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A Systemic Analysis of the Health Entrepreneurial Ecosystem for Improving the Performance of Knowledge-Based Startups: Applying Soft Systems Methodology

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Abstract

This article aims to analyze the problematic situation of the health entrepreneurial ecosystem and to develop a systemic framework for improving the performance of knowledge-based startups in this field. The main problem addressed in this study is that the performance of health startups is not merely determined by technical capabilities, internal resources, or the initial business idea; rather, it is shaped within a network of interactions among government and regulatory bodies, knowledge-based firms, healthcare centers, markets, universities, intermediary institutions, and investors. This study is applied-developmental in terms of purpose and qualitative-exploratory in terms of method. Soft Systems Methodology (SSM) was employed to analyze the complex, multi-actor, and ill-structured nature of the research problem. Data were collected through semi-structured interviews with 20 experts, managers of knowledge-based firms, startup actors, investors, managers of science parks and accelerators, and health ecosystem specialists in Tehran. Participants were selected through purposive and snowball sampling. Data analysis was conducted based on the main stages of SSM, including identifying the problematic situation, developing the rich picture, formulating root definitions, conducting CATWOE analysis, designing conceptual models, comparing the real world with the desirable models, and identifying feasible and desirable change actions. The findings indicate that the key problem of the health entrepreneurial ecosystem is not the absolute absence of actors, but institutional misalignment, weak intermediary mechanisms, conflicting decision logics, lack of patient capital, weak institutional learning, and poor uncertainty management. The study concludes that improving the performance of health startups requires a transition from reactive, fragmented, and person-centered governance toward anticipatory, participatory, evidence-based, and learning-oriented governance.

Keywords: Health entrepreneurial ecosystem, Knowledge-based startups, Health startups, Soft Systems Methodology, Learning governance, Uncertainty.

1. Introduction

Entrepreneurship and startup development have become central pillars of economic growth, technological advancement, and sustainable competitiveness in knowledge-based economies. In recent decades, the emergence of startups as agile,

innovation-driven, and opportunity-seeking organizations has transformed the logic of value creation across industries, especially in technology-intensive and knowledge-oriented sectors. However, the success and performance of startups cannot be understood solely through internal organizational capabilities such as innovation, entrepreneurial orientation, or technical expertise. Rather, startup performance is deeply embedded within broader entrepreneurial ecosystems composed of interconnected actors, institutions, infrastructures, markets, financial mechanisms, knowledge networks, cultural norms, and governance structures (Ratten, 2020; Spigel & Harrison, 2018). In this context, entrepreneurial ecosystems are increasingly recognized as dynamic and systemic environments that shape the emergence, survival, scalability, and internationalization of startups.

The entrepreneurial ecosystem perspective has evolved beyond traditional views of entrepreneurship that focused primarily on individual entrepreneurs or isolated firms. Contemporary scholarship conceptualizes ecosystems as interactive, adaptive, and multi-level structures in which different actors co-create opportunities, exchange resources, and collectively influence entrepreneurial outcomes (Chaudhary et al., 2024; Ferreira et al., 2023). This perspective highlights that entrepreneurial success is not merely a consequence of entrepreneurial talent or innovation capacity, but also depends on the quality of institutional support, network connectivity, access to resources, policy coordination, and ecosystem learning mechanisms. Spigel and Harrison argued that entrepreneurial ecosystems should be understood as evolutionary processes shaped by local interactions, institutional histories, and contextual dynamics rather than static collections of entrepreneurial elements (Spigel & Harrison, 2018). Accordingly, entrepreneurial ecosystems function as socially and institutionally embedded systems in which startups continuously interact with governments, universities, investors, intermediaries, markets, and other firms.

The growing importance of entrepreneurial ecosystems is particularly evident in knowledge-based and technology-oriented businesses. In such firms, value creation depends heavily on innovation, knowledge transfer, technological capabilities, and collaborative learning. As a result, ecosystems play a critical role in facilitating access to specialized knowledge, financial capital, infrastructure, mentorship, market legitimacy, and international opportunities (Faizi et al., 2025; Ferreira et al., 2024). Knowledge-based startups usually operate under high uncertainty, rapid technological change, resource scarcity, and intense competitive pressure. Consequently, the ecosystem surrounding these firms significantly influences their capacity for innovation, growth, adaptation, and survival. Recent studies have shown that entrepreneurial ecosystems can accelerate innovation diffusion, strengthen entrepreneurial resilience, improve internationalization capacity, and enhance long-term business sustainability (Ferreira et al., 2023; Jan et al., 2025).

