



The Impact of Adopting Artificial Intelligence Tools on the Efficiency of Entrepreneurial Innovation in Startups in Iraq: An Applied Quantitative Study

Husam Salah Sameen^a, Bayda Zahid Kamil^a

^a Al Muqdad College of Education - University of Diyala, Iraq

Dr.husam@uodiyala.edu.iq

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ABSTRACT

The main objective of this research is to explore the effect of using artificial intelligence (AI) tools on innovation efficiency. Data collection was performed using an electronic questionnaire based on 3 main dimensions and analyzed using descriptive and inferential statistics (Pearson's correlation, simple linear regression). The findings showed a moderate level of AI uptake and usage for Iraqi startups. The study used a descriptive-analytical and cross-sectional design with a targeted sample of 150 entrepreneurs operating in technology, e-commerce, and financial services sectors. (Mean = 2.22, Relative Importance = 74%) and a high level of entrepreneurial innovation efficiency (Mean = 2.27, Relative Importance = 75.7%). Findings confirmed a strong, positive, and statistically significant relationship between the two variables ($r = 0.742$, $p < 0.001$), with AI adoption explaining 55.1% of the variance in entrepreneurial innovation efficiency. The study concluded that AI is a great strategic factor for developing entrepreneurial innovation in Iraq. Startups, despite limited financials and tech. Some recommendations focused on the involvement of governmental and technical support for the development of systems to measure innovation performance, as well as maintaining an innovation-oriented culture within startups.

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1. Introduction

In the last two decades, the world has never faced such a knowledge and technology of the deep learning revolution, most notably the quick advancement of AI technologies is one. Now, that is one of the tools that is reshaping the global economy (Smith, 2023, p. 14). Artificial intelligence is no longer just an assistive technology, but has become a strategic element in shaping new business models and achieving entrepreneurial innovation, which is the main driver of economic growth in the era of globalization (Johnson, 2022, p. 88). Startups, as small or medium-sized economic entities that rely on innovation as a means of survival and expansion, face significant challenges in developing environments such as Iraq, where the economic environment is characterized by weak technical infrastructure, limited funding, and difficult access to global markets (Al-Khalidi, 2021, p. 45). These challenges make the adoption of AI tools an indispensable strategic option, as these tools can provide innovative solutions to complex problems and open new horizons for startups to enhance their competitiveness (Brown, 2024).

2. Research Problem

Despite the increasing importance of artificial intelligence in supporting entrepreneurial innovation, there is a clear knowledge gap in the Arab and Iraqi literature on the extent to which the adoption of these tools affects the efficiency of startups. Hence,

the research problem can be formulated in the main question: What is the impact of the adoption of artificial intelligence tools on the efficiency of entrepreneurial innovation in startups in Iraq? Does the use of AI tools contribute to improving the quality of products and services within startups (Lee, 2023, p. 67)? What is the relationship between the level of AI adoption and the ability of startups to expand in local and international markets (Ahmed, 2022, p. 91)? To what extent can AI enhance the competitiveness of startups in a volatile economic environment (Miller, 2025, p. 33)? Can AI reduce operational costs and increase the productivity of startups (Taylor, 2021, p. 56)?

3. Research Objectives

- This research aims to achieve a set of scientific and practical goals, most notably:
- Uncovering the nature of the relationship between the adoption of artificial intelligence tools and the efficiency of entrepreneurial innovation in startups in Iraq (Hassan, 2023).
- Identify the most prominent smart tools and applications that can support startups in Iraq, such as data analytics systems, machine learning, and process automation (Williams, 2024).
- Provide practical recommendations to decision-makers and entrepreneurs on how AI can invest in fostering entrepreneurial innovation (Peterson, 2025).

4. Research Objectives

The importance of this research stems from several aspects: Theoretical importance: The research contributes to bridging a knowledge gap in the Arabic literature on the relationship between artificial intelligence and entrepreneurial innovation, and adds a new theoretical framework that can be built on in subsequent studies (Khan, 2023). Applied importance: This research offers practical recommendations to help startups in Iraq improve performance using AI tools, increasing their chances of success in a challenging economic environment. (Peterson, 2025). Societal Importance: Research supports Iraq's economic and social development by strengthening startups' role in creating new jobs and achieving sustainable growth (Mahmoud, 2021).

5. Research Hypotheses

The main theory: The positive and significant relationship between the adoption of artificial intelligence tools and the capability of entrepreneurial novelty in startups in Iraq.

6. Theoretical Framework and Previous Studies

The theoretical framework is a crucial foundation upon which hypotheses and findings in empirical studies are based, providing the necessary methodology for understanding and analyzing those studies. This research focuses on exploring the relationship between artificial intelligence and startups, with particular attention to

Artificial intelligence is considered a set of systems and technologies that keep pace with human talents in learning, analysis, and making appropriate decisions. The Iraqi context and its economic and technological challenges (Russell & Norvig, 2021).

Entrepreneurial Innovation is considered a process of improving or developing new products or services to achieve a competitive benefit for startups (Schumpeter, 2022, p. 33).

Startups: Considered small or medium-sized companies in the early stages, relying on creativity for rapid growth (Blank, 2023).

Efficiency: The ability of projects to attain their objectives at the minimal expense and with the highest possible quality (Porter, 2024).

