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Designing and Explaining an Entrepreneurship Model for Artificial Intelligence–Based Businesses

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ABSTRACT

The primary objective of the present study was to design and explain an entrepreneurship model for artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies located in Tehran Province. In terms of purpose, the study was applied, and in terms of approach, it was a qualitative study employing a sequential exploratory design. In the qualitative phase, grounded theory was applied using the systematic approach to identify and conceptualize the dimensions, components, and relationships among the variables affecting AI-based entrepreneurship. The qualitative research field consisted of senior and middle managers, specialists, experts, and experienced employees working in the information and communications technology and computer software industries of knowledge-based companies in Tehran Province. Participants were selected through purposive sampling, which continued until theoretical saturation was reached. Qualitative data were collected through semi-structured interviews and analyzed using MAXQDA 2024. To enhance the credibility and trustworthiness of the data, triangulation and Lincoln and Guba's criteria, including credibility, transferability, dependability, and confirmability, were employed. The findings indicated that the entrepreneurship model for AI-based businesses consists of an interconnected set of causal conditions, contextual conditions, intervening conditions, strategies, and consequences. The causal conditions included factors such as market needs and technological gaps, entrepreneurial opportunity recognition, and customers' digital preferences, all of which played a fundamental role in the formation of AI-based entrepreneurship. The contextual conditions included the need to establish a knowledge-based ecosystem, policymaking and regulations, financial capabilities and initial investment, advanced technological capacities, specialized human capital, team competencies, and intraorganizational collaboration. Intervening conditions, including legal and regulatory constraints associated with sensitive data and cybersecurity, as well as economic restrictions and sanctions, were also found to affect the development of entrepreneurship. According to the findings, the key strategies were the development of strategic collaborations, product development and upgrading, digital marketing and market penetration, and human capital empowerment. Finally, the consequences of implementing the model included economic and financial maturity, the development of technological authority, social and employment effects, digital transformation in upstream industries, and software export development.

Keywords: artificial intelligence–based entrepreneurship, knowledge-based companies, information and communications technology, grounded theory, structural equation modeling, digital economy

Introduction

Artificial intelligence (AI) has become one of the most consequential technological forces reshaping contemporary economies, organizational structures, business models, and entrepreneurial processes. Its influence



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extends beyond the automation of routine tasks and increasingly encompasses opportunity recognition, product design, customer analysis, organizational decision-making, knowledge creation, and the development of new forms of value. In this context, AI-based entrepreneurship refers to the process through which entrepreneurs identify, create, develop, and exploit business opportunities by using intelligent algorithms, machine learning, natural language processing, data analytics, automation, and related digital technologies. Unlike conventional forms of entrepreneurship, AI-based entrepreneurship is fundamentally dependent on data, computational infrastructure, specialized knowledge, dynamic learning capabilities, and the capacity to transform technological outputs into scalable commercial solutions. Recent literature has therefore emphasized that AI is not merely an operational tool but an entrepreneurial resource capable of altering how opportunities are discovered, evaluated, and commercialized across industries (1, 2).

The rapid diffusion of AI has changed the nature of innovation by enabling firms to analyze large volumes of heterogeneous data, predict market behavior, personalize services, improve operational efficiency, and design products that continuously adapt to user needs. AI technologies can reduce uncertainty in entrepreneurial decision-making by providing more accurate information about market trends, consumer preferences, production constraints, and emerging risks. They can also shorten product-development cycles, facilitate experimentation, and enable firms to create business models based on intelligent platforms, digital services, predictive analytics, and automated interactions. The integration of AI with other advanced technologies, such as blockchain, cloud computing, and digital platforms, has further expanded the scope of business innovation and created new mechanisms for trust, coordination, and value exchange (3). Consequently, entrepreneurship in AI-based businesses must be understood as a multidimensional phenomenon in which technological capabilities interact with strategic orientation, organizational learning, market conditions, human capital, regulatory institutions, and financial resources.

The expanding academic literature on AI and entrepreneurship confirms that this relationship is complex and extends across technological, organizational, educational, social, and institutional domains. A comprehensive hybrid review of AI technologies and entrepreneurship demonstrates that AI influences entrepreneurial activities through several mechanisms, including enhanced opportunity identification, automated decision support, business model innovation, improved resource allocation, and more precise customer targeting (1). Similarly, recent research has shown that AI can stimulate business innovation by enabling firms to generate novel ideas, reconfigure existing capabilities, and develop more responsive and scalable entrepreneurial ventures (2). These developments suggest that the success of AI-based businesses depends not only on access to advanced technology but also on the ability of entrepreneurs to integrate technical knowledge with market insight, strategic thinking, and organizational execution.

The information and communications technology (ICT) and computer software industries occupy a central position in this transformation because they provide both the infrastructure and the commercial applications through which AI is developed and deployed. Within the ICT sector, AI-driven innovation is associated with the creation of intelligent software, automated services, predictive systems, adaptive platforms, and data-based solutions for public and private organizations. Research on AI-driven innovation in the ICT sector indicates that artificial intelligence can enhance competitiveness, improve service delivery, and support the emergence of new entrepreneurial ecosystems, particularly when firms possess sufficient digital capabilities and operate within supportive institutional environments (4). The ICT sector is therefore not merely a user of AI technologies; it is one of the principal environments in which AI-based entrepreneurial opportunities are generated, tested, and scaled.

The growing importance of AI is also evident in specialized scientific and professional applications. For example, the use of machine learning for noninvasive clinical assessment demonstrates how AI can transform expert knowledge into practical decision-support systems and create opportunities for technology-based product and service development (5). Although such applications may emerge in specific sectors, their entrepreneurial significance is broader. They show that AI-based ventures can create value by converting complex datasets into actionable insights, reducing the time and cost of professional assessment, and developing solutions that can be adapted to different markets. Similar developments are observable in healthcare, finance, manufacturing, education, transportation, agriculture, and public services. These cross-sector applications reinforce the need for entrepreneurship models capable of explaining how technological knowledge becomes a commercially viable and institutionally sustainable business.

AI-based entrepreneurship is closely connected to the broader concept of digital entrepreneurship. Digital entrepreneurship refers to entrepreneurial activities in which digital technologies play a central role in creating, delivering, and capturing value. Compared with traditional entrepreneurship, digital entrepreneurship often involves lower geographical constraints, faster scaling, platform-based interactions, and a greater dependence on digital networks and data resources. Reviews of digital entrepreneurship emphasize that entrepreneurial success in digital environments is influenced by digital competencies, technological infrastructure, innovation capacity, network relationships, and the ability to respond to rapidly changing markets (6). AI-based entrepreneurship may be considered an advanced form of digital entrepreneurship because it relies not only on digital channels but also on systems capable of learning, prediction, pattern recognition, and autonomous or semi-autonomous decision-making.

The emergence of data-driven smart business ecosystems further highlights the systemic nature of AI entrepreneurship. AI-based ventures rarely operate in isolation; rather, they depend on relationships with universities, accelerators, investors, regulatory bodies, technology providers, customers, and other firms. A data-driven smart business ecosystem requires mechanisms for data sharing, technological integration, organizational coordination, and continuous innovation (7). In such an ecosystem, the quality of institutional linkages can determine whether entrepreneurial ideas remain at the experimental stage or progress toward commercialization and market expansion. The development of AI-based entrepreneurship therefore requires a coherent ecosystem in which technological, financial, legal, educational, and organizational resources are aligned.

Knowledge-based companies are particularly important in this process because they serve as intermediaries between scientific knowledge and commercial application. Such companies convert research findings, specialized expertise, and technological capabilities into marketable products and services. Their role is especially significant in economies seeking to reduce dependence on traditional industries and strengthen innovation-driven growth. Research addressing the role of knowledge-based companies in international entrepreneurship indicates that these firms can facilitate market entry, knowledge transfer, technological upgrading, and the internationalization of innovation-oriented businesses (8). However, their success depends on access to specialized personnel, financing, supportive regulations, intellectual property protection, international networks, and markets capable of adopting advanced products.