At the same time, startup performance itself has become a major research concern because traditional performance evaluation frameworks are often inadequate for capturing the dynamic and uncertain nature of startups. Conventional organizational performance models were primarily designed for large and stable firms operating in predictable environments. However, startups typically experience rapid growth, uncertain markets, evolving business models, technological ambiguity, and continuous strategic pivots. Antunes et al. emphasized that startup performance assessment must therefore be dynamic, flexible, stage-sensitive, and compatible with ecosystem conditions rather than relying solely on traditional financial metrics (Antunes et al., 2021). This shift has encouraged researchers to examine startup performance through broader ecosystem-based perspectives that incorporate relational, institutional, technological, and contextual dimensions.

In recent years, the relationship between entrepreneurial ecosystems and startup performance has attracted growing scholarly attention across different sectors and countries. Jan et al. demonstrated that entrepreneurial culture, social support, government policies, and sustainable digital innovation significantly contribute to business performance in startup ecosystems (Jan et al., 2025). Similarly, Lee and Kim identified financial resources, digital infrastructure, market accessibility, and human capital as key determinants of entrepreneurial ecosystem effectiveness in ICT startups (Lee & Kim, 2025). These findings indicate that startup performance is strongly influenced by ecosystem conditions rather than isolated organizational characteristics. Furthermore, Ferreira et al. argued that sustainable entrepreneurial performance in the circular economy requires coordinated interactions across macro-, meso-, and micro-level ecosystem structures (Ferreira et al., 2024). Their study emphasized that sustainability-oriented startups cannot succeed without institutional alignment, collaborative governance, and supportive ecosystem infrastructures.

Entrepreneurial skills and team dynamics have also emerged as critical dimensions within entrepreneurial ecosystems. Botella-Carrubi et al. showed that networking capability, negotiation skills, risk management, and investor communication significantly influence startup financial performance (Botella-Carrubi et al., 2025). Likewise, Irannejad Parizi et al. highlighted the importance of team entrepreneurial passion, psychological capital, and collective self-efficacy in shaping startup outcomes (Irannejad Parizi et al., 2024). These studies demonstrate that entrepreneurial ecosystems not only provide external resources but also shape internal organizational behaviors, motivations, and collaborative capabilities. In ecosystems characterized by trust, knowledge exchange, and supportive interactions, startups are more likely to develop adaptive capacities and innovation-oriented cultures.

Another important dimension of entrepreneurial ecosystems concerns internationalization and global competitiveness. Ferreira et al. argued that entrepreneurial ecosystems significantly affect the international expansion of SMEs by facilitating network connections, knowledge transfer, and market access (Ferreira et al., 2023). Razavi and Tajpour similarly emphasized that knowledge-based companies require supportive ecosystem mechanisms to successfully enter international markets and achieve sustainable growth (Razavi & Tajpour, 2023). In technology-intensive industries, startups rarely succeed solely through technological superiority; they also need institutional legitimacy, strategic partnerships, and ecosystem support structures capable of enabling global integration. Consequently, ecosystem quality increasingly determines the ability of startups to compete internationally and sustain innovation over time.

The emergence of digital transformation and advanced technologies has further reinforced the significance of entrepreneurial ecosystems. Digital innovation, artificial intelligence, platform technologies, and smart systems have reshaped the operational environment of startups and intensified the need for adaptive ecosystem governance. Fayezi and Karimi demonstrated that artificial intelligence utilization can significantly accelerate startup development and organizational growth by improving decision-making, operational efficiency, and innovation processes (Fayezi & Karimi, 2024). Taherzadeh also emphasized the transformative role of digital twins in entrepreneurial operations management and startup performance optimization (Taherzadeh, 2026). These technological developments require entrepreneurial ecosystems to become more agile, learning-oriented, and capable of managing complex technological uncertainties.