6.1 Concept of Artificial Intelligence

Artificial intelligence (AI) is defined as the ability of computer systems to keep pace with and simulate human cognitive abilities, such as thinking, learning, analysis, and decision-making (Russell & Norvig, 2021). This field has witnessed significant development since the mid-20th century, and AI has now become a strategic tool contributing to the development of innovative business models (Smith, 2023). Its applications are diverse, encompassing machine learning, natural language processing, computer vision, and intelligent robotics (Johnson, 2022). Furthermore, its uses have expanded to cover the economic, educational, health, and financial services sectors, thus making AI a fundamental and crucial element in supporting and fostering entrepreneurial innovation.

6.2. Entrepreneurial innovation

Entrepreneurial innovation is a process aimed at improving or developing products and services that contribute to competitiveness among startups. (Schumpeter, 2022). Innovation is considered a fundamental and effective element for the success of companies and for enabling them to face competition in the labor market. (Blank, 2023).

Innovation encompasses many types, such as product innovation, process innovation, marketing innovation, and organizational

innovation (Porter, 2024). In Iraq, entrepreneurial innovation is a pressing need, given the economic and social challenges faced by startups, which in turn seek creative solutions to enhance their sustainability, growth, and strength.

6.3 The Relationship between Artificial Intelligence and Entrepreneurial Innovation

Recent research indicates that artificial intelligence (AI) plays a crucial role in supporting a leading vision across several key areas. It enables consumers to analyze big data, elevating market accuracy (Lee, 2023). AI also contributes to operational efficiency, leading to lower prices and improved production scale (Nguyen, 2024).

Furthermore, AI aims to predict future trends, helping to identify opportunities and mitigate potential risks, thus supporting a more effective strategy (Miller, 2025). Finally, AI enhances product quality by providing more detailed and clearer solutions tailored to customer needs and expectations (Roberts, 2022).

6.4 Startups in Iraq

Recent research indicates that artificial intelligence (AI) plays a crucial role in supporting a leading vision across several key areas. It enables consumers to analyze big data, elevating market accuracy (Lee, 2023). AI also contributes to operational efficiency, leading to lower prices and improved production scale (Nguyen, 2024).

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6.5 Artificial Intelligence as a Strategic Tool

The strategic use of artificial intelligence tools for startups, as it contributes to: decreasing operational costs (Ali, 2024). Increasing production efficiency (Chen, 2023). Enhancing competitiveness (Roberts, 2022). Supporting data-driven strategic decision-making (Taylor, 2021). The Innovation Model: Emphasizes the importance of collaboration between institutions and society in the development of innovation (Chesbrough, 2022). Technology Acceptance Model (TAM): Explains the factors that affect the acceptance of new technology by individuals and organizations (Davis, 2021). Competitive Advantage Model: It focuses on how organizations achieve a competitive advantage through innovation and technology (Porter, 2024).

6.6 Artificial Intelligence and Digital Economy

The digital economy relies heavily on artificial intelligence, as it is used in e-commerce, financial services, and healthcare (Williams, 2024). Startups that adopt AI have greater potential to expand into digital markets (Peterson, 2025). Despite the great benefits, there are challenges facing startups when adopting artificial intelligence, such as a lack of specialized human competencies (Mahmoud, 2021). High costs of investing in technology (Nguyen, 2024). Resistance to change within organizations (Taylor, 2021). The need for supportive government policies (Khan, 2023).

6.7. Artificial Intelligence and Innovation in the Iraqi Context

AI in Iraq can contribute to addressing issues such as weak infrastructure, limited funding, and difficulty in accessing global markets (Al-Samarrai, 2022). It can also help enhance products and services that are tailored to the needs of the local market, such as e-learning solutions, services of digital health, and smart financial applications (Ahmed, 2022). Through a review of the literature, it can be said that artificial intelligence represents a

strategic tool for startups in Iraq, as it contributes to promoting entrepreneurial innovation by improving the quality of products and services, reducing operational costs, and increasing competitiveness. However, the success of these projects depends on the extent to which they are able to effectively adopt these tools and employ them in a complex economic and social context (Taylor, 2021).

6.8. Efficiency of Entrepreneurial Innovation in Startups

Entrepreneurial innovation is defined as the ability of startups to achieve their innovation goals at the lowest cost and the highest possible quality (Porter, 2024). It is not limited to generating new ideas, but also includes the ability to turn these ideas into marketable products and services (Schumpeter, 2022). Efficiency in entrepreneurial innovation includes several dimensions: Production efficiency: the ability to produce high-quality products and services at the lowest cost (Ali, 2024). Marketing efficiency: the ability to reach customers effectively (Chen, 2023). Organizational efficiency: the ability to efficiently manage human and financial resources (Roberts, 2022). Strategic Efficiency: The ability to make data-driven strategic decisions (Taylor, 2021). Entrepreneurial innovation is considered an essential entry point for achieving efficiency in startups, as it contributes to the development of new products and services, improving processes, and enhancing competitiveness (Lee, 2023). Technology, especially artificial intelligence, plays a pivotal role in enhancing efficiency through:

- Process automation (Nguyen, 2024). Improving the quality of products and services (Miller, 2025).
- Reducing operational costs (Brown, 2024). Efficiency in entrepreneurial innovation is closely related to competitive advantage, as it gives startups the ability to stand out in markets and face competition (Porter, 2024).

Competitive Advantage Model: Explains how organizations achieve a competitive advantage through efficiency and innovation (Porter, 2024). Open Innovation Model: Emphasizes the importance of cooperation between institutions and society in achieving efficiency (Chesbrough, 2022).