In Tehran Province, the concentration of universities, research institutions, technology parks, financial organizations, government agencies, skilled professionals, and knowledge-based companies creates substantial potential for AI-based entrepreneurship. Tehran represents the principal center of Iran’s ICT and software industries

and provides an environment in which technological expertise, entrepreneurial activity, and institutional resources are comparatively concentrated. Nevertheless, concentration alone does not guarantee successful entrepreneurship. Knowledge-based companies face challenges related to unstable economic conditions, restricted access to international technologies, financial uncertainty, sanctions, data governance, cybersecurity, licensing procedures, talent migration, and limited access to global markets. These conditions can simultaneously create incentives for local innovation and impose major barriers on commercialization and growth.

The entrepreneurial performance of AI-based businesses is also shaped by the characteristics and competencies of entrepreneurs and entrepreneurial teams. Empirical evidence from the creative industries shows that entrepreneurial characteristics and competencies can significantly affect business performance, particularly when they include opportunity recognition, innovation, risk management, strategic orientation, and the ability to mobilize resources (9). In AI-based ventures, these competencies must be combined with technical literacy, data-oriented decision-making, interdisciplinary collaboration, and the ability to manage uncertainty arising from rapid technological change. Entrepreneurial teams must often integrate software engineering, data science, product management, marketing, legal expertise, and domain-specific knowledge. Accordingly, team composition and internal collaboration are likely to constitute central dimensions of any model designed to explain entrepreneurship in AI-based businesses.

Opportunity recognition is especially important because AI technologies create both explicit and latent market opportunities. Entrepreneurs may identify demand for automation, cost reduction, personalization, risk prediction, intelligent customer service, or data-based decision support. They may also discover market gaps where existing foreign software is not adapted to local language, regulations, culture, or organizational practices. In technology-oriented sectors, the ability to convert academic knowledge into commercial solutions is a critical entrepreneurial function. Studies of technological and innovative entrepreneurship have shown that market conditions, institutional support, knowledge resources, infrastructure, and innovation capabilities collectively affect the development of entrepreneurial activities in specialized industries (10). These findings support the view that AI-based entrepreneurship cannot be reduced to individual initiative; rather, it emerges from the interaction between entrepreneurial agency and a wider technological and institutional environment.

The economic and social consequences of entrepreneurship also increase the importance of developing an explanatory model. Entrepreneurship can contribute to employment creation, income generation, regional development, and economic growth. Research examining entrepreneurship and employment in the tourism industry, for instance, demonstrates that sectoral development can create entrepreneurial opportunities and positively affect economic performance (11). Although AI-based businesses differ from tourism enterprises, the underlying principle remains relevant: when entrepreneurial activity is supported by appropriate capabilities and institutions, it can generate direct and indirect employment, stimulate complementary industries, and contribute to broader economic development. In AI-intensive sectors, the value added of employment may be particularly high because jobs often require advanced technical and analytical skills.

Sustainable entrepreneurship provides another important perspective. AI technologies can support sustainability by optimizing resource use, reducing waste, improving logistics, monitoring environmental conditions, and enabling more efficient business processes. An analysis of AI-based technologies in sustainable entrepreneurship indicates that intelligent systems can facilitate innovation that simultaneously addresses economic, environmental, and social objectives (12). Nevertheless, sustainability requires more than technical efficiency. It also requires ethical data use,

responsible governance, transparency, cybersecurity, and attention to the social consequences of automation. An entrepreneurship model for AI-based businesses should therefore account for both value creation and the responsibilities associated with data-intensive innovation.

The importance of education and skills development is equally evident. AI entrepreneurship depends on a workforce capable of understanding technological principles, identifying commercial applications, and continuously updating its knowledge. Research on AI and entrepreneurship education has emphasized that higher education institutions should integrate AI literacy, entrepreneurial thinking, and practical innovation capabilities to prepare students and professionals for post-pandemic economic environments (13). Business education can also use AI tools to improve learning, decision-making, simulation, and problem-solving, thereby strengthening the competencies required for modern entrepreneurship (14). These educational developments are directly relevant to knowledge-based companies because their capacity for innovation depends on the continuous development of specialized human capital.

At the same time, the use of AI in education illustrates the dual nature of technological innovation. Studies addressing AI in teaching and learning have identified benefits such as personalization, rapid access to information, and improved instructional support, alongside disadvantages related to dependence, inaccurate outputs, ethical concerns, and reduced human interaction (15). Similar advantages and limitations have been reported in specialized educational fields, including chemistry education, where AI can support visualization and individualized learning but may also produce reliability and implementation challenges (16). Historical studies and history education likewise demonstrate that AI can expand access to sources and analytical tools while raising methodological, epistemological, and ethical concerns regarding interpretation, authenticity, and bias (17). These observations are relevant to entrepreneurship because they show that market opportunities created by AI are accompanied by risks that must be addressed through responsible product design and effective governance.

The ethical challenges associated with AI are particularly visible in knowledge production and information environments. Large language models have transformed scholarly communication by assisting with writing, summarization, translation, and information retrieval, while simultaneously raising concerns regarding authorship, originality, accuracy, accountability, and research integrity (18). Research on AI and information-seeking behavior further indicates that intelligent systems increasingly mediate how individuals locate, evaluate, and use information, thereby creating opportunities for innovative services but also requiring attention to information quality, trust, and user behavior (19). Bibliometric analyses of influential AI research in library and information science show that the field has expanded rapidly and has developed into a significant interdisciplinary research domain (20). For AI-based businesses, these developments highlight the importance of trustworthiness, transparency, and data quality as both ethical obligations and sources of competitive advantage.

Regulatory and institutional conditions are therefore central to the viability of AI entrepreneurship. AI-based products may involve sensitive data, automated recommendations, intellectual property, privacy concerns, and cybersecurity risks. Entrepreneurs must navigate uncertain or evolving regulatory frameworks while maintaining sufficient flexibility to innovate. Excessive ambiguity can discourage investment, delay commercialization, and increase legal risk, whereas clear and proportionate regulation can strengthen trust and market stability. The need for a balanced institutional environment is particularly important in emerging economies, where legal frameworks may not evolve at the same speed as technological innovation. In addition, economic restrictions, sanctions,

exchange-rate volatility, and limited access to international application programming interfaces, software licenses, and advanced hardware may significantly influence the strategic choices of AI-based firms.

Models of entrepreneurship developed in other organizational settings provide useful methodological precedents but may not fully capture the distinctive characteristics of AI-based businesses. For example, an entrepreneurship model developed for non-presential services in a public social security organization demonstrates the value of identifying causal conditions, contextual factors, intervening conditions, strategies, and outcomes within a specific institutional setting (21). However, AI-based businesses differ because their products are data-intensive, technically complex, rapidly evolving, and potentially scalable across geographical boundaries. They also require a stronger integration of technological infrastructure, specialized human capital, intellectual property, cybersecurity, and digital market orientation. Consequently, a context-specific model is needed to explain how these factors interact within knowledge-based ICT and software companies.

Despite the expansion of research on AI, business innovation, digital entrepreneurship, and entrepreneurial ecosystems, an important gap remains in understanding the integrated process through which AI-based entrepreneurship develops in knowledge-based companies in Tehran Province. Existing studies often focus on isolated dimensions, such as technological adoption, entrepreneurial competencies, education, sustainability, business innovation, or digital ecosystems. Fewer studies have examined the complete configuration of causal drivers, contextual foundations, intervening constraints, strategic actions, and economic, technological, and social consequences within a single explanatory framework. Moreover, models developed in other countries or industries may not adequately reflect the regulatory, economic, technological, and institutional realities of Iran's knowledge-based sector.

Addressing this gap requires an exploratory qualitative approach capable of deriving concepts directly from the experiences of managers, specialists, experts, and experienced employees involved in AI-based businesses. Grounded theory is particularly appropriate because it enables the systematic identification of categories and the development of an explanatory model based on empirical data. Such a model can provide both theoretical and practical value by clarifying the mechanisms through which market needs, entrepreneurial opportunity recognition, digital customer preferences, technological capabilities, human capital, financial resources, regulations, sanctions, strategic collaborations, product development, marketing, and organizational learning interact. It can also support policymakers, investors, universities, accelerators, and company managers in designing interventions that strengthen the development and sustainability of AI-based entrepreneurship.