The concept of uncertainty occupies a central place within entrepreneurial ecosystem research. Startups typically operate under conditions characterized by market ambiguity, technological volatility, regulatory instability, resource constraints, and unpredictable competitive dynamics. Under such circumstances, ecosystem quality becomes essential for reducing uncertainty and facilitating entrepreneurial action. Yadollahi Farsi et al. argued that entrepreneurial action is deeply rooted in existential interpretations of uncertainty, opportunity recognition, and meaning-making processes (Yadollahi Farsi et al., 2025). Their phenomenological analysis suggests that entrepreneurship involves not only economic activity but also cognitive and existential engagement with uncertain environments. This perspective highlights the importance of ecosystem structures capable of supporting learning, adaptation, and strategic experimentation.

The COVID-19 pandemic further demonstrated the vulnerability and importance of entrepreneurial ecosystems under crisis conditions. Ratten showed that ecosystem resilience, institutional adaptability, and collaborative support mechanisms became critical factors for business continuity during global disruptions (Ratten, 2020). The pandemic revealed that entrepreneurial ecosystems are not static systems but dynamic structures requiring continuous coordination, learning, and institutional responsiveness. Startups operating in fragmented or weak ecosystems experienced greater difficulties in accessing finance, markets, and operational support during periods of crisis. Therefore, resilient ecosystem governance has become increasingly important for sustaining entrepreneurial performance in uncertain and rapidly changing environments.

In parallel with international developments, domestic research has increasingly focused on entrepreneurial ecosystems, knowledge-based firms, and startup development in Iran. Sanagoo Motlagh et al. identified multiple ecosystem components including governmental policies, infrastructures, human capital, financial resources, and institutional supports within special economic zones (Sanagoo Motlagh et al., 2021). Similarly, Baharestan et al. proposed an excellence model for spin-off companies operating within university entrepreneurial ecosystems and emphasized the importance of knowledge transfer, innovation networks, and institutional collaboration (Baharestan et al., 2023). These studies reflect a growing recognition that entrepreneurial development in Iran requires ecosystem-oriented policymaking rather than isolated support programs.

Research on ecosystem evaluation and capability development has also expanded considerably. Khajeh Pourshirvan et al. validated a framework for assessing entrepreneurial ecosystems in science and technology parks and identified infrastructure, interaction quality, capacity building, and financial support as essential ecosystem dimensions (Khajeh Pourshirvan et al., 2024). Jalilian et al. similarly developed an entrepreneurial ecosystem model focused on employment capability within knowledge-based businesses and highlighted the significance of institutional coordination and capability enhancement (Jalilian et al., 2024). Soukhtanlou et al. identified financing, technology absorption, legal structures, and commercialization capability as major dimensions of technological entrepreneurial ecosystems in processing industries (Soukhtanlou et al., 2023). These studies collectively indicate that entrepreneurial ecosystems in Iran face substantial structural and institutional challenges despite significant technological and human capacities.

The role of intermediary institutions, service design, and organizational empowerment has also attracted scholarly attention. Sartipi et al. proposed a service design framework for ICT startups and emphasized the importance of customer-centered innovation, ecosystem interactions, and collaborative learning (Sartipi et al., 2023). Mohammadkazemi et al. developed an empowerment model for knowledge-based SMEs and demonstrated the importance of strategic coordination, institutional support, and networked learning processes (Mohammadkazemi et al., 2021). Furthermore, Mohammadkazemi and Gholizadeh's systematic review of international entrepreneurial opportunities highlighted the role of institutional environments and ecosystem dynamics in shaping opportunity recognition and entrepreneurial expansion (Mohammadkazemi & Gholizadeh, 2022). Together, these findings underscore the need for integrated and systemic approaches to entrepreneurial development.

Despite these advances, important theoretical and methodological gaps remain in the entrepreneurial ecosystem literature. Much of the existing research has concentrated on identifying ecosystem components, prioritizing factors, measuring statistical relationships, or evaluating isolated dimensions of startup performance. Comparatively less attention has been devoted to understanding how ecosystem actors interact in practice, how institutional conflicts emerge, how uncertainties are managed, and how ecosystem governance can evolve toward learning-oriented and adaptive structures. Moreover, many studies remain descriptive or factor-oriented and fail to capture the complex, dynamic, and multi-actor nature of entrepreneurial ecosystems.