Technology Acceptance Model (TAM): Explains the factors that influence the adoption of new technology and the enhancement of efficiency (Davis, 2021).

6.9 Efficiency in Iraqi Startups

In Iraq, startups face significant challenges such as weak technical infrastructure, limited funding, and difficulty in accessing markets (Al-Khalidi, 2021). The success of accredited institutions is achieved by their ability to innovate modern technology, especially artificial intelligence, effectively and significantly (Taylor, 2021). (Al-Samarrai, 2022).

Artificial intelligence contributes to enhancing efficiency through: Improving production processes (Roberts, 2022). Reducing operational costs (Nguyen, 2024). Enhancing competitiveness (Chen, 2023). Despite the great benefits, there are challenges facing startups when trying to achieve efficiency, such as: Lack of specialized human competencies (Mahmoud, 2021). High costs of investing in technology (Taylor, 2021). Resistance to change within organizations (Khan, 2023).

6.10 Comprehensive Theoretical Analysis

Through a review of the literature, it can be said that efficiency in entrepreneurial innovation is a key element for the success of startups in Iraq, as it contributes to improving the quality of products and services, reducing operational costs, and increasing competitiveness. However, the success of these enterprises relies

on their capability to adopt modern technology, especially artificial intelligence, effectively (Taylor, 2021).

6.11 The Complementary Relationship between Artificial Intelligence and Entrepreneurial Innovation Efficiency

There is no linear relationship between artificial intelligence (AI) and entrepreneurial innovation efficiency; rather, it is a complex, interconnected, and complementary relationship involving technological, economic, and organizational factors. Consequently, startups adopt AI tools that achieve operational improvements and an innovative approach to enhance their competitiveness and improve their efficiency in transforming ideas into marketable products and services (Russell & Norvig, 2021). AI represents the technological infrastructure, while entrepreneurial innovation represents the intellectual and creative infrastructure (Russell & Norvig, 2021). Intelligence represents the technical infrastructure, while entrepreneurial innovation represents the intellectual and creative structure. The integration between them means that technology does not work in isolation from entrepreneurial thought, but is used as a tool to accelerate and improve innovation processes (Smith, 2023).

One of the most prominent aspects of integration is that artificial intelligence enables startups to analyze big data related to consumer behavior and market trends, which enhances the efficiency of entrepreneurial innovation in developing products and services that are compatible with customer needs (Lee, 2023).

Process automation using artificial intelligence reduces operational costs and increases production efficiency, which is directly reflected in the ability of startups to innovate more effectively (Nguyen, 2024).

Intelligence provides startups with the ability to predict future opportunities and risks, which helps them make more accurate strategic decisions and enhances their efficiency in entrepreneurial innovation (Miller, 2025).

Through the use of artificial intelligence technologies, startups can improve the quality of their products and services, which increases customer satisfaction and enhances their competitiveness (Roberts, 2022).

Artificial intelligence helps startups manage their human and financial resources more efficiently, allowing them to focus on entrepreneurial innovation and develop new products and services (Ali, 2024).

Strategic decisions based on data provided by artificial intelligence enhance the efficiency of entrepreneurial innovation, as it allows startups to adapt to market changes faster and more effectively (Taylor, 2021). In Iraq, AI can contribute to addressing issues such as poor infrastructure and limited funding, thereby enhancing the efficiency of entrepreneurial innovation in startups (Al-Samarrai, 2022).

Despite the great benefits, there are challenges facing startups when trying to integrate artificial intelligence and entrepreneurial innovation efficiency, such as the lack of specialized human competencies, high costs of investing in technology, and resistance to change within organizations (Khan, 2023).

Through a review of the literature, it can be said that the complementary relationship between artificial intelligence and the efficiency of entrepreneurial innovation is a key element for the success of startups in Iraq, as they contribute to improving the quality of products and services, reducing operational costs, and increasing competitiveness. However, the success of these projects depends on the extent to which they are able to effectively adopt modern technology and employ it in a complex economic and social context (Taylor, 2021).

7. Previous Studies

(Ali, 2024) examined the impact of using AI tools on improving the quality of products and services within startups in developing environments. The study aims to contribute to raising the level of customer satisfaction, but faces challenges due to the lack of specialized human competencies. Strengths: The study relied on quantitative data and advanced statistical analysis. Weaknesses: It did not directly address the Iraqi context.

(Roberts, 2022) Explain the impact of AI on the expansion of startups in local and international markets. It concluded that AI helps to scale, but it requires significant financial investments. Strengths: It addressed the international dimension of expansion. Weaknesses: It did not focus on small enterprises with limited resources.

(Al-Samarrai, 2022) dealt with startups in Iraq and pointed out that the weakness of the technical infrastructure is a major obstacle to the adoption of artificial intelligence tools. It recommended the need for government support for infrastructure development. Strengths: It focused on the Iraqi context directly. Weaknesses: It was limited to the descriptive aspect and did not provide an applied quantitative study.

(Miller, 2025) addressed the role of artificial intelligence in predicting the future trends of startups. It found that the use of AI in predictive analysis enhances the ability of enterprises to make more accurate strategic decisions. Strengths: Focused on the strategic aspect and predictive analysis. Weaknesses: It did not address the challenges associated with human resources and finance.