Accordingly, the aim of the present study was to design and explain an entrepreneurship model for artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies in Tehran Province.

1. Methodology

In terms of research approach, the present study was conducted using a qualitative research method. The study was based on grounded theory. In terms of purpose, it was an applied study, while its method and strategy in the qualitative phase were exploratory-inductive. It was exploratory because the study sought to identify, extract, and explore the components, elements, and dimensions of entrepreneurship in artificial intelligence–based businesses.

In this study, semi-structured interviews were used as the data collection instrument for identifying, extracting, and exploring the components, elements, and dimensions of the entrepreneurship model for artificial intelligence–

based businesses. The interviews were conducted with experts. To assist the interviewees, a list of guiding dimensions and components was developed based on a review of entrepreneurship in artificial intelligence–based businesses and presented to the experts.

Open-ended interviews were used to collect the data in this study. Given the exploratory and qualitative nature of the research, this instrument was considered the most appropriate means of achieving the research objectives.

Following initial coordination with knowledgeable experts and specialists in knowledge-based companies in Tehran Province, preliminary interviews were conducted. At this stage, 15 experienced managers and experts from knowledge-based companies and the information and communications technology industry were selected as the initial participants. The interviews were conducted over a 10-day period. After the interviews had been conducted and analyzed, the findings were returned to the participants for verification of their accuracy and correctness. This process ensured that the findings and the designed model were grounded in the participants' actual experiences and realities and possessed the required validity and reliability. Participant confirmation further indicated that the AI-based entrepreneurship model developed in this study could be used as an applied framework for knowledge-based companies and the information and communications technology industry.

The participants in the qualitative phase, who were selected to identify, extract, and explore the components, elements, and dimensions of the AI-based entrepreneurship model, consisted of employees working in the information and communications technology and computer software industries of knowledge-based companies in Tehran Province who had prior experience working in a knowledge-based company. Senior and middle managers, experts and specialists, and experienced employees in the information and communications technology and computer software industries of knowledge-based companies in Tehran Province constituted the research population in this phase.

The qualitative sample was selected from among experts in online marketing and sales through purposive sampling and the snowball sampling strategy. Interviews continued until theoretical saturation was reached. Specifically, after interviews had been conducted with 15 participants, no new data or concepts emerged, and the components, elements, and dimensions of the AI-based entrepreneurship model began to recur.

The data were analyzed using the grounded theory technique. Concepts, categories, and propositions are the three principal elements of qualitative content analysis. Qualitative content analysis is conducted in three main stages:

a. Open coding: In content analysis, the smallest meaningful units are first identified, and the initial themes are formed.

b. Axial coding: At this stage, similarities and relationships among the identified initial themes are examined, and several related initial themes are combined to form concepts.

c. Selective coding: At a higher level, the concepts obtained from the preceding stage, namely axial coding, are differentiated and refined. Several related concepts are then integrated to form categories, ultimately leading to the central proposition, namely the explanation of the entrepreneurship model for artificial intelligence–based businesses.

The qualitative data analysis was based on the grounded theory strategy and Strauss and Corbin's systematic framework. Accordingly, the research process was founded on inductive logic and constant comparison, with data collection and analysis conducted simultaneously and iteratively. At the operational stage, following precise verbatim transcription of the interviews, the extracted texts were reviewed several times. This procedure enabled

the identification of meaning units and conceptual indicators embedded in the data before the three coding stages began and established the foundation for developing the conceptual model.

During open coding, the interview transcripts were examined and labeled line by line and statement by statement. In addition to assigning appropriate conceptual codes, in vivo codes were used to accurately reflect the participants' language and intended meanings. Semantically similar and related codes were classified and integrated into initial concepts. The characteristics and dimensions of each concept were then defined and specified to clearly distinguish among the concepts. Concurrently with the coding process, continuous comparisons were made among events, existing codes, and emerging concepts, leading to the revision, integration, or separation of codes to improve the precision and comprehensiveness of the analysis. Theoretical memos were also prepared and maintained to document ideas, questions, provisional hypotheses, and the course of analytical decision-making. These memos played an important role in clarifying the analyst's reasoning and decision-making process and in developing the final theory.

During the main coding stage, the data were organized and classified according to a newly developed structure. Through the development of a conceptual network of different codes and continuous comparison, shared codes were identified and axial categories were extracted. Through an iterative and gradual process, and based on the comprehensive set of indicators and concepts derived from the initial coding, the final categories and subcategories were carefully determined and stabilized. Where theoretical ambiguity or gaps in the data were identified, purposive theoretical sampling was employed to collect supplementary data, thereby enriching the conceptual content of the categories and defining their conceptual boundaries more precisely and transparently. This flexible and iterative approach ensured that the final concepts and categories provided a deep and comprehensive understanding of the phenomenon under investigation and possessed the required validity and reliability.

During selective coding, the category with the greatest explanatory and integrative capacity was selected as the central core category. The other categories were then coherently and systematically organized around this central category. In this manner, the principal phenomenon under investigation and its relationship with causal, contextual, and intervening conditions, action and interaction strategies, and the resulting consequences were systematically examined and mapped. By emphasizing causal relationships and distinguishing different levels of contextual conditions from intervening conditions, the logic of actions and the underlying mechanisms of the phenomenon were clearly explained. At this stage, a comprehensive theoretical narrative was developed, and theoretical propositions explaining the relationships among conditions, strategies, and consequences were formulated. Through repeated returns to the data and the research field, provisional propositions were tested, exceptional cases were identified, and existing gaps were addressed until theoretical saturation was achieved. The final outcome of this process was a coherent and comprehensive conceptual model illustrating the mechanisms underlying the emergence and continuity of the phenomenon under investigation.

2. Findings and Results

In grounded theory, the core phenomenon refers to the central event or condition that attracts the primary attention of the participants and around which a set of actions and interactions is organized for its management, control, or resolution. As the principal integrative axis of the categories, this phenomenon guides the theoretical narrative and causes the other categories and their relationships to converge around it, thereby giving them meaning and direction. In this study, the core phenomenon was conceptualized as entrepreneurship in artificial

intelligence–based businesses, with a focus on ICT and computer software in knowledge-based companies in Tehran Province. This phenomenon represents a strategic, deliberate, and continuous process pursued for the purpose of creating, developing, and exploiting commercial opportunities in artificial intelligence and information technology. Within this framework, entrepreneurs create value and competitive advantage in the market through the development and representation of their ideas, opportunities, and capabilities. Therefore, in the paradigmatic model of the study, the core phenomenon constitutes the central point around which causal, contextual, and intervening conditions, strategies, and consequences are organized, thereby shaping the explanatory logic of the theory emerging from the data.

Table 1. Open Codes and Categories Related to the Core Phenomenon

Selective Codes	Axial Codes	Open Codes
Core phenomenon	Entrepreneurship in artificial intelligence–based businesses, with a focus on ICT and computer software in knowledge-based companies in Tehran Province	Innovation in the delivery of intelligent software services/products
		Alignment with the needs of the local market in Tehran Province
		Commercialization of artificial intelligence technical knowledge through start-up companies

3.

Within the grounded theory framework, causal conditions comprise events, experiences, and situational variables that directly contribute to the emergence, intensification, or transformation of the phenomenon and effectively initiate the actions and interactions associated with it. In terms of function, these conditions differ from contextual and intervening conditions because they primarily serve as motivators and drivers rather than as contextual foundations or moderating forces. They emerge before the phenomenon appears or at critical points in its development. From this perspective, causal conditions include factors that directly create the motivation, necessity, or decision for entrepreneurs to enter the domain of creating, developing, and exploiting commercial opportunities in artificial intelligence and influence their decision to enter this field.

These factors, together with their corresponding codes, are presented in Table 2.