In response to these limitations, systemic and interpretive approaches such as Soft Systems Methodology (SSM) have gained increasing relevance. SSM is specifically designed for analyzing ill-structured, ambiguous, and multi-stakeholder problems characterized by conflicting perspectives and institutional complexity. Dewi et al. demonstrated that SSM can effectively facilitate entrepreneurial design processes by promoting collaborative learning and stakeholder interaction (Dewi et al., 2024). Tayebnia et al. also showed that SSM can contribute to designing entrepreneurship education ecosystems by identifying actor relationships, conceptual models, and institutional improvement pathways (Tayebnia et al., 2023). Likewise, Strielkowski et al. emphasized that soft systems approaches are particularly useful for addressing organizational sustainability, process optimization, and human capital development under uncertain conditions (Strielkowski et al., 2023).

The increasing complexity of entrepreneurial ecosystems further reinforces the need for systemic analysis. Entrepreneurial ecosystems involve heterogeneous actors with different interests, decision-making logics, resource dependencies, and institutional constraints. Governments prioritize regulation and public accountability; investors focus on risk and return; startups emphasize innovation and survival; universities seek knowledge production; and markets demand usability, quality, and trust. Without effective mechanisms for coordination, mediation, and institutional learning, these differing logics can generate friction, inefficiency, and ecosystem fragmentation. Consequently, ecosystem performance depends not only on the presence of actors but also on the quality of relationships, governance structures, and learning architectures connecting them.

The significance of systemic ecosystem analysis is particularly evident in knowledge-intensive and innovation-driven contexts where uncertainty management becomes central to entrepreneurial success. Mohebbi Amirhosseini et al. demonstrated the growing importance of industrial SME ecosystems and highlighted the role of coordinated development strategies in fostering sustainable entrepreneurial growth (Mohebbi Amirhosseini et al., 2025). Similarly, Tekic and Kurnosova showed that ecosystem performance differs significantly between advanced and emerging economies due to contextual and institutional

factors (Tekic & Kurnosova, 2024). These findings suggest that entrepreneurial ecosystems must be analyzed within their specific social, institutional, technological, and economic contexts rather than through universal or purely structural models.

Bibliometric and scientometric studies also confirm the rapid expansion and diversification of entrepreneurial ecosystem research. Fotovat Eskandari et al. demonstrated that research on entrepreneurial ecosystems increasingly emphasizes policymaking, institutional support, innovation capability, and network interactions as drivers of business performance (Fotovat Eskandari et al., 2025). Trabskaia et al. similarly identified strong conceptual connections between entrepreneurial ecosystems, social entrepreneurship, innovation systems, and sustainability-oriented development (Trabskaia et al., 2023). These developments indicate that entrepreneurial ecosystems are now understood as multidimensional systems influencing not only economic outcomes but also social transformation, sustainability, technological advancement, and institutional resilience.

Furthermore, ecosystem formation itself depends on enabling institutional conditions. Faizi et al. identified legal infrastructures, governmental support, collaborative networks, environmental factors, and inter-firm interactions as major enablers of knowledge-based ecosystems (Faizi et al., 2025). Shahraki-Moghadam and Farsijani similarly emphasized that startup growth in Iran depends heavily on ecosystem quality, policy consistency, and institutional coordination (Shahraki-Moghadam & Farsijani, 2022). These findings demonstrate that entrepreneurial ecosystems require more than financial investment or technological infrastructure; they also depend on governance quality, institutional trust, and collaborative learning mechanisms.

Accordingly, the present study is grounded in the assumption that entrepreneurial ecosystem performance should be understood as the outcome of systemic interactions among institutional actors, governance structures, technological capabilities, market mechanisms, and learning processes. Rather than viewing startup success as merely an organizational outcome, this perspective conceptualizes performance as an emergent property of ecosystem alignment, coordination, and adaptability. Such an approach becomes especially important in knowledge-based entrepreneurial environments characterized by uncertainty, rapid technological change, institutional fragmentation, and complex stakeholder interactions.

Therefore, the aim of this study is to analyze the entrepreneurial ecosystem and develop a systemic framework for improving the performance of knowledge-based startups through a Soft Systems Methodology approach.

