company's results or services meet or exceed customer expectations. It also assesses how a customer interacts with a brand, which affects promotion, loyalty, and the business. According to Shaikh (2024), Customer satisfaction is commonly defined as a measure of how well a company's services or products meet or surpass customer expectations, leading to satisfaction or disappointment based on the comparison between perceived performance and primary expectations. Otto et al. (2020) identify a positive relationship between customer satisfaction and enterprise performance, which can only be assessed when a specific set of marketing strategies and performance measures is used.
Technology Infrastructure (TI): Technology infrastructure refers to the basic physical and virtual resources that manage data storage, processing, and analysis (software, hardware, networks, data centers, etc.), as well as the organization of qualified people who manage and maintain these resources and develop them. An Information Technology (IT) organization comprises the collective set of hardware, software, and networks that enable the overall functioning of an enterprise's IT environment. It delivers the entire skeleton, enabling the

company to offer a range of tasks and services to its internal employees and external customers. Van et al. (2024) described digital and technological infrastructure as commonly used technologies, systems, products, and platforms (e.g., the Internet, social media, mobile technology, cloud computing, blockchain) that support economic partnerships and transactions in business and society.

2.3 Innovation Environment (IE)

The innovation environment (Dependent Variable) focuses on broader aspects, including the culture, environment, and structures that encourage the creation, development, implementation, and diffusion of new ideas, processes, services, or products. The innovation ecosystem is a multi-layered system consisting of institutional resources, networks, and cultural elements that together create an atmosphere where innovation can thrive and grow; also, note that its effectiveness relies on the capacity of its supporting institutions, the quality of interaction between actors, and resource endowments (Baldwin et al., 2024). Technological innovation, when embedded in a supportive environment, leads to higher customer satisfaction by improving service quality, responsiveness, and personalization. Customer involvement in co-development and the use of digital tools further mediate satisfaction outcomes (Dean et al., 2024). The Technology–Organization–Environment (TOE) is a theoretical framework that explains how organizations adopt and implement new technologies, initially proposed by Tornatzky and Fleischer in 1990. The technological aspect of the TOE framework refers to the features of AI technologies that affect their adoption. Researchers have found that factors such as relative advantage, compatibility, and perceived complexity influence the adoption of AI. The perceived relative advantage of AI technologies is a critical driver of SMEs' adoption, improving their operational and economic performance (Badghish & Soomro, 2024; Sharma et al., 2024).

The Unified Theory of Acceptance and Use of Technology (UTAUT) model was used in this study to provide empirical evidence on how AI adoption stimulates innovation and national R&D transformation. Venkatesh et al. (2012) established the theory to predict users' IT adoption behavior in business environments. Startups adopt AI when it enhances competitive advantage and aligns with business goals. A comprehensive analysis highlights a surge in UTAUT-based AI research in business, where performance expectancy and social influence are key drivers of adoption (Kadim et al., 2024). Human-centric and ethical considerations, such as job threats, bias, and privacy concerns, are crucial to the adoption of AI across startups, the economy, and corporations. These factors further refine UTAUT to reflect better behavioral intentions and real-world constraints in business environments (Alasmari, 2024). The findings, which bridge Saudi Arabia's top-down AI strategy with the bottom-up innovation potential of start-ups, aim to provide policymakers, entrepreneurs, and scholars with practical insights on building a better innovation environment for the Kingdom.