This study: Focuses on the impact of the adoption of AI tools on the efficiency of entrepreneurial innovation in startups in Iraq, using an applied quantitative methodology. Previous studies: Some studies focused on the quality of products and services (Ali, 2024). Others focused on competitiveness in digital markets (Chen, 2023). (Roberts, 2022) addressed international expansion. (Al-Samarrai, 2022) focused on the Iraqi context but in a descriptive way. (Miller, 2025) addressed the strategic and predictive aspect.

Similarities: All studies confirm that AI contributes to promoting entrepreneurial innovation, whether by improving quality, enhancing competitiveness, or supporting strategic decisions.

Differences: This study differs from previous studies in that it is quantitatively applied in the Iraqi context, while most previous studies have either focused on global markets or dealt with the Iraqi context only in a descriptive way. This study fills a clear knowledge gap, as it provides a quantitative analysis of the impact of artificial intelligence on the efficiency of entrepreneurial innovation in startups in Iraq, which has not been directly addressed in previous studies.

8. Methodology

This study relied on the descriptive-analytical approach using a cross-sectional design, in order to suit the nature of the research that aims to describe the reality of the adoption of artificial intelligence tools in Iraqi startups, measure the efficiency of entrepreneurial innovation, and analyze the relationship and impact between the two variables at a single point in time. This method was chosen because of its ability to provide an accurate description of the phenomenon as it exists in reality, and the possibility of testing hypotheses and relationships between variables in a quantitative way.

9. The Research Community and its Sample

The research population consisted of all entrepreneurs and startup owners in Iraq registered in incubators and accelerators in the Iraqi

governorates (Baghdad, Basra, Erbil, Sulaymaniyah, and other governorates). A non-probability sample of 150 entrepreneurs/startups was selected according to specific selection criteria that included: the project should be in the establishment or early growth stage (less than 5 years), and work in the targeted sectors (information technology, e-commerce, financial services). The participant must be in the position of founder, partner, or manager in the project.

9.1 Data Collection Tool

An electronic questionnaire was designed as the main tool for data collection and consists of three main axes: the first axis included demographic data and project characteristics (8 categorical items), the second axis measured the variable of adopting artificial intelligence tools (10 items), and the third axis measured the variable of the efficiency of entrepreneurial innovation (10 items). The 3-point Likert scale was used to measure the responses of the participants, where: (3 = I agree, 2 = Neutral, 1 = I disagree).

9.2 Statistical Measures Used

1- Descriptive Statistics:

- **Frequencies and percentages:** to describe the demographics of the sample
- **Arithmetic averages:** Measure the level of approval for each paragraph
- **Standard deviation:** to measure the uniformity of participants' responses
- **Relative importance:** To calculate the percentage of achievement of each paragraph of the maximum score
- **Ranks:** To arrange paragraphs according to their importance.

2-Inferential Statistics:

- **Pearson's correlation coefficient (Pearson's r):** to measure the strength and direction of the linear relationship between the two variables
- **Simple Linear Regression Analysis:** To test the main hypothesis and determine the strength of the effect
- **T-value:** to test the significance of statistical coefficients
- **Probability value (p-value):** to determine the level of statistical significance
- **Coefficient of determination (R²):** to measure the ratio of variance explained in the dependent variable
- **Regression coefficient (B and β):** to measure the size of the impact.

9.3 Study Variables

The independent variable: the adoption of artificial intelligence tools, and it was procedurally defined by the average scores of the participants on the paragraphs of the second axis. The dependent variable: the efficiency of entrepreneurial innovation, and it was procedurally defined by the average scores of the participants on the paragraphs of the third axis. Control variables: gender, age group, educational qualification, main sector, number of employees, and governorate, as shown in Table (1).

Table (1) shows the frequency and relative distribution of the characteristics of the sample.

Variable	Category	Repetition	Percentage %
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1	Gender	Male	95	63.30%
		Female	55	36.70%
		Total	150	100%
2	Age Group	Under 25 years old	28	18.70%
		25-34 years	72	48.00%
		35-44 years	38	25.30%
		45 years and older	12	8.00%
		Total	150	100%
3	Educational Qualification	Secondary/Diploma	22	14.70%
		Bachelor	89	59.30%
		Master	32	21.30%
		PhD	7	4.70%
		Total	150	100%
6	Number of Employees	1-5	68	45.30%
		6-20	52	34.70%
		21-50	22	14.70%
		More than 50	8	5.30%
		Total	150	100%
7	Main Sector	Technology	71	47.30%
		E-commerce	45	30.00%
		Financial services	21	14.00%
		Other	13	8.70%
		Total	150	100%
8	Governorate	Baghdad	67	44.70%
		Basra	28	18.70%
		Erbil	26	17.30%
		Sulaymaniyah	18	12.00%
		Other	11	7.30%
		Total	150	100%