2. Methods and Materials

In terms of its objective, this study is applied–developmental, and in terms of its nature, it is qualitative and exploratory. Since the subject of the article is the analysis and improvement of the performance status of knowledge-based startups within the health entrepreneurial ecosystem, the research problem is considered a complex, multi-actor, and ill-structured problem; that is, a problem in which different actors have different perceptions, interests, constraints, and decision-making logics. Accordingly, Soft Systems Methodology (SSM) was used in this article. The research population consisted of experts and key actors of the health entrepreneurial ecosystem in Tehran. These individuals were selected from among managers of knowledge-based firms and health startups, actors in the field of Medical Devices, managers of accelerators and science and technology parks, Venture Capital investors, mentors, business consultants, managers of health platforms, and individuals familiar with commercialization and regulatory processes. The main criterion for including participants in the study was having direct experience, specialized knowledge, and practical familiarity with the ecosystem of knowledge-based startups in the health field. The sampling method was purposive and snowball sampling; that is, individuals with relevant experience and professional qualifications were first selected, and then they were asked to introduce other knowledgeable individuals. The interview process continued until theoretical saturation was reached, and finally 20 individuals participated in the study. The participants' work experience ranged from 5 to 29 years, which indicates that the study relied on valid empirical and field-based data.

The main data collection instrument was the semi-structured interview. This instrument was selected because of its flexibility and its capacity to explore the diverse perspectives of actors. The interview themes included the current status of the health entrepreneurial ecosystem, the role and performance of the main actors, barriers to the growth of knowledge-based firms, licensing and regulatory challenges, problems related to attracting capital, relationships with healthcare centers and the market, the role of universities and intermediary institutions, environmental uncertainties, and improvement solutions. In addition to

interviews, documents, relevant records, field knowledge, and complementary information about active institutions in the ecosystem were also reviewed in order to enrich the analysis and draw the rich picture.

For data analysis, the seven stages of SSM were employed. In the first stage, the problematic situation of the health entrepreneurial ecosystem was identified through the participants' narratives. The findings showed that the main issue of the ecosystem is not merely the lack of support or financial resources, but rather institutional misalignment, weak interactions, multiplicity of custodians, ambiguity in rules, slow licensing processes, lack of patient capital, and gaps among the logics of actors. In the second stage, this situation was represented in the form of a rich picture in order to clarify the relationships among four main actors, including government and regulators, knowledge-based firms and health startups, healthcare centers and the market, and investors and financial institutions. The rich picture showed that the ecosystem does not suffer from a shortage of actors; rather, the main issue lies in the quality of communication, coordination, and learning among actors.

In the third stage, root definitions were extracted for each of the main actors using CATWOE analysis. In this analysis, the customers, actors, transformation process, worldview, owners, and environmental constraints of each system were identified. For example, government and regulators operate according to the logic of control, safety, and public accountability; knowledge-based firms operate according to the logic of innovation, survival, and market entry; healthcare centers and the market operate according to the logic of trust, quality, and efficiency; and investors operate according to the logic of return, risk control, and exit possibility. In the fourth stage, based on the root definitions, conceptual models were designed for the four groups of actors. These models represented the desirable world; that is, what activities each actor should perform in order to play an effective role in the ecosystem.

In the fifth stage, the conceptual models were compared with the real world. This comparison showed that many desirable activities either do not exist in reality or are carried out in a limited, person-centered, unstable, and reactive manner. For example, receiving feedback from actors is non-systematic, a joint think tank and a continuous uncertainty radar do not exist, the development of policy scenarios is limited, pre-implementation testing is not conducted, and institutional learning after implementation is weak. In the sixth stage, desirable and feasible changes were identified and organized within five proposed ecosystems, including the ecosystem of problem definition, scenario development, pre-implementation control, implementation, and post-implementation control. In the seventh stage, given the academic nature of the study, no direct action was taken in the field; however, a set of strategic actions was presented to improve ecosystem governance, interactions, and performance.

To ensure the credibility of the study, diversity among participants, repeated review of data, comparison of the perspectives of different actors, alignment of findings with the theoretical literature, and presentation of some analytical interpretations to experts were used. In addition, by providing a precise description of the research population, sampling method, stages of analysis, and the logic of model extraction, the transferability and dependability of the findings were strengthened.