2.4 Challenges of AI adoption

Artificial Intelligence (AI) is quickly becoming one of the most impactful enabling technologies for improving research and development (R&D) efficiency and innovation performance for start-up enterprises. However, its adoption has raised ethical and strategic controversies. Also, critics have said that the sudden adoption of AI to make decisions and solve problems will exacerbate issues of data bias and privacy violation, and create other problems, such as lost jobs, making them question the viability of the AI ascendance in the long run; and, this balancing act between innovation and regulation is crucial in the Saudi Arabian landscape, particularly in light of the Vision 2030 initiative which promotes technological development and economic diversification; Beyond funding and skills shortages, startups also face institutional inertia, a lack of clear regulatory frameworks, and public concern, all of which can slow AI adoption and affect its effectiveness. Supporters praise how AI can make data more widely available and foster greater entrepreneurship. This enables easier, scalable ventures for entrepreneurs as AI improves market and economic analysis, enhances customer engagement, and makes overall business processes more efficient (Usman et al., 2024). Thus, while the growing penetration of AI within Saudi start-ups to drive productivity gains and competitive advantage is to be welcomed, it is essential

To provide ethical governance at the gates so that advancements in technology can remain consistent with the principles of social responsibility, transparency, and inclusive growth in the emerging innovation ecosystem of the Kingdom.

2.5 Theoretical Framework and Hypotheses Development

AI-Oriented Organizational Competencies (AIOC) describe a firm's ability to orchestrate, deploy, and repurpose AI (artificial intelligence) technologies to maximize value creation from core business competencies, such as process automation, cognitive insight generation, and cognitive engagement, thereby improving organizational performance and enabling it to thrive in rapidly changing business environments. These are supported by a mix of physical (infrastructure), intangible (data assets), and human (AI or other skill sets) resources, serving as the foundation for individual firms' digital transformation and innovation (Neiroukh et al., 2024). These capabilities, including decision-making efficiency, problem-solving capacity, productivity enhancement, customer responsiveness, and technological base, can significantly impact start-up performance. The elements can each be contributed to or removed from a strategy without completely undermining it. However, the combination of these two produces a grander strategic collaboration than either capability does individually. Without the right people, advanced technology alone is not very helpful, and human expertise is useless without innovative systems or tools. AIOC, therefore, can draw its strength collectively from the synergistic mix of these complementary competencies, which in unison create an environment enabling innovation and maximizing the efficacy of R&D. This conceptualization serves as the basis for the hypotheses of this study, which stipulate that AIOC positively affects the innovation environment and the performance of start-up enterprises and that the innovation environment in proposed research model Fig 1 and complete list of hypothesis Table 1.