The study sample consisted of 150 entrepreneurs who are start-ups in Iraq, and the results showed that the majority of the participants were male (63.3%) compared to 36.7% female, reflecting the relatively dominant male nature of the entrepreneurial environment in Iraq, although women's participation is considered encouraging. In terms of age group, the vast majority of respondents were concentrated in the 25-34 age group (48.0%), followed by the 35-44 age group (25.3%), confirming that entrepreneurship in Iraq is led by young people in their early years, which is in line with global trends. At the educational level, the sample was characterized by a significant increase in the educational level, with holders of a bachelor's degree constituting the largest percentage (59.3%), followed by master's holders (21.3%), and a total of 85.3% of the sample holding a university qualification (bachelor's degree or higher), indicating that entrepreneurship in Iraq attracts learners and that there is a clear link between innovation and educational achievement. In terms of the size of projects, very small projects dominated the sample, with 45.3% of projects working with 1-5 employees, 34.7% with 6-20 employees, and a total of 80% of projects employing fewer than 20 workers, confirming that the sample actually represents startups in their early stages of formation rather than mature companies. At the sectoral level, the digital sector was clearly dominant, with technology (47.3%) and e-commerce (30.0%) together accounting for 77.3% of the sample, followed by financial services (14.0%), reflecting Iraq's rapid digital transformation and the attractiveness of the technology sector to young entrepreneurs and the low barriers to entry to the sector. Geographically, the sample was concentrated in the capital, Baghdad, at 44.7%, followed by Basra (18.7%) and Erbil (17.3%), with a total of 80.7% of projects concentrated in these three major governorates, reflecting the economic centralization of Baghdad and the availability of infrastructure, investment opportunities, and business incubators in major cities. In general, these characteristics show that the study sample represents educated young entrepreneurs working in small startups in the digital sector and based in major cities, characteristics that are compatible with the nature of modern entrepreneurship in Iraq and qualify this sample to study the topic of adopting artificial intelligence and entrepreneurial innovation appropriately.

Source: Prepared by the researchers based on the results of the calculator.

Table (2): Mathematical Averages, Standard Deviations, Relative Importance, and Ranks for the Adoption of Artificial Intelligence Tools

#	Ferry	Medium	Standard deviation	Relative Importance %	Rank	Level of Approval
1	Clearly recognize the right AI applications for my project	2.42	0.68	80.7	3	high
2	The project team has the basic skills to handle AI tools	2.18	0.74	72.7	7	Medium
3	We use AI tools to analyze market and customer data	2.35	0.71	78.3	4	high
4	We employ AI to automate routine operations	2.08	0.76	69.3	9	Medium
5	We rely on AI to support marketing and sales decisions	2.28	0.69	76	5	high
6	We use predictive models to predict future trends or risks	1.95	0.81	65	10	Medium
7	We apply AI solutions in the development of new products/services	2.12	0.73	70.7	8	Medium
8	We use chatbots or virtual assistants in customer service	2.45	0.72	81.7	2	high
9	AI is part of our long-term digital strategy	2.52	0.65	84	1	Very high
10	We allocate an adequate budget to invest in AI technologies	1.88	0.79	62.7	11	Medium
Axis as a whole	Medium Axis	2.22	0.58	74	-	high

Source: Prepared by the researchers based on the results of the calculator.

The results of the analysis of the responses of the study sample (n = 150) on the practices of adopting AI tools in their startup projects showed that the overall arithmetic average of the axis was 2.22 out of 3, with a standard deviation of 0.58, indicating a relatively high level of AI adoption among the entrepreneurs participating in the study, with an overall relative importance of 74.0%. When analyzing the paragraphs in detail, the phrase (9) "Artificial intelligence is part of our long-term digital strategy" topped the first rank with a high arithmetic average of 2.52, a standard deviation of 0.65, and a relative importance of 84.0%, reflecting a clear strategic awareness among entrepreneurs of the importance of artificial intelligence as a key component in their future vision, and this is in line with the nature of the young and educated sample that tends to adopt modern technologies. Phrase (8) "We use chatbots or virtual assistants for customer service" came in second place with an average of 2.45, a standard deviation of 0.72, and a relative importance of 81.7%, which can be easily explained by the application of this technology and the availability of ready-made and affordable tools, in addition to the growing need to provide round-the-clock customer service in a competitive business environment. The phrase (1) "Clearly recognize the right AI applications for my project" came in third place with an average of 2.42 and a relative importance of 80.7%, indicating a good level of cognitive awareness of AI applications, which corresponds to the high educational level of the sample (85.3% with university qualifications). Phrase (3) "We use AI tools to analyze market and customer data" came in fourth place with an average of 2.35, followed by phrase (5) "We rely on AI to support marketing and sales decisions" in fifth place with an average of 2.28, reflecting the entrepreneurs' focus on the direct applied aspects of AI that contribute to improving marketing performance and increasing

sales. On the other hand, the phrase (10) "We allocate a sufficient budget to invest in AI technologies" ranked last with a relatively low average of 1.88, a standard deviation of 0.79, and a relative importance of 62.7%, which can be explained by the financial constraints facing startups in Iraq, especially since 80% of the sample works in small projects (fewer than 20 workers), which limits their ability to allocate large budgets to technology. This statement was preceded in the lower ranks by "We use predictive models to predict future trends or risks" with an average of 1.95, which may reflect the need for these advanced technologies for higher technical skills and more sophisticated infrastructure, which may not be readily available to small enterprises in the Iraqi context. The phrase "we use AI to automate routine operations" came in ninth with an average of 2.08, which may indicate that entrepreneurs are focusing more on external applications (such as customer service and marketing) than internal processes, or that the nature of their small businesses still does not require high levels of automation. In general, the standard deviation of the paragraphs ranges from 0.58 to 0.81, indicating that there is a moderate variation in the responses of the sample members, i.e., there is relative agreement between them, with some differences that can be attributed to the different nature of projects, sectors, or levels of technical expertise. It is noteworthy that the paragraphs with high averages were concentrated in the cognitive and strategic aspects (awareness, strategy, customer service), while the paragraphs with low averages were concentrated in the advanced financial and technical aspects (budgeting, predictive models, automation), reflecting a reality represented by the high strategic ambition and knowledge awareness, coupled with material and technical constraints that limit the overall application.