3. Findings and Results

The findings obtained from applying Soft Systems Methodology showed that the current state of the health entrepreneurial ecosystem, particularly in relation to knowledge-based firms and health startups, is a multilayered and multi-actor problematic situation. In this situation, the main problem is not merely a shortage of actors, a lack of technological capacity, or the absence of market demand; rather, the core issue lies in institutional misalignment, weak linking mechanisms, the absence of shared understanding among actors, and the dominance of different decision-making logics. The interview data showed that the main ecosystem actors are present, but the relationships among them are not sufficiently regulated, transparent, facilitative, aligned, and learning-oriented. As a result, part of the energy of startups and knowledge-based firms, instead of being focused on product development, innovation, market validation, and scalability, is spent on overcoming institutional barriers, following up licensing procedures, securing minimal resources, managing uncertainties, and maintaining survival.

In the first stage of analysis, the main ecosystem actors were identified at two levels: the near environment and the distant environment. The near environment includes actors that are directly involved in the formation, development, regulation, financing, market acceptance, and commercialization of health innovations. The distant environment includes macro and contextual forces that, although not directly involved in the day-to-day operations of firms, influence decision-making, risk,

investment, sustainability, and the overall performance of the ecosystem. Table 1 presents the classification of the main actors and the forces of the distant environment.

Table 1. Main actors and forces affecting the health entrepreneurial ecosystem

Level of analysis	Main group	Examples and roles
Near environment	Government and regulators	Ministry of Health, Food and Drug Organization, Directorate General of Medical Devices, Ministry of Industry, Mine and Trade, insurance organizations, customs, taxation authorities, Vice Presidency for Science and Technology, and other policymaking, regulatory, and licensing institutions
Near environment	Knowledge-based firms and health startups	Firms active in Medical Devices, pharmaceuticals, health platforms, research and development services, preventive products, rehabilitation technologies, hospital equipment, and other innovative businesses in the health field
Near environment	Healthcare centers and the market	Hospitals, pharmacies, physicians, patients, related industries, foundations, welfare organizations, and organizational or individual customers that play roles in product acceptance, purchasing, testing, and validation
Near environment	Investors and financial institutions	Individual investors, funds, Venture Capital investors, Corporate Venture Capital funds, banks, and other financing institutions
Distant environment	Macro and contextual conditions	Sanctions, inflation, exchange-rate fluctuations, regulatory instability, managerial changes, migration of specialized human resources, weakness of legal and intellectual property infrastructures, and public culture toward health technology and prevention

The results of Table 1 show that the health entrepreneurial ecosystem does not suffer from a lack of actor diversity; rather, the main problem lies in the way these actors are connected, coordinated, and aligned. Government and regulators occupy the position of actors with the power to stop, approve, or facilitate firms' activities. Knowledge-based firms and health startups constitute the core of technology creation and innovation. Healthcare centers and the market form the arena for real validation, acceptance, and application of technology, while investors play the role of providing resources and accelerating growth. Nevertheless, each of these actors operates according to its own logic, and in the absence of intermediary mechanisms, dialogue, and coordination, these differences in logic lead to slower innovation, mistrust, firm erosion, and difficulties in commercialization.