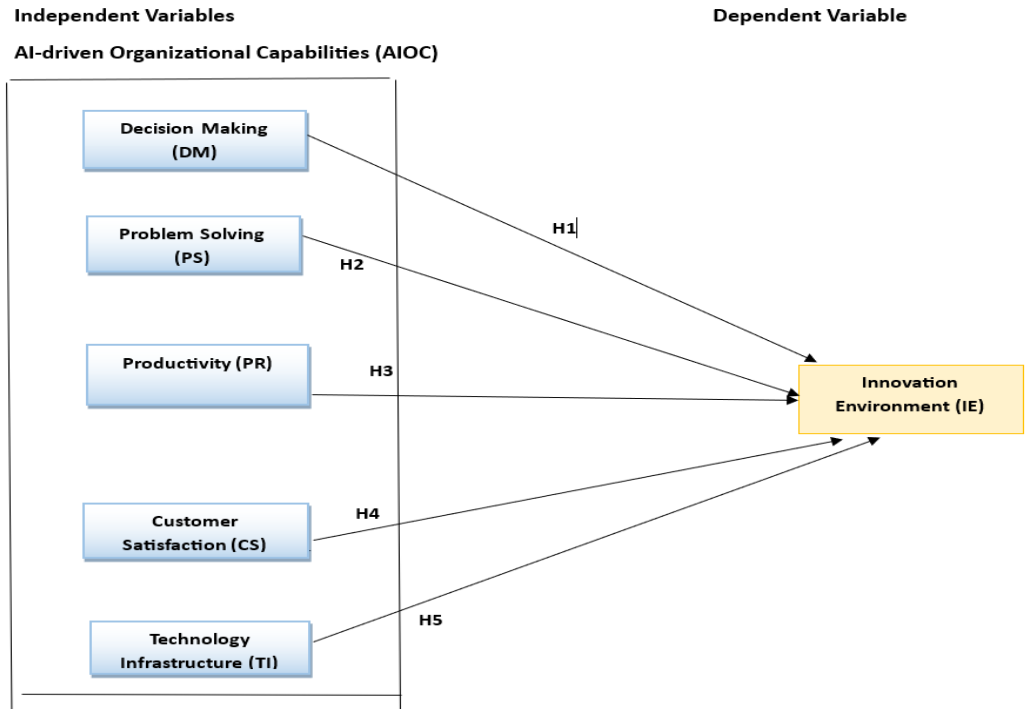

Fig.1: Proposed Research Model.

Table 1: The list of hypotheses.

No	Expected Outcome
H1	AI-driven Decision-Making positively impacts the Innovation Environment.
H2	AI-driven Problem-Solving positively influences the Innovation Environment.
H3	AI-driven Productivity positively affects the Innovation Environment.
H4	AI-driven Customer Satisfaction positively influences the Innovation Environment.
H5	AI-driven technology infrastructure has a positive impact on the Innovation Environment.

3. Methodology

This research employs a quantitative, cross-sectional design to investigate the impact of AI-based organizational capabilities on the innovation ecosystems of Saudi start-ups. The TOE and UTAUT are the relevant frameworks utilized by this study, which identifies innovation environment in fifteen categories of AI abilities: decision-making, problem-solving, productivity, customer satisfaction, and technology infrastructure, as central elements of influence; and data were gathered using a structured online questionnaire, distributed among 384 sampled participants from diverse sectors within Saudi start-ups, such as technology, healthcare, and manufacturing. The instrument included demographic information and 30 questions with 5-point Likert-scale items from previous validated studies. The cross-sectional design was selected to assess the current state of AI adoption and its impact on innovation, to create a digital, knowledge-based Saudi economy.

The data were analyzed using SPSS and Partial Least Squares Structural Equation Modeling (PLS-SEM) with SmartPLS 4.0 in a two-stage procedure: measurement model assessment and structural model evaluation. Demographic and organizational characteristics of the firms were summarized using descriptive statistics, and the predicted direct effects of AI-driven capabilities on the innovation environment were further investigated using path analysis. The validity and reliability of this model were confirmed through composite reliability, Average Variance Extracted (AVE), and discriminant validity tests. To check the significance of path coefficients, bootstrapping with 5,000 resamples was applied (Hair et al., 2022).

4. Results

The study surveyed 384 respondents representing a diverse range of Saudi start-ups. As shown in Table 2, most were male (54.7%) and aged 25–54, indicating a mid-career workforce. Regarding education, 34.4% held a bachelor's degree, 29% had a diploma or master's degree, and 16.4% held a PhD. Participants primarily worked in the e-commerce, manufacturing, finance, technology, and healthcare sectors. Nearly 27% were employed in firms operating for 1–3 years, and 26% in companies with over six years of activity. In terms of size, 38.5% worked in medium-sized enterprises (50–249 employees), followed by 22.1% in large firms (250 or more employees). The demographic profile reflects a balanced and experienced sample suitable for analysing AI-driven innovation in Saudi start-ups.

Table 2: Demographic Data Descriptive Analysis

Factor	Category	Frequency (N = 384)	Percent (%)
Gender	Male	210	54.7
	Female	174	45.3
Age	18–24	84	21.9
	25–34	69	18.0
	35–44	75	19.5
	45–54	92	24.0
	55 and above	64	16.7
Education Degree	High School	41	10.7

	Diploma	66	17.2
	Bachelor	132	34.4
	Master	48	12.5
	PhD / Doctorate	63	16.4
	Others	34	8.9
Industry	Technology	60	15.6
	Healthcare	53	13.8
	E-Commerce	70	18.2
	Finance	69	18.0
	Manufacturing	70	18.2
	Oil & Gas	4	1.0
	Others	58	15.1
Years of Company	Less than 1 year	95	24.7
	1–3 years	102	26.6
	4–6 years	86	22.4
	More than 6 years	101	26.3
Size of Company	1–5 employees	73	19.0
	6–49 employees	78	20.3
	50–249 employees	148	38.5
	More than 250 employees	85	22.1