Table 2. Open Codes and Categories Related to Causal Conditions

Dimension	Component	Concepts
Causal conditions	Market needs and technological gaps	Industry demand for intelligent process automation
		The need to reduce operating costs through AI
	Entrepreneurial opportunity recognition	Monitoring global artificial intelligence trends by company managers
		Identification of niche markets in the software industry
		Capacity to transform academic knowledge into commercial products
	Customers' digital preferences	High levels of digital literacy in Tehran's target market
		Changes in consumer behavior toward online services

Accordingly, entrepreneurship in artificial intelligence–based businesses, with a focus on ICT and computer software in knowledge-based companies in Tehran Province, is driven by several factors, each of which is explained below.

Market Needs and Technological Gaps

The growing need of industries to optimize their structures constitutes one of the main drivers of entrepreneurship in artificial intelligence. Within Tehran's economic ecosystem, manufacturing and service industries face challenges

such as rising operating costs and the inefficiency of traditional processes. Consequently, demand for intelligent process automation has become a strategic necessity. Artificial intelligence addresses technological gaps through big data analytics and accurate forecasting, thereby reducing human error and optimizing resource consumption. The gap between the current state of industries and the desired level of productivity therefore provides a unique opportunity for software-based knowledge companies to offer AI-based solutions, respond to critical market needs, and create economic value.

Entrepreneurial Opportunity Recognition

Opportunity recognition in knowledge-based companies in Tehran Province creates a systematic connection between the monitoring of global trends and local capabilities. By continuously observing international developments in machine learning algorithms and natural language processing, forward-looking managers have succeeded in identifying niche markets in the software industry that have not yet been saturated by major market actors. The explanatory basis of this driver lies in the capacity to convert intellectual capital and academic knowledge produced at leading universities in Tehran into commercial products. Entrepreneurship in this sector is therefore not merely an economic activity but an intelligent process of translating technical knowledge into practical tools. By analyzing gaps in the supply and demand of specialized software, this process significantly increases the likelihood of success for start-up businesses.

Customers' Digital Preferences

The paradigm shift in consumer behavior and the improvement of digital literacy in the Tehran metropolitan area have created the environmental conditions necessary for the adoption of artificial intelligence innovations. The high concentration of educated people and widespread access to information technology infrastructure in Tehran have resulted in the emergence of customers who are not only familiar with online services but also expect the services they receive to be intelligent and personalized. High levels of digital preference therefore reduce market risk for knowledge-based companies because the costs of customer education and technology adoption are minimized in this market. Such cognitive and behavioral readiness in the target market acts as a catalyst that accelerates the penetration of AI-based products and encourages entrepreneurs to develop more sophisticated software based on intelligent user experiences.

In grounded theory, contextual conditions comprise the specific situational characteristics within which the phenomenon occurs and acquires meaning. These conditions describe the temporal-spatial and cultural-organizational context in which actions and interactions are formed to control, manage, and respond to the phenomenon. Contextual conditions determine how strategies become feasible, preferable, or constrained. They differ from causal conditions because, rather than initiating the phenomenon, they shape the manner in which it emerges, is formulated, and is addressed through strategies. Contextual conditions also differ from intervening conditions because they refer to specific characteristics of the context under investigation rather than broad, cross-cutting, moderating forces. In this study, contextual conditions included a set of factors that provide the foundation for the emergence and development of the entrepreneurial process in AI-based businesses and influence its formation and pursuit. Within the axial coding framework, the contextual categories derived from the data, together with their corresponding codes and indicators, are presented in Table 3.

Table 3. Open Codes and Categories Related to Contextual Conditions

Dimension	Component	Concepts

Contextual conditions	The need to establish a knowledge-based ecosystem	Proximity and access to governmental and decision-making institutions
		Presence of specialized digital-sector accelerators
		Close collaboration with universities and research centers
		Network interactions and strategic interfirm collaborations
	Policymaking and regulations	Governmental and nongovernmental support
		Data privacy and ethical frameworks
		Security and protection standards
	Financial capabilities and initial investment	Creation of financing opportunities and project budgeting models
		Financial risk-taking
	Advanced technological capacities	Access to big data
		Cloud computing and hardware infrastructure
		Maturity of open-source algorithms
	Specialized human capital	Supporting engineering and computer science elites and preventing their migration
		Technical competencies in artificial intelligence and complex problem-solving skills
		Experience of technical teams in developing scalable software
	Team competencies and intraorganizational collaboration	Team culture and entrepreneurial orientation
		Organizational learning capability

Accordingly, entrepreneurship in artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies in Tehran Province, requires attention to several contextual foundations and infrastructures, each of which is described below.

The Need to Establish a Knowledge-Based Ecosystem

The knowledge-based ecosystem in Tehran Province functions as a strategic cluster that facilitates the flow of knowledge through physical and institutional proximity. Direct access to decision-making institutions and the presence of specialized accelerators alongside leading universities reduce transaction costs and accelerate the process of transforming ideas into tangible innovations. The logical explanation in this regard is based on knowledge spillover effects. Network interactions and strategic interfirm collaborations create a dynamic environment in which small AI companies can use shared infrastructure and institutional support to overcome initial market uncertainties and improve their survival rates.

Policymaking and Regulations

Legal frameworks and macro-level policies constitute the foundation of trust and stability in data-driven businesses. The development of regulations concerning privacy, AI ethics, and security standards does not merely impose restrictions; rather, by clarifying the rules of the market, it reduces legal risks for entrepreneurs. From an academic perspective, governmental and nongovernmental support, alongside a coherent regulatory system, serves as an institutional support mechanism. By protecting the intellectual and data assets of knowledge-based companies, such a framework creates the conditions necessary for long-term investment and the sustainable development of intelligent software in the Tehran metropolitan area.

Financial Capabilities and Initial Investment

Access to diverse financial resources and flexible budgeting models is the lifeline of entrepreneurship in frontier technologies. Because knowledge-based companies in Tehran are located in the country's financial center, they possess greater potential to attract venture capital and government credit facilities. The logical explanation of this factor suggests that, given the high-risk nature of AI projects, financial risk tolerance among investors and the

creation of staged financing opportunities enable entrepreneurs to focus on research and development without excessive concern about initial failures. Such financial capability is a prerequisite for crossing the “valley of death” faced by start-up businesses and reaching the commercialization stage.

Advanced Technological Capacities

The development of artificial intelligence is highly dependent on hardware infrastructure and access to big data. As the country’s information technology hub, Tehran Province possesses some of the most advanced cloud computing infrastructure and data centers, enabling the hosting of computationally intensive deep learning projects. It can be argued that the maturity of open-source algorithms, combined with this infrastructure, has reduced barriers to entry into the software industry. The convergence of big data and computing power allows knowledge-based companies to train their AI models with high accuracy and produce scalable products that meet international standards.

Specialized Human Capital

Specialized human resources constitute the most important asset of knowledge-based companies in a knowledge-driven economy. The concentration of engineering and computer science elites in Tehran, together with their technical competencies in solving complex problems, serves as the driving force behind innovation in artificial intelligence. Supporting these specialists and creating attractive employment opportunities not only prevents the migration of highly skilled talent but also facilitates the formation of experienced technical teams capable of developing sophisticated and scalable software. This concentration of expertise creates a sustainable competitive advantage that cannot easily be replicated in other geographical regions.

Team Competencies and Intraorganizational Collaboration

Success in AI entrepreneurship requires more than technical knowledge; it also depends on a learning-oriented organizational culture and an entrepreneurial orientation at the team level. Team competencies include collective problem-solving capability, flexibility in responding to rapid technological change, and synergy among team members. From a strategic management perspective, organizational learning capability enables knowledge-based companies to rapidly adapt to new versions of AI libraries and frameworks. Such internal cohesion and teamwork culture strengthen the company’s operational capacity to address unexpected technical challenges and commercialize innovative ideas.

Within the grounded theory framework, intervening conditions comprise broad and cross-cutting forces that affect actions and interactions at the individual, organizational, and environmental levels. These conditions have moderating and directional functions, meaning that they facilitate, disrupt, or reconfigure the intensity, direction, timing, and effectiveness of the adopted strategies. In this study, intervening conditions included internal and external factors that influence the scope and quality of entrepreneurship in AI-based businesses. These factors may strengthen or weaken the entrepreneurial process and affect its success or failure. A detailed list of the intervening categories, together with their representative codes and indicators, is provided in Table 4.