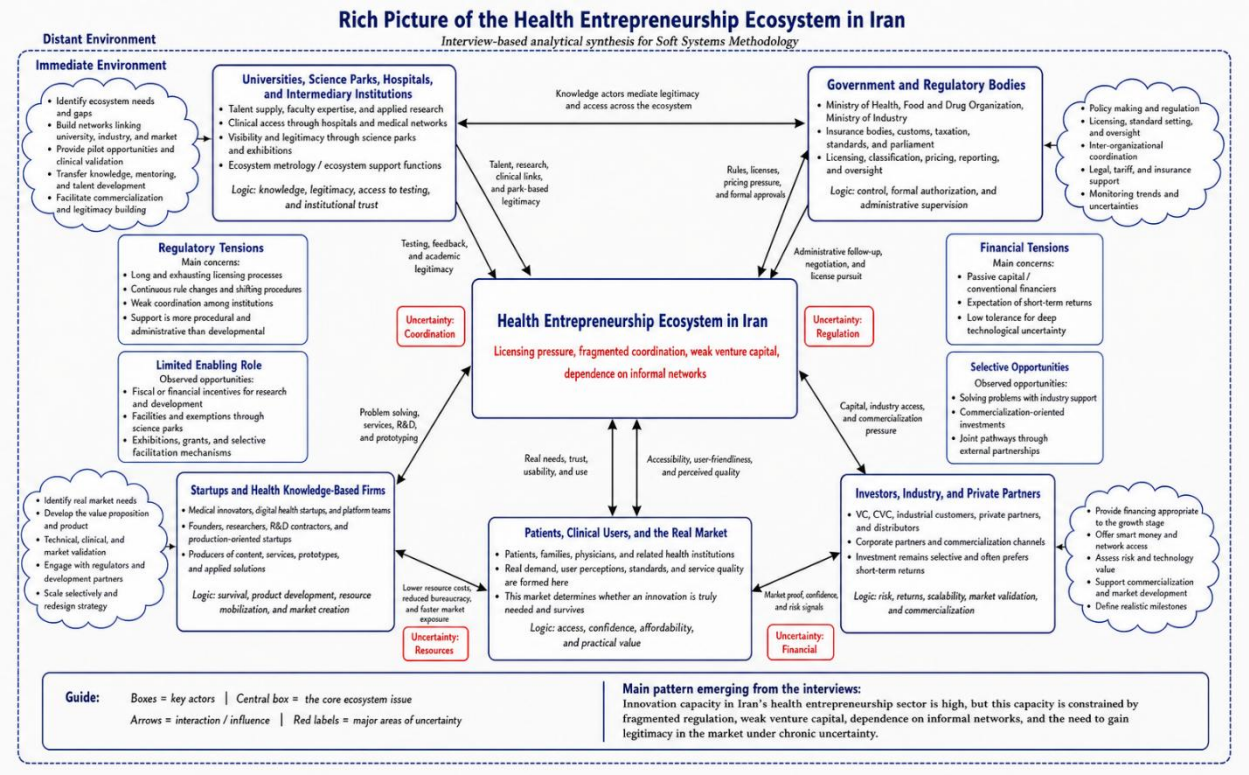

Figure 1. Rich picture of the health entrepreneurial ecosystem

Figure 1 displays the rich picture of the current state of the health entrepreneurial ecosystem. This picture shows that government and regulators directly influence the activity path of firms through licensing, regulation, standardization, and

administrative controls. Knowledge-based firms and health startups are located at the center of technology creation and innovation; however, they simultaneously face barriers such as licensing complexity, lack of capital, exchange-rate volatility, difficulty in entering the market, and the absence of shared understanding of emerging technologies. Healthcare centers and the market, on the one hand, are sources of real needs, clinical data, and practical feedback; on the other hand, due to delayed payments, professional resistance, budget constraints, complex organizational purchasing processes, and mistrust toward new technologies, they can themselves become part of the problem. Investors, despite their potential role in firms' growth, are often not aligned with the logic of health technology development because of risk aversion, expectations of short-term returns, the absence of a technology valuation system, and difficulty in exiting investments. Surrounding these relationships, distant-environment forces such as sanctions, inflation, exchange-rate volatility, regulatory instability, and the migration of human resources intensify ecosystem uncertainties.

In the next step, in order to clarify the logic of the main actors, root definitions were extracted using CATWOE analysis. This analysis showed that each group of actors views the ecosystem problem from its own perspective, and these differences in worldviews are one of the main sources of conflict, slowness, and misalignment in the ecosystem. Table 2 presents a summary of the root definitions of the four main groups of actors.

Table 2. Root definitions of the main actors of the health entrepreneurial ecosystem based on CATWOE