4.1 Measurement Model

The measurement model demonstrates in Fig. 2 strong indicator loadings and construct reliability for all variables in the study; also, five exogenous constructs: Decision Making (DM), Problem Solving (PS), Productivity (PR), Customer Satisfaction (CS), and Technology Infrastructure (TI) were used to represent AI-driven organizational capabilities. At the same time, Innovation Environment (IE) is the dependent variable. All factor loadings exceeded the 0.70 threshold, and the composite reliability ranged from 0.858 to 0.951, confirming internal consistency. The AVE values were all above 0.50, thus confirming good convergent validity. The structural paths indicate that AI capabilities, specifically productivity, customer satisfaction, and problem-solving, have a positive impact on the innovation environment in Saudi Arabia's start-up ecosystem.

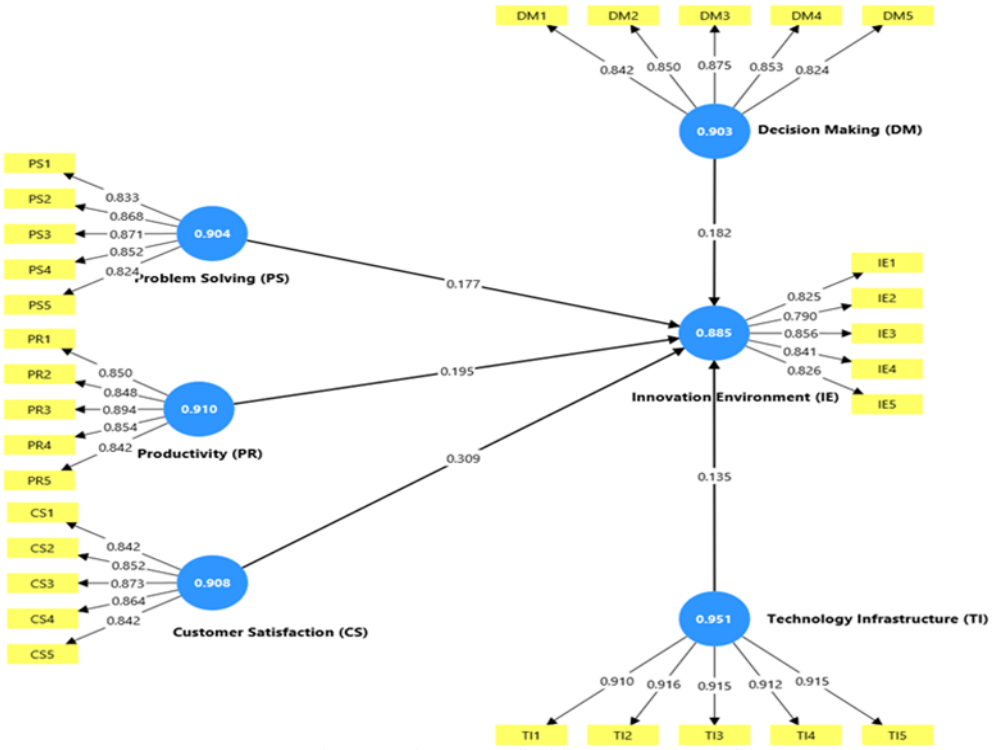

Fig. 2: The Research Framework with Measurement Model.

The reliability and validity results for the reflective constructs are shown in Table 3. Cronbach's alpha and composite reliability (CR) showed an internal consistency with Cronbach's alpha values between 0.885 and 0.951, and CR values greater than 0.90, indicating excellent internal consistency for all measures. All AVEs exceed 0.50, indicating sufficient convergent validity; furthermore, for CS (0.731), DM (0.721), IE (0.685), PR (0.736), PS (0.722), and TI (0.835), the AVEs are considered satisfactory. These findings confirm the reliability and validity of the constructs used in this study, making them suitable for future structural model analysis.