Table 4. Open Codes and Categories Related to Intervening Conditions

Dimension	Component	Concepts
Intervening conditions	Legal and regulatory constraints associated with sensitive data and cybersecurity	Data protection laws and legal gaps concerning the intellectual property ownership of AI code
		Complexity of obtaining licenses from governmental authorities
	Economic restrictions and sanctions	Difficult access to international APIs and software licenses

		Exchange-rate fluctuations and their effects on equipment prices
		Difficulties in software exports and international financial transactions

Accordingly, several barriers and facilitating factors affect entrepreneurship in artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies in Tehran Province. Each of these factors is described below.

Legal and Regulatory Constraints Associated With Sensitive Data and Cybersecurity

The legal and regulatory environment, as a key intervening factor, plays a dual role in stabilizing or weakening AI-based businesses. On the one hand, legal gaps concerning the intellectual property ownership of AI-generated code and the absence of explicit frameworks governing the rights of developers of self-learning software threaten the security of intellectual investment. On the other hand, bureaucratic complexity in obtaining licenses from governmental authorities reduces the speed with which knowledge-based companies can respond to immediate market needs. Consequently, the absence of transparent regulations concerning the protection of sensitive data leaves entrepreneurs caught between data-driven innovation and the risk of privacy violations. This situation increases legal risks and leads to excessive caution in the development of transformative products.

Economic Restrictions and Sanctions

Economic intervening factors, particularly in the context of international sanctions, operate as structural barriers affecting the performance of information technology knowledge-based companies in Tehran. Restricted access to advanced international APIs and foundational software licenses forces Iranian companies either to incur substantial costs in recreating existing technologies or to use lower-quality alternatives. In addition, exchange-rate fluctuations increase the price of high-performance computing hardware, such as graphics processing units, thereby raising the final cost of products. Difficulties in international financial transactions and barriers to software exports not only disrupt foreign-currency revenue streams but also prevent these companies from integrating into the global AI value chain and limit their scalability to domestic markets. This enforced isolation substantially affects the return on investment in large-scale AI projects.

Within the grounded theory framework, action and interaction strategies are purposeful patterns of actions and decisions used by actors to systematically address, manage, and control the core phenomenon and to respond to it in a context-sensitive and appropriate manner. These strategies emerge from causal conditions, become feasible and preferable within specific contexts, and are moderated in terms of intensity, direction, and effectiveness by intervening conditions. Strategies therefore constitute the link between the phenomenon and its consequences in the paradigmatic model. In this study, with a focus on entrepreneurship in AI-based businesses, strategies refer to the set of practical and planned actions and instruments used by entrepreneurs to exploit opportunities and address challenges. Through content analysis of the interviews and constant comparison, four fundamental strategies were extracted and conceptualized. These strategies, together with their codes and operational indicators, are presented in detail in Table 5.

Table 5. Open Codes and Categories Related to Strategies

Dimension	Component	Concepts
Strategies	Development of strategic collaborations	Formation of joint consortia among knowledge-based companies
		Collaboration with reputable universities in Tehran on product and service upgrading projects

	Use of specialized outsourcing capacities
Product development and upgrading	Localization of language and processing models
	Continuous improvement of the user experience based on intelligent feedback
Digital marketing and market penetration	Use of data-driven approaches to customer acquisition
	General and personalized branding
Human capital empowerment	Internal retraining programs on emerging technologies
	Intergenerational convergence in technological entrepreneurship
	Development of multidisciplinary teams

Accordingly, several proposed strategies and solutions should be considered for entrepreneurship in artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies in Tehran Province. Each strategy is described below.

Development of Strategic Collaborations

The strategic collaboration approach is based on open innovation theory, according to which companies share resources to overcome the technical complexities of artificial intelligence. The formation of joint consortia among knowledge-based companies in Tehran and the establishment of systematic relationships with leading universities reduce research and development costs and accelerate product commercialization. The use of specialized outsourcing capacities also allows companies to focus on their core competencies while drawing on complementary expertise within the network, thereby significantly accelerating time to market.

Product Development and Upgrading

In artificial intelligence, product development strategies should focus on localization and cultural adaptation. The localization of large language models and processing models in accordance with the Persian language and local characteristics creates a competitive advantage that foreign alternatives lack. This strategy indicates that the continuous improvement of user experience through intelligent feedback and user behavior analysis leads to the development of human-centered products. Such quality improvement increases the penetration of domestic software in sensitive markets and ensures product sustainability throughout the technology life cycle.

Digital Marketing and Market Penetration

Marketing strategies in AI-oriented businesses have shifted from traditional approaches toward predictive marketing. The use of data-driven approaches to accurately identify promising market segments and implement personalized branding enables knowledge-based companies to achieve higher customer acquisition rates at lower costs. Within Tehran’s competitive ecosystem, a successful company is one that can use big data analysis to predict latent customer needs and intelligently communicate its brand message to the target audience. This capacity directly affects the company’s market share.

Human Capital Empowerment

Given the dynamic nature of artificial intelligence, empowerment strategies should focus on lifelong learning and interdisciplinary synergy. Retraining programs addressing emerging technologies and the creation of multidisciplinary teams contribute to the development of more comprehensive solutions. The logical basis of this strategy emphasizes intergenerational convergence, whereby the enthusiasm and innovation of younger generations are combined with the managerial experience of older generations. This combination reduces operational risks and ensures organizational dynamism in responding to complex technical challenges.

In grounded theory, consequences refer to the outcomes and effects resulting from actors' actions and interactions in response to the phenomenon under investigation and under the influence of causal, contextual, and intervening conditions. Consequences form the final component of the paradigmatic model and indicate the changes produced at different levels by the adopted strategies. These outcomes may be intended or unintended, short-term or long-term, and direct or indirect. Although they arise from purposeful actions, they are also dependent on contextual conditions and moderating forces. In this study, the consequences of entrepreneurship in AI-based businesses refer to the outcomes and effects resulting from the implementation of entrepreneurial strategies. A detailed list of these consequences, together with their corresponding codes, is presented in Table 6.

Table 6. Open Codes and Categories Related to Consequences

Dimension	Component	Concepts
Consequences	Economic and financial maturity	Increased market share in the national ICT industry
		Improved profitability and return on investment
	Development of technological authority	Registration of patents and novel intellectual assets
		Scientific leadership through industry–university linkages
	Social and employment effects	Creation of high-value-added employment opportunities for the younger generation
		Improvement of technical knowledge among Tehran's professional community
	Digital transformation in upstream industries	Increased productivity in other industries through AI services
		Reduced national dependence on foreign intelligent software
	Software export development	Entry into regional and neighboring-country markets
		Foreign-exchange earnings through international corporate freelancing projects
		Global competitiveness of Iranian products

Accordingly, entrepreneurship in artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies in Tehran Province, produces several outcomes and consequences, each of which is explained below.

Economic and Financial Maturity

Economic maturity, as a direct consequence of market sustainability, indicates a transition from the initial growth stage to stability and profitability. An increased share of the national information technology market and an improved return on investment represent the logical outcomes of optimized business models and scalable AI products. From an academic perspective, financial maturity means reduced dependence on government support funding and the achievement of financial self-reliance, enabling a company to independently finance its innovation cycle. Sustainable profitability in this field not only increases the attractiveness of the sector to private investors but also facilitates capital accumulation, thereby enabling companies to undertake larger-scale and higher-risk research and development projects.

Development of Technological Authority

The development of technological authority is a strategic consequence of transforming technical knowledge into registered intellectual assets and scientific leadership. When knowledge-based companies in Tehran successfully register their innovations at the national and international levels, they transform the relationship between industry and universities from a theoretical association into value-creating collaboration. The logical explanation of this consequence indicates that technological authority creates entry barriers for foreign competitors and strengthens the country's geopolitical position in the knowledge-based economy. Such authority establishes the company as a

standard-setting institution in artificial intelligence and significantly enhances its bargaining power in technology transfer and international collaboration.