Table (3): Mathematical Averages, Standard Deviations, Relative Importance, and Ranks of the Entrepreneurial Innovation Efficiency Paragraphs

#	Ferry	Medium	Standard deviation	Relative Importance %	Rank	Efficiency Level
11	We produce new ideas/services faster than competitors	2.15	0.72	71.7	8	Medium
12	We have a systematic mechanism to turn customer feedback into innovative ideas	2.28	0.69	76	5	high
13	We encourage employees to propose creative solutions to operational problems	2.38	0.67	79.3	3	high
14	We can turn innovative ideas into prototypes in a short time	2.22	0.71	74	7	Medium
15	We apply agile methodologies to develop products on an iterative basis	2.32	0.68	77.3	4	high
16	We succeed in launching innovative products that meet the needs of the Iraqi market precisely	2.45	0.64	81.7	2	high
17	Our innovations have helped differentiate our project from competitors locally	2.48	0.62	82.7	1	high
18	Our innovative products have increased market share or revenue	2.08	0.76	69.3	10	Medium
19	We receive positive customer feedback for the quality of our entrepreneurial innovations	2.42	0.65	80.7	2	high
20	We regularly measure the impact of innovations on competitive project performance	1.95	0.79	65	11	Medium
Axis as a whole	Medium Axis	2.27	0.56	75.7	-	high

Source: Prepared by the researchers based on the results of the calculator.

The results of the analysis of the responses of the study sample (n = 150) on the efficiency of entrepreneurial innovation in their startups showed that the overall arithmetic average of the axis was 2.27 out of 3, with a standard deviation of 0.56, which indicates a relatively high level of entrepreneurial innovation efficiency among the projects participating in the study, with an overall relative importance of 75.7%, which reflects the ability of Iraqi

startups to practice innovation effectively despite the challenges. When analyzing the paragraphs in detail, the phrase (17) "Our innovations have contributed to differentiating our project from competitors locally" topped the first rank with a high arithmetic average of 2.48, a standard deviation of 0.62, and a relative importance of 82.7%, indicating that Iraqi entrepreneurs clearly understand the value of innovation as a tool for competitive

differentiation in the local market, and this corresponds to the nature of the sample that is concentrated in the digital sector (77.3%), where differentiation is a critical factor for success. The phrase (16) "We succeed in launching innovative products that accurately meet the needs of the Iraqi market" came in second place with an average of 2.45, a standard deviation of 0.64, and a relative importance of 81.7%, which reflects the ability of startups to understand the needs of the local market and develop appropriate solutions for it, which may be due to the proximity of entrepreneurs to their customers and their deep knowledge of the Iraqi context. Phrase (19) "We have a positive customer evaluation of the quality of our entrepreneurial innovations" came in third place with an average of 2.42 and a relative importance of 80.7%, indicating that the innovations presented by entrepreneurs are well received by customers, which is a positive indicator of the quality and suitability of these innovations for the market. Phrase (13) "We encourage employees to propose creative solutions to operational problems" came in fourth place with an average of 2.38, which reflects an organizational culture that supports creativity within startups, which is consistent with the small size of these projects (80% of which are less than 20 workers), which facilitates open communication and encourages creative participation. Phrase (15) "We apply agile methodologies for product development on an iterative basis" came in fifth place with an average of 2.32, reflecting the adoption of modern development practices by Iraqi startups, especially in the technology sector, which dominates the sample. On the other hand, the phrase (20) "We regularly measure the impact of innovations on competitive project performance" ranked last with a relatively low average of 1.95, a standard deviation of 0.79, and a relative importance of 65.0%, which can be explained by several factors: first, the small size of projects and the lack of advanced performance measurement systems; second, the lack of expertise in the field of analytics and performance; and third, the focus on development and launch rather than measurement and evaluation. This statement was preceded in the lower ranks by "Our innovative products increased market share or revenue" with an average of 2.08, which may reflect that projects are still in their early stages and have not yet achieved a clear financial impact of their innovations, or that measuring the financial impact of these projects is still a challenge. The phrase "We are generating new ideas/services at a faster pace than competitors" came in eighth place with an average of 2.15, which may indicate that the speed of innovation is still a challenge, perhaps due to resource constraints or the need to balance innovation with day-to-day operations. In general, the standard deviation of the paragraphs ranges from 0.56 to 0.79, indicating that there is moderate variation in the responses of the sample members, with relative agreement among them on innovation practices. It is noteworthy that the paragraphs with high averages focused on aspects related to visible results and differentiation (differentiation from competitors, meeting market needs, customer evaluation), while the paragraphs with low averages were concentrated on aspects related to measurement and systematic tracking (impact

measurement, speed of production, financial impact), reflecting the reality that projects are able to achieve tangible innovative results, but with weaknesses in formal systems of measurement and evaluation.

10. Key Hypothesis Testing: The Impact of Adopting AI Tools on the Efficiency of Entrepreneurial Innovation

Main Hypothesis: "There is a Statistically Significant Impact of the Adoption of Artificial Intelligence Tools on the Efficiency of Entrepreneurial Innovation in Startups in Iraq"

Hypothesis (H₀): There is no statistically significant effect of the adoption of AI tools on the efficiency of entrepreneurial innovation.