Table 3: Cronbach's alpha, Composite Reliability and Validity Tests

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
CS	0.908	0.908	0.931	0.731
DM	0.903	0.904	0.928	0.721
IE	0.885	0.887	0.916	0.685
PR	0.910	0.913	0.933	0.736
PS	0.904	0.906	0.929	0.722
TI	0.951	0.951	0.962	0.835

Discriminant validity was examined among the constructs using HTMT values summarized in Table 4. All HTMT values are below the threshold of 0.85, thereby confirming that no constructions are similar to each other. HTMT The highest HTMT value observed is 0.794 (between IE & CS), but all remain within the acceptable range, indicating no multicollinearity/overlap between the variables. Hence, the results confirm discriminant validity, implying that each construct measures a distinct conceptual domain within the model.

Table 4: HTMT (Heterotrait–Monotrait Ratio) results

	CS	DM	IE	PR	PS	TI
CS						
DM	0.614					
IE	0.794	0.754				
PR	0.724	0.715	0.784			
PS	0.622	0.714	0.746	0.691		
TI	0.592	0.656	0.690	0.630	0.633	

4.2 Structural Model

The structural model results in Fig. 3 show that AI-based organizational capabilities account for 68.5% of the variance in the Innovation Environment (IE), with an R^2 of 0.685 (adjusted R^2 of 0.681), providing strong explanatory power. According to Hair et al. (2022), R^2 values greater than 0.50 indicate strong predictive power (Alderson et al., 2021), indicating that the new model can explain most of the factors that determine the innovation climate in Saudi launch start-ups, as shown in Table 5.

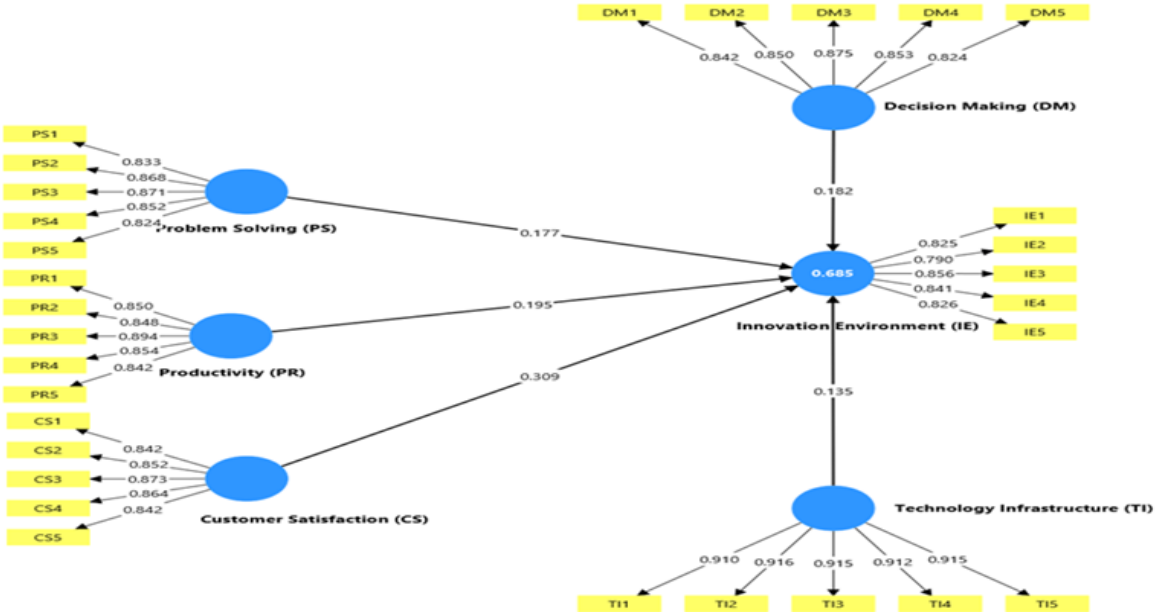

Fig. 3: The Research Framework with Structural Model.