Social and Employment Effects

Entrepreneurship in artificial intelligence generates positive social consequences, including the creation of sustainable, high-value-added employment for a new generation of highly skilled professionals. This process extends beyond unemployment statistics by emphasizing employment quality. By recruiting graduates from leading universities in Tehran, it helps prevent brain drain and promotes the circulation of highly skilled talent within the country. The participation of these specialists in complex projects enhances the technical knowledge of the broader professional community and embeds a culture of innovation within society. This consequence transforms the country's human capital into a dynamic national asset capable of addressing major national challenges through technological tools.

Digital Transformation in Upstream Industries

One of the most important consequences of artificial intelligence development is its catalytic role in the digital transformation of upstream industries, such as oil, gas, banking, and healthcare. The implementation of intelligent solutions increases productivity, reduces waste, and optimizes complex processes in these industries. The academic explanation of this issue emphasizes the concept of innovation spillovers. The products developed by knowledge-based companies reduce the country's strategic dependence on foreign intelligent software and enhance the security of critical infrastructure. The digitalization of foundational industries not only improves national profitability but also substantially strengthens the country's economic resilience to technological sanctions.

Software Export Development

The ultimate consequence and a principal indicator of the international success of AI entrepreneurship is entry into global markets and the development of software exports. Foreign-exchange earnings generated through international corporate freelancing projects and participation in regional markets indicate that Iranian products are competitive at the global level. From an international economics perspective, the export of knowledge-based products, which have no physical weight and possess very high added value, represents one of the most viable alternatives to oil exports. Success in neighboring and international markets improves the trade balance, contributes to technology diplomacy, and reconstructs Iran's national brand image as a country operating at the forefront of artificial intelligence technologies.

Based on the findings obtained from axial and selective coding, the paradigmatic model of entrepreneurship in artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies in Tehran Province, was developed. The model provides an integrated and concise representation of the explanatory logic of the theory emerging from the data and serves as a basis for the detailed interpretation and presentation of the findings in subsequent sections.

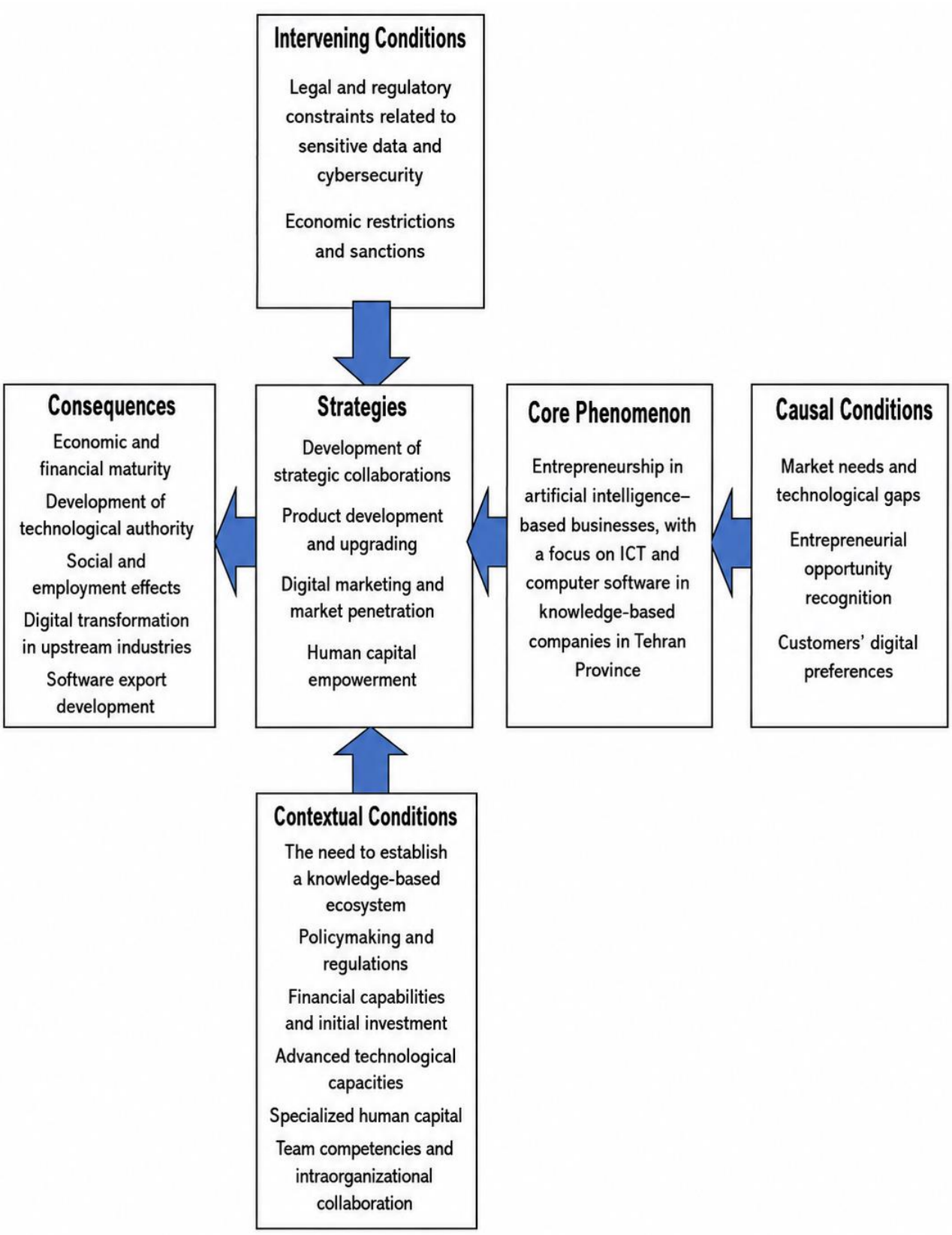


Figure 1. Final Model of the Study

4. Discussion and Conclusion

The present study was conducted to design and explain an entrepreneurship model for artificial intelligence–based businesses, with a focus on the information and communications technology and computer software industries in knowledge-based companies in Tehran Province. The findings indicated that AI-based entrepreneurship is a multidimensional and systemic phenomenon shaped by the interaction of causal conditions, contextual conditions, intervening conditions, entrepreneurial strategies, and economic, technological, and social consequences. The model identified market needs and technological gaps, entrepreneurial opportunity recognition, and customers' digital preferences as the principal causal conditions. The contextual conditions included the establishment of a knowledge-based ecosystem, policymaking and regulation, financial capabilities and initial investment, advanced technological capacities, specialized human capital, and team competencies and intraorganizational collaboration. Legal and regulatory constraints related to sensitive data and cybersecurity, together with economic restrictions and sanctions, emerged as intervening conditions. The principal strategies consisted of developing strategic collaborations, developing and upgrading products, employing digital marketing and market-penetration approaches, and empowering human capital. Finally, the consequences included economic and financial maturity, technological authority, social and employment effects, digital transformation in upstream industries, and software export development.

The identification of market needs and technological gaps as a causal condition indicates that AI-based entrepreneurship emerges when entrepreneurs perceive a discrepancy between the existing performance of industries and the level of efficiency that could be achieved through intelligent technologies. In the present study, demand for intelligent process automation, the need to reduce operating costs, and the inadequacy of conventional software systems created opportunities for knowledge-based companies to develop AI-enabled products and services. This finding is consistent with the argument that artificial intelligence stimulates entrepreneurship by enabling firms to recognize unmet needs, improve decision-making, and design new value propositions (1, 2). It is also aligned with the view that the integration of AI with other digital technologies can support business model innovation and improve operational efficiency (3). Therefore, technological gaps should not be viewed solely as weaknesses in an economic system; they may also function as opportunity spaces in which entrepreneurial firms can create value through innovation.

The emergence of entrepreneurial opportunity recognition as another causal condition demonstrates that technological knowledge alone is insufficient for entrepreneurial success. Managers must continuously monitor global developments, identify niche markets, evaluate local demands, and translate technical knowledge into commercially viable solutions. This result supports the broader literature on entrepreneurial competencies, which emphasizes opportunity recognition, strategic orientation, innovation, and resource mobilization as determinants of business performance (9). It is also consistent with research on technological and innovative entrepreneurship, which has shown that the development of entrepreneurship depends on the ability to connect market opportunities with technological capabilities and institutional resources (10). In AI-based businesses, this capability is especially important because technological cycles are short, market boundaries are unstable, and products may rapidly become obsolete. Accordingly, opportunity recognition must be dynamic, data-driven, and closely linked to technological foresight.