Hypothesis (H₁): There is a statistically significant effect of the adoption of AI tools on the efficiency of entrepreneurial innovation.

Table (4): Pearson Correlation Coefficient between Artificial Intelligence Adoption and Entrepreneurial Innovation Efficiency

Variables	Adopting AI
Entrepreneurial Innovation Efficiency	0.742 **
Probability value (p)	0.001
Sample size	150

Source: Prepared by the researchers based on the results of the calculator.

10.1 Interpretation of the correlation coefficient

The Pearson correlation coefficient ($r = 0.742$, $p < 0.001$) indicates:

Relationship strength: Very strong correlation (Cohen scale: 0.50 and above = strong)

Relationship direction: Positive direct relationship, i.e., the more AI tools are adopted, the more efficient the entrepreneurial innovation will be.

Statistical significance: The relationship is statistically significant at the level of 0.01, which means that this relationship is real and not random

Determining coefficient ($r^2 = 0.551$): AI adoption accounts for 55.1% of the variation in the efficiency of entrepreneurial innovation, which is high and very acceptable in social research.

Table (5): Results of the Simple Linear Regression Analysis of the Impact of Artificial Intelligence Adoption on Innovation Efficiency

Model	Independent variable	B (non-standard)	β (Standardized)	Standard Error	t	Probability value (p)	Significance
Fixed	(Constant)	0.623	-	0.142	4.387	0.000	D
Predictor	Adopting AI	0.738	0.742	0.063	11.714	0.000	D

Source: Prepared by the researchers based on the results of the calculator.

The simple linear regression analysis table shows that there is a strong, statistically significant effect of the adoption of artificial intelligence tools on the efficiency of entrepreneurial innovation in startups in Iraq, where the value of the constant was (0.623), which is statistically significant at the level of ($p = 0.000$), which indicates that there is a basic degree of innovation even in the case

of not using artificial intelligence due to other factors such as human creativity and experience. The non-standard regression coefficient (B) reached (0.738), which means that every one-degree increase of one degree in the adoption of AI tools leads to an increase in the efficiency of entrepreneurial innovation by (0.738) degrees, which is a positive and strong effect that reflects

the direct relationship between the two variables. The standard coefficient was ($\beta = 0.742$), which is a high coefficient that is classified as a very strong effect according to statistical standards, confirming that the adoption of AI is a strong predictor of the efficiency of entrepreneurial innovation. In terms of statistical significance, the value of ($t = 11.714$) was at the significance level of ($p = 0.000$), which is a very low value that confirms that this effect is statistically significant at the level of (0.01) and that the probability of this result appearing by chance is less than 0.1%. Based on these results, the alternative hypothesis was accepted, and the null hypothesis was rejected, confirming that the adoption of AI tools is a strong and statistically significant factor in enhancing the efficiency of entrepreneurial innovation among startups in Iraq, and this relationship can be represented by the equation: innovation efficiency = $+0.623 (0.738 \times \text{AI adoption})$, a result that supports the importance of Iraqi entrepreneurs' investment in AI technologies as a strategic tool to enhance their innovation capabilities and achieve competitive differentiation in the local market.

11. Results and Discussion

This chapter is one of the most important chapters of the research, as it presents the statistical results reached through the analysis of the sample data ($n = 150$), and then discusses them in the light of previous studies and the theoretical framework. The aim is to show the extent to which the hypotheses have been realized, and to clarify the impact of the adoption of artificial intelligence tools on the efficiency of entrepreneurial innovation in Iraqi startups.

Regarding the results of the adoption of AI tools, the overall arithmetic average of the axis of adoption of AI tools reached (2.22 out of 3) with a standard deviation of (0.58), indicating a relatively high level of adoption. The phrase "AI is part of our long-term digital strategy" topped the first rank with an average of (2.52) and relative importance (84%), reflecting a strategic awareness among entrepreneurs (Smith, 2023). The phrase "we allocate enough budget to invest in AI technologies" came in last place with an average of (1.88) and relative importance (62.7%), reflecting the financial constraints facing startups (Al-Khalidi, 2021).

Results of Entrepreneurial Innovation Efficiency: the overall arithmetic average of the Entrepreneurial Innovation Efficiency Axis was (2.27 out of 3) with a standard deviation of (0.56), indicating a relatively high level of efficiency. The phrase "Our innovations contributed to differentiating our project from competitors locally" topped the first rank with an average of (2.48) and relative importance (82.7%) (Porter, 2024). The phrase "we regularly measure the impact of innovations on competitive project performance" came in last place with an average of (1.95) and relative importance (65%), reflecting the weakness of the measurement and evaluation systems of startups (Taylor, 2021).

The results of the test of the main hypothesis, the Pearson correlation coefficient between the adoption of artificial intelligence tools and the efficiency of entrepreneurial innovation was ($r = 0.742$, $p < 0.001$), indicating a strong positive relationship and a statistically significant relationship (Ali, 2024). The coefficient of determination ($R^2 = 0.551$) shows that AI adoption explains 55.1% of the variation in the efficiency of entrepreneurial innovation, a high percentage that emphasizes the strength of the impact (Hair et al., 2019).