Table 5: R^2 Result

	R-square	R-square adjusted
IE	0.685	0.681

4.3 Hypothesis Testing

Hypothesis testing results for AI-driven organizational capabilities in the Innovation Environment (IE) are presented in Table 6. Statistical support was found for all five hypotheses ($p < 0.01$), indicating positive and significant relationships. Customer Satisfaction ($\beta = 0.309$, $p < 0.001$) was the most prominent predictor of the innovation environment, followed by Productivity ($\beta = 0.195$, $p < 0.01$) and Decision-Making ($\beta = 0.182$, $p < 0.01$). The other components, Problem-Solving ($\beta = 0.177$, $p < 0.01$) and Technology Infrastructure ($\beta = 0.135$, $p < 0.01$), were also statistically significant with meaningful effects. All these results, illustrated in their entirety, show that all dimensions of AI-driven organizational capabilities contribute more to the Saudi start-up innovation environment.

Table 6: Hypothesis Testing

	Original sample (O)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values	Result
Customer Satisfaction (CS) → Innovation Environment (IE)	0.309	0.056	5.540	0.000	Supported
Decision Making (DM) → Innovation Environment (IE)	0.182	0.061	3.001	0.003	Supported
Problem Solving (PS) → Innovation Environment (IE)	0.177	0.056	3.164	0.002	Supported
Productivity (PR) → Innovation Environment (IE)	0.195	0.059	3.329	0.001	Supported
Technology Infrastructure (TI) → Innovation Environment (IE)	0.135	0.049	2.757	0.006	Supported

5. Discussion

The results of this study present robust empirical evidence that organizational capabilities driven by AI improve the innovation environment and performance of start-up companies in Saudi Arabia Of the five categories of capability examined, customer satisfaction and productivity were found to be leading innovators, reinforcing the idea that tools that help brands engage customers and automate processes are key enablers in innovation ecosystems; Utilizing AI for customer intelligence, customization of services, and making operations as productive as possible, New-age companies that are more innovative in their execution and the result to get better performance. Additionally, enhanced decision-making and problem-solving capabilities improved the fast-paced start-up's agility and strategic responsiveness, confirming that AI enables data-driven, evidence-based decisions that help firms navigate uncertainty and explore new avenues of growth. These results align with findings from studies worldwide, confirming that AI reshapes research, development, and innovation through improved information dissemination and reduced friction in finding new combinations of ideas, as well as through policy experimentation (Robin, 2023; Massoudi et al., 2024).

The analysis further demonstrates that AR and AI-driven capabilities play a critical role in shaping the innovation environment and driving enterprise performance. It underscores that organizational resources alone are not enough to drive this mindset; they are supported by a supportive ecosystem that includes knowledge sharing, collaboration, and digital infrastructure. The finding is that the highest level of impact is when AI integration is in innovation ecosystems characterized by access to resources, supportive regulatory environments, and institutional interconnectedness. This result aligns with Saudi Vision 2030, which is focused on diversification driven by innovation and the establishment of a prosperous digital economy. It shows that only with external enablers, such as funding programs, research partnerships, and policy incentives that support digital transformation, can start-ups build a sustained competitive advantage through internal AI capabilities.

From an accounting and economic standpoint, these results broaden the scope of AI-based capabilities beyond innovation and operational performance to include the financial and strategic aspects of start-up management. AI integration into decision-making and productivity enhances R&D outcomes, improves cost optimization, and increases the accuracy of economic forecasting and R&D productivity transparency, all of which are essential drivers of sustainable enterprise performance, including disclosure of a company's social responsibility, environmental impact, and governance practices reporting. Start-ups can enhance their return on capital, calibrate their cost bases, and align innovation spending with economic returns by embedding AI-enabled analytics into financial and managerial processes. As such, the study integrates innovation with firm profitability, offering readers a different and more comprehensive perspective on the intricacy of how AI enhances the dual aspects of reinforcement, organizational agility, and accounting efficiency through a multi-path, multi-mediation approach in an emerging market context.