Customers' digital preferences were also identified as a causal condition. The findings showed that the high level of digital literacy in Tehran's target market and the growing preference for online, personalized, and intelligent services reduced the barriers to the adoption of AI-based products. This result is compatible with the literature on digital entrepreneurship, which emphasizes the importance of digitally prepared customers, online platforms, and technology-mediated interactions in entrepreneurial development (6). It is also supported by studies indicating that AI increasingly shapes information-seeking behavior and user expectations by offering faster, more personalized, and interactive access to information and services (19). Thus, customers' readiness to use intelligent systems can reduce market uncertainty and facilitate the commercialization of AI products. However, customer acceptance is likely to remain dependent on perceived usefulness, trust, transparency, privacy protection, and the quality of the user experience.

The findings regarding contextual conditions highlighted the importance of a knowledge-based ecosystem. Close access to universities, research centers, accelerators, government institutions, and other knowledge-based companies created a favorable environment for the circulation of knowledge, the formation of strategic networks, and the commercialization of ideas. This result is consistent with the concept of a data-driven smart business ecosystem, in which firms, institutions, technologies, and data resources interact to facilitate innovation and entrepreneurial growth (7). It is also aligned with research showing that AI-driven innovation in the ICT sector is strengthened by institutional support, collaboration, and access to technological networks (4). The findings therefore demonstrate that AI entrepreneurship is not an isolated firm-level activity. It is embedded in a broader ecosystem whose quality determines access to resources, knowledge, legitimacy, and markets.

The role of policymaking and regulation as a contextual condition further indicates that supportive governance can reduce uncertainty and encourage long-term investment. The participants emphasized the need for governmental and nongovernmental support, data privacy frameworks, ethical principles, and cybersecurity standards. These findings are particularly important because AI-based businesses operate in environments in which data ownership, algorithmic accountability, intellectual property, and privacy are often uncertain. Research on the ethical implications of large language models has similarly highlighted concerns about authorship, accuracy, accountability, and responsible use (18). Studies examining AI in education and research have also identified ethical and methodological challenges alongside technological advantages (15-17). Consequently, well-designed regulation should not merely impose restrictions; it should clarify responsibilities, protect stakeholders, and create a stable foundation for innovation.

Financial capabilities and initial investment emerged as another essential contextual condition. AI projects often require substantial expenditure on data acquisition, cloud computing, hardware, software development, and specialized human resources before they generate stable income. The findings showed that risk-tolerant investment, flexible budgeting, and staged financing can enable start-ups to survive early failures and continue research and development. This result is consistent with the literature on knowledge-based companies, which emphasizes the role of financing, institutional support, and market access in international entrepreneurial development (8). It also corresponds with studies of entrepreneurship in other sectors showing that financial resources and investment capacity are central to employment creation and economic growth (11). Hence, the financing requirements of AI-based ventures should be understood as long-term and innovation-oriented rather than evaluated exclusively through short-term profitability indicators.

Advanced technological capacities, including access to large datasets, cloud computing, hardware infrastructure, and mature open-source algorithms, were also identified as central contextual conditions. This finding confirms that AI-based entrepreneurship depends on a technological infrastructure capable of supporting experimentation, model training, deployment, and scaling. The expanding application of machine learning in specialized areas, such as noninvasive clinical assessment, illustrates how computational capacity and data can be transformed into practical and commercially relevant solutions (5). Similarly, the integration of AI and blockchain technologies has been associated with improvements in innovation, data management, and business processes (3). Therefore, technological infrastructure should be treated as a strategic entrepreneurial resource rather than merely an operational facility.

Specialized human capital and team competencies were found to be equally important. The model showed that technical expertise in AI, complex problem-solving ability, experience in scalable software development, entrepreneurial team culture, and organizational learning capability provide the human foundation for innovation. This result aligns with evidence that entrepreneurial characteristics and competencies significantly influence business performance (9). It also supports the emphasis placed on AI literacy and entrepreneurship education in higher education institutions (13). Business education studies similarly suggest that AI-based tools can strengthen analytical skills, simulation, decision-making, and entrepreneurial learning (14). Accordingly, firms require not only technically competent employees but multidisciplinary teams capable of connecting data science, software engineering, marketing, management, legal knowledge, and industry-specific expertise.

The intervening conditions revealed the constraining effects of legal ambiguity, data sensitivity, cybersecurity concerns, sanctions, exchange-rate volatility, and restricted access to international technologies. The legal gap surrounding the ownership of AI-generated code and the complexity of licensing processes were perceived as barriers to investment and rapid market response. These concerns correspond with previous studies that have noted the ethical, legal, and reliability risks associated with AI systems in academic, educational, and information environments (17, 18). Moreover, research on AI applications has shown that technological advantages are often accompanied by limitations involving data quality, system reliability, and governance (15, 16). The present findings extend this argument to entrepreneurship by showing that regulatory uncertainty can directly influence strategic decisions, product development, and investment behavior.

Economic sanctions and international restrictions constituted another major intervening condition. Difficult access to application programming interfaces, software licenses, advanced hardware, and international financial systems increased development costs and restricted global scaling. These constraints may force firms to localize technologies and develop domestic substitutes, but they can also slow innovation and reduce competitiveness. The result supports the view that entrepreneurship must be analyzed within its institutional and macroeconomic environment rather than solely through firm-level capabilities. Models developed in public and service organizations have similarly demonstrated that environmental and institutional constraints shape entrepreneurial strategies and outcomes (21). Thus, the entrepreneurial potential of AI-based firms in Tehran is simultaneously strengthened by local demand and weakened by international isolation.

The strategies identified in the study provide practical mechanisms for responding to these conditions. The development of strategic collaborations was emphasized as a means of sharing resources, accessing complementary expertise, reducing research and development costs, and accelerating commercialization. This finding strongly aligns with research on AI-driven innovation in the ICT sector and smart business ecosystems, both

of which stress collaboration, networking, and institutional integration (4, 7). It is also consistent with the broader argument that AI-based entrepreneurship increasingly depends on ecosystem-level relationships rather than self-contained organizational capabilities (1). Strategic collaboration can therefore compensate for resource shortages and help companies manage complex technological projects.

Product development and upgrading were also identified as key strategies. The localization of language and processing models, improvement of user experience, and adaptation to local cultural and linguistic conditions were particularly important. These findings indicate that domestic firms may achieve competitive advantage by offering solutions better suited to Persian-language users and Iranian organizational contexts. The strategy is compatible with the literature on business innovation, which shows that AI enables firms to redesign products, personalize services, and continuously adapt offerings on the basis of user data (2). It also reflects the practical importance of translating scientific advances into context-sensitive applications, as demonstrated by specialized machine-learning solutions in professional fields (5).

Digital marketing and market penetration represented another strategic dimension. The findings showed that data-driven customer acquisition, predictive analysis, and personalized branding can help AI-based firms identify high-potential market segments and reduce marketing costs. This conclusion is consistent with research showing that AI improves market analysis, customer targeting, and decision-making (1, 2). It is also connected to the changing information behavior of users, who increasingly interact with AI-mediated systems and expect personalized access to information and services (19). Therefore, marketing in AI-based businesses should itself become intelligent, iterative, and evidence-based.

Human capital empowerment was the fourth strategy identified. Internal retraining, multidisciplinary team development, and intergenerational collaboration were regarded as necessary for adapting to rapid technological change. This result aligns with research on AI and entrepreneurship education, which highlights the need to combine technological literacy with entrepreneurial competencies (13). It is also supported by studies of AI in business education, which show that intelligent tools can strengthen learning, problem-solving, and decision-making (14). The growing volume and interdisciplinarity of AI research further demonstrate the need for continuous learning and knowledge renewal (20). Thus, human capital empowerment is not a supplementary activity but a central strategy for organizational survival and innovation.