12. Discussion of the Results

Discussing the adoption of AI tools: The results showed that Iraqi entrepreneurs have a strategic awareness of the importance of AI, but face financial and technical constraints that limit its overall implementation. This is consistent with a study (Al-Samarrai 2022, p. 38) that indicated the weakness of Iraq's technical infrastructure, but adds a new dimension of having strategic awareness despite the limitations.

Discussion of the efficiency of entrepreneurial innovation: Iraqi startups have demonstrated the ability to differentiate themselves from competitors and meet the needs of the local market, but weak measurement and evaluation systems are a challenge. This is consistent with a Roberts (2022, p. 101) study that noted that startups face difficulty in measuring the financial impact of innovation, but differs from it in its focus on the Iraqi context.

Discussing the relationship between AI and entrepreneurial innovation: The strong relationship between AI and entrepreneurial innovation efficiency ($r = 0.742$) confirms that AI is not just a technical tool, but a strategic element that enhances the ability of startups to innovate (Chen, 2023, p. 77). This finding is consistent with Chen's (2023, p. 77) study that found that AI enhances competitiveness in digital markets, but differs from it in its focus on a developing environment such as Iraq. Miller's (2025, p. 33) findings also support the role of AI in predicting future trends, as this study showed that Iraqi startups have already started using analytical and predictive tools, albeit in a limited way.

13. Comparing this Study with Previous Studies

Similarities: All previous studies have confirmed that AI promotes entrepreneurial innovation. **Differences:** This study differs in that it is quantitative and applied in the Iraqi context, while most of the previous studies have been descriptive or focused on global markets. **Scientific addition:** this research provides practical evidence of the relationship between AI and entrepreneurial innovation efficiency in Iraq, and shows that AI explains more than half of the disparity in efficiency. This is not directly addressed by previous studies (Hassan, 2023).

14. Conclusion

The results of the study proved that the adoption of AI tools has a strong and direct impact on the efficiency of entrepreneurial innovation in Iraqi startups. The findings support the main hypothesis and confirm that AI is a strategic element to promote innovation, despite financial and technical challenges. These findings are an important scientific addition and open the way for practical recommendations for decision-makers and entrepreneurs in Iraq.

- The impact of artificial intelligence on entrepreneurial innovation: The study proved that there is a strong positive relationship between the adoption of artificial intelligence tools and the efficiency of entrepreneurial innovation ($r = 0.742$, $p < 0.001$), which means that artificial intelligence represents a strategic factor to promote innovation in Iraqi startups (Ali, 2024).
- Strategic awareness among entrepreneurs: The results showed that the majority of entrepreneurs are aware of the importance of AI as part of their long-term digital strategy, which is a positive indicator of their willingness to adopt modern technology (Smith, 2023).
- Financial and technical constraints: Despite high awareness, startups face financial constraints that limit their ability to allocate sufficient budgets to invest in AI technologies, in addition to weak technical infrastructure (Al-Khalidi, 2021).
- Entrepreneurial innovation efficiency: Startups have demonstrated the ability to differentiate from competitors and meet the needs of the local market, but weak measurement and evaluation systems represent a major challenge to sustainably enhancing efficiency (Taylor, 2021).
- The research gap: This study is one of the first applied quantitative studies linking artificial intelligence and the efficiency of entrepreneurial innovation in Iraq, which fills a clear knowledge gap in the Arabic literature (Al-Samarrai, 2022).

The results of this research demonstrate the importance of artificial intelligence (AI) as a pivotal factor in enhancing business efficiency and supporting and developing innovation within Iraqi startups. They also reveal a growing strategic awareness among entrepreneurs regarding the importance of this technology and its role in improving performance and enhancing competitiveness. However, a number of challenges, primarily financial and technical constraints, continue to hinder the comprehensive and effective application of AI technologies. Based on the above findings, this research offers a set of recommendations for entrepreneurs, government entities, business incubators, and researchers, aiming to promote the use of AI and leverage its potential to support entrepreneurial innovation. AI is a crucial factor in achieving sustainable economic development and fostering the growth of startups in Iraq.

Recommendations

For entrepreneurs and startups: The need to gradually invest in AI tools, starting with simple applications such as chatbots and customer data analysis (Nguyen, 2024). Promote a culture of innovation within enterprises by encouraging employees to propose creative solutions and adopt agile (Agile) methodologies (Porter, 2024). Develop innovation performance measurement systems to periodically assess their impact on market share and revenue (Taylor, 2021).

For decision-makers and government entities: Provide financial and technical support to startups through funding programs dedicated to the adoption of modern technology (Khan, 2023, p. 82). Develop digital infrastructure in Iraq, especially in governorates outside Baghdad, to facilitate startups' access to AI tools (Mahmoud, 2021). Establish specialized training centers to qualify entrepreneurs and human cadres in the use of artificial intelligence technologies (Williams, 2024).

Incubators and accelerators: Integrate training programs on AI and entrepreneurial innovation into their activities (Chesbrough, 2022, p. 54). Provide shared digital platforms that allow startups to access AI tools at a low cost (Peterson, 2025). Encourage collaboration between startups to share experiences in AI applications (Lee, 2023).

For researchers and academics: Conduct future studies using longitudinal approaches to measure the impact of AI on entrepreneurial innovation over time (Miller, 2025). Expand the research to other sectors such as agriculture, industry, and education (Brown, 2024). Study the impact of intermediate variables such as organizational culture and government support on the relationship between AI and entrepreneurial innovation (Davis, 2021).

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