Actor group	Government and regulators	Knowledge-based firms and health startups	Healthcare centers and the market	Investors and financial institutions
Main customers or stakeholders	People, patients, government, health system	Patients, healthcare centers, industry, market, society	Patients, end users, physicians, purchasing organizations	Shareholders, investee firms, financial market
Implementing actors	Ministry of Health, Food and Drug Organization, Directorate General of Medical Devices, Ministry of Industry, Mine and Trade, insurance organizations, customs, Vice Presidency for Science and Technology	Founders, technical team, product team, research and development team, managers, communication networks, and development partners	Hospitals, pharmacies, physicians, patients, industries, foundations, organizational customers	Venture Capital investors, CVCs, funds, banks, individual investors, boards of directors
Expected transformation	Transforming a diverse, heterogeneous, and high-risk health market into a controlled, licensed, monitorable space with minimum safety and accountability	Transforming knowledge, ideas, and technological capacity into an impactful, commercializable, scalable product or service that solves a problem in the health field	Transforming therapeutic, rehabilitation, preventive, or operational needs into valid demand, practical feedback, and real acceptance for health technology	Transforming financial resources into investment opportunities in the health field with acceptable returns, controlled risk, and appropriate exit possibilities
Dominant worldview	Health is a sensitive and high-risk domain, and without control, standardization, and institutional intervention, safety and order cannot be maintained	Innovation in health is meaningful when it moves beyond the idea stage, reaches the market, creates real impact, and has economic sustainability	Health technology is valuable when it works in the real field, is understandable and usable, creates trust, and improves quality, speed, or cost	Investment in health is meaningful when the market outlook, technology value, commercialization path, and investment-return horizon are clear
Owners or holders of stopping power	Government, Parliament, governing institutions	Owners, founders, and in some cases investors or regulators	Managers of healthcare centers, purchasing units, tariff and insurance systems	Investor, financial institution, board of directors
Environmental constraints	Sanctions, public opinion pressure, budget constraints, changes of governments, institutional overlap, weak infrastructure	Complex licensing, lack of capital, migration of human resources, sanctions, exchange-rate volatility, weak intellectual property protection	Delayed payments, budget constraints, professional resistance, informal relationships, public procurement mechanisms, weak clinical acceptance	Inflation, political risk, economic uncertainty, absence of accurate technology valuation, long investment-return period

The analysis of Table 2 shows that the roots of many ecosystem conflicts lie in differences among actors' logics of action. Government and regulators act according to the logic of safety, control, and public accountability, whereas knowledge-based firms face the logic of innovation, survival, problem-solving, and market entry. Healthcare centers and the market, rather than focusing solely on innovation, think about reliability, efficiency, price, quality, and usability of technology. Investors also make decisions according to the logic of return, liquidity, risk control, and exit possibility. Therefore, the main ecosystem problem emerges when these logics stand against one another without mechanisms of translation, mediation, and coordination. From this perspective, the health ecosystem needs the redesign of relationships, rules, and coordinating mechanisms among existing actors more than it needs the addition of new actors.

Another important finding of the study was the identification of uncertainties affecting the ecosystem. In participants' narratives, uncertainty was not merely understood as not knowing the future, but rather as instability of rules, absence of reliable information, unpredictability of actors' behavior, and inability to estimate the consequences of decisions. Table 3 presents the most important instances of uncertainty and the actors associated with them.

Table 3. Main uncertainties affecting the health entrepreneurial ecosystem

Type of uncertainty	Related actors
Frequent changes in regulations, directives, and different interpretations of laws	Government and regulators, firms, healthcare centers
Sanctions, restrictions on importing equipment, money transfer, and international cooperation	Firms, investors, regulators
Exchange-rate volatility, inflation, declining purchasing power, and instability in financial planning	All actors
Absence of a credible technology and intellectual property valuation system	Firms, investors
Risk-averse investor behavior and absence of patient capital	Firms, investors
Non-acceptance or slow acceptance of new technologies by the market, physicians, and healthcare centers	Firms, healthcare centers
Retention of specialized human resources and migration	Firms
Delayed payments by hospitals, insurance organizations, and organizational buyers	Firms, healthcare centers
Changes in managers and lack of continuity in institutional decision-making	Regulators, firms
Institutional understanding gap regarding advanced and emerging technologies	Regulators, investors, market
Absence of a coordinating mechanism among industry, university, park, market, and regulatory institutions	All actors

As Table 3 shows, uncertainties are not limited to the macroeconomic level; rather, they are also present in institutional, financial, technological, market, and human layers. Uncertainty caused by regulatory changes and different legal interpretations makes firms' decision-making paths ambiguous. Economic uncertainty makes financial planning and pricing difficult. The absence of accurate technology valuation and intellectual property protection makes the relationship between firms and investors fragile. Delayed payments disrupt the cash flow of startups, and the migration of specialized human resources threatens the sustainability of firms' technological capacity. Taken together, these issues indicate that the health entrepreneurial ecosystem needs a permanent mechanism for monitoring, analyzing, and responding to uncertainties; a mechanism that is not institutionally and sustainably observable in the current situation.