The consequences identified in the model demonstrate the potential contribution of AI-based entrepreneurship to firm-level and national development. Economic and financial maturity included increased market share, profitability, and return on investment. These outcomes are consistent with evidence that AI can improve business performance, innovation, and operational efficiency (2, 3). Technological authority, reflected in patent registration, intellectual assets, and stronger industry–university relations, also corresponds with the knowledge-based and innovation-oriented nature of AI entrepreneurship. Research on knowledge-based companies has similarly emphasized their capacity to support international entrepreneurship and technological upgrading (8).

The social and employment consequences included the creation of high-value-added jobs, the retention of specialized talent, and the improvement of technical knowledge within the professional community. This finding is consistent with research showing that entrepreneurship can promote employment and economic growth (11). It also complements the sustainable entrepreneurship perspective, according to which AI can support economic, social, and environmental value creation when implemented responsibly (12). The identified consequence of digital transformation in upstream industries further demonstrates that AI-based entrepreneurship can produce innovation

spillovers by improving productivity in sectors such as oil, gas, banking, and healthcare. Finally, software export development reflects the potential of AI-based firms to enter regional markets, generate foreign-exchange revenues, and increase the international competitiveness of Iranian knowledge-based products.

The present study was limited to managers, specialists, experts, and experienced employees working in knowledge-based companies in the information and communications technology and computer software industries of Tehran Province. Therefore, the findings may not fully represent AI-based entrepreneurship in other provinces, industries, or organizational contexts. The qualitative nature of the research also means that the findings were based on participants' interpretations and experiences and may have been influenced by subjective perceptions, professional positions, and organizational interests. In addition, rapid technological, regulatory, and economic changes in the field of artificial intelligence may alter some of the identified conditions over time.

Future studies should quantitatively test the proposed model using a large and diverse sample of knowledge-based companies and apply structural equation modeling to assess the relationships among the identified dimensions. Comparative studies could examine differences between Tehran Province and other regions or between software, healthcare, finance, manufacturing, and agricultural AI ventures. Longitudinal research is also recommended to investigate how entrepreneurial strategies and outcomes change across different stages of venture development. Further studies could additionally explore the effects of data governance, intellectual property protection, sanctions, international networking, and customer trust as independent or moderating variables.

Policymakers should develop transparent and flexible regulations concerning data protection, cybersecurity, intellectual property, and the commercial use of artificial intelligence while simplifying licensing procedures for knowledge-based firms. Investors and financial institutions should establish staged financing mechanisms, specialized venture capital funds, and long-term evaluation criteria tailored to the risk profile of AI projects. Knowledge-based companies should strengthen collaboration with universities, accelerators, and complementary firms; invest in localized and user-centered products; adopt data-driven marketing; and implement continuous training programs for multidisciplinary teams. Measures should also be taken to retain specialized talent, improve access to computing infrastructure, and support the entry of domestic AI products into regional and international markets.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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References

1. Uriarte S, Baier-Fuentes H, Espinoza-Benavides J, Inzunza-Mendoza W. Artificial Intelligence Technologies and Entrepreneurship: A Hybrid Literature Review. Review of Managerial Science. 2026;20(1):251-99. doi: 10.1007/s11846-025-00839-4.
2. Singh R, Khan S, Joshi A, Katragadda R, Kumar V. Exploring the Role of Artificial Intelligence on Business Innovation and Entrepreneurship. Strategy & Leadership. 2026;54(3):302-22. doi: 10.1108/SL-04-2025-0080.
3. Wang Z, Li M, Lu J, Cheng X. Business Innovation Based on Artificial Intelligence and Blockchain Technology. Information Processing & Management. 2022;59(1):102759. doi: 10.1016/j.ipm.2021.102759.
4. Grabocka E, Ndoka E. AI-Driven Innovation Within the ICT Sector. Smart Cities and Regional Development Journal. 2025;9(1):77-97. doi: 10.25019/qkspkd85.
5. Dondapati A, Rodenhouse A, Carroll TJ, Lillie J, Anand A, Pink L, et al. Noninvasive Assessment of the Ulnar Nerve in the Upper Extremity Using Machine Learning. Journal of Hand Surgery Global Online. 2026;8(3):100953. doi: 10.1016/j.jhsg.2026.100953.
6. Naseri S, Javadi A. A Review of the Concept of Digital Entrepreneurship. First National Conference on Entrepreneurship Potential, Employment, and Sustainable Development; Gonbad-e Kavus2024.
7. Tarsali R, Ali J, Movahedi Sefat Z, Mohammad H. Presenting a Conceptual Model of the Data-Driven Smart Business Ecosystem. Defense Logistics and Technology Quarterly. 2025;8(3):179-214.
8. Zarei M, Abbasi Nami H, Davari A. Explaining a Model of the Role of Knowledge-Based Companies in International Entrepreneurship. 2022.
9. Gunawan AF. The Impact of Entrepreneurial Characteristics and Competencies on Business Performance in the Creative Industry in Indonesia. Asia Pacific Journal of Innovation and Entrepreneurship. 2024;18(3):300-17. doi: 10.1108/APJIE-09-2023-0172.
10. Jamshidi O, Shafiei H. Analysis of Components Affecting the Development of Technological and Innovative Entrepreneurship in Fisheries and Fishing in Iran's Northern Provinces. Entrepreneurship and Sustainable Agricultural Development Studies. 2024;11(2):94-115.
11. Habibi Koushkouhi H, Ghorbani Shamshadsara J, Hosseini Aliabad SMR. The Role of Tourism Industry Development in Creating Entrepreneurship and Employment and Its Impact on Economic Growth: A Case Study of Gilan Province. 2023.
12. Gupta BB, Gaurav A, Panigrahi PK, Arya V. Analysis of Artificial Intelligence-Based Technologies and Approaches on Sustainable Entrepreneurship. Technological Forecasting and Social Change. 2023;186:122152. doi: 10.1016/j.techfore.2022.122152.
13. Alqahtani M. Artificial Intelligence and Entrepreneurship Education: A Paradigm in Qatari Higher Education Institutions After the COVID-19 Pandemic. International Journal of Data and Network Science. 2023;7(2):695-706. doi: 10.5267/j.ijdns.2023.3.002.
14. Surugiu C, Grădinaru C, Surugiu MR. Artificial Intelligence in Business Education: Benefits and Tools. Amfiteatru Economic. 2024;26(65):241-58. doi: 10.24818/EA/2024/65/241.

15. Najafi M, Rasouli Z. Challenges, Advantages, and Disadvantages of Artificial Intelligence in the Teaching and Learning Process. Fifteenth International Conference on Management and Humanities Research in Iran2023. p. 4202-13.

16. Soltani N. Advantages and Disadvantages of Artificial Intelligence in Chemistry Education. Fourth International Conference on Modern Research in Educational Systems and Educational Sciences2025.

17. Karimi B. Artificial Intelligence and History: Possibilities, Scope, Advantages, and Challenges of Applying Artificial Intelligence in Historical Studies and History Education. Historical Perspective and Historiography. 2024;118(33):205-36.

18. Lund BD, Wang T, Mannuru NR, Nie B, Shimray S, Wang Z. ChatGPT and a New Academic Reality: Artificial Intelligence-Written Research Papers and the Ethics of Large Language Models in Scholarly Publishing. Journal of the Association for Information Science and Technology. 2023;74(5):570-81. doi: 10.1002/asi.24750.

19. Lund BD, Mannuru NR, Katta M, Hota SSLM, Pamukuntla A, Uppala S, et al. Bringing Artificial Intelligence (AI) into Health Information Seeking Behavior: A Study of AI and Information Seeking Research. Journal of Health Communication. 2025:1-6. doi: 10.1080/10810730.2025.2533820.

20. Shamsi A, Wang T, Lund B. The 100 Most Cited Articles in Artificial Intelligence in Library and Information Science: A Bibliometric Approach. International Journal of Information. 2026;24(2):1-18.

21. Varmaradi S, Eqbal MR, Fani M. Designing and Explaining an Entrepreneurship Model in the Non-Presential Services of the Social Security Organization: A Study of Razavi Khorasan Province. Urban Economics and Management Quarterly. 2023;11(44):119-39.