Finally, the findings support the expectation that AI adoption has a positive impact on innovation, productivity, and financial resilience in Saudi start-ups. However, on the other hand, it highlights that the effectiveness of AI in R&D ultimately depends on how robust the rest of the innovation ecosystem is. These results further elucidate the combination of enabling AI capabilities, an innovative culture, and a financial strategy necessary to achieve the combined goals of renewables-led economic diversification and sustainable enterprise growth in Saudi Arabia.

6. Recommendations

According to the study results, start-up leaders need to make informed decisions about which AI capabilities to implement to strengthen the performance and innovation advantages of talent. They are advised to emphasize decision-making, problem-solving, and AI-powered customer analytics systems, as these functions are found to yield the highest returns in terms of innovation productivity and R&D outcomes. A commonly preferred phased approach is to begin with data management and customer engagement automation, moving up the value chain toward predictive analytics and innovation modelling, thereby minimizing waste and risk during implementation, particularly for small companies working on shoestring budgets.

The implications of the results for policymakers and innovation authorities, including SDAIA and RDIA, are similar. There is a need for adaptive regulatory environments that support responsible AI experimentation while maintaining a balance between data privacy protection and ethical principles. Further investments are needed in AI infrastructure, open data-sharing platforms, and national upskilling programs to strengthen the digital assets and capabilities of entrepreneurs and SMEs. Finally, institutional mechanisms must be established to foster collaboration among academia, industry, and government through innovation labs and public-private partnerships that channel AI-driven research to address the specific needs of Saudi start-ups. These actions will help kick-start the AI era, stimulate innovative entrepreneurship, and support the Kingdom's objective of building a knowledge-based, globally competitive economy.

7. Future Work and Limitations

This study contributes to the existing literature on how AI-enabled organizational capabilities, in turn, impact start-up performance and the innovative environment in Saudi Arabia; however, it has limitations due to its cross-sectional design. Given its focus on the Riyadh start-up environment, the generalizability of the findings may be limited to other regions or industries in the Kingdom. Longitudinal designs that assess the progress of AI integration over time and the dynamic nature of ongoing adoption on the sustainability of enterprise performance and innovation should be carried out in future research.

Moreover, including qualitative methods such as in-depth case studies, expert interviews, or focus groups would enable to better understanding of the contextual subtleties behind the difficulties and success enablers of AI implementation; and, Broader comparative studies across various Saudi regions (e.g. Jeddah, Eastern Province) or bordering GCC or MENA countries (e.g. Kuwait, Qatar, Bahrain, UAE, Oman, Jordan, or Egypt) might also increase generalizability of results and contrast regional predispositions towards AI readiness, regulatory climates, and entrepreneurial culture. Future research of this nature would not only corroborate the findings of this study but also provide a broader appreciation of the nature of AI-enabled innovation ecosystems in the Gulf, thereby serving both academic and policy-oriented audiences.

8. Conclusion

This paper highlights the significance of utilizing artificial intelligence (AI) tools to inform decision-making, enhance problem-solving, boost productivity, improve customer satisfaction, and optimize technology infrastructure, ultimately fostering a more innovative environment and improved performance among Saudi start-ups. The positive and significant associations between these variables support the idea that AI is a driver of radical improvements in more innovative R&D processes and sustainable growth. The research focuses on the innovation environment as a factor, providing empirical evidence that AI adoption success requires both internal and external factors. This has never been done before at this level of research, giving contextualization on what AI-driven innovation entails in the context of Saudi Arabia´s Vision 2030. It serves as an ultimate guide for entrepreneurs, academia, and policymakers on leveraging national economic transformation through AI-driven innovation tools.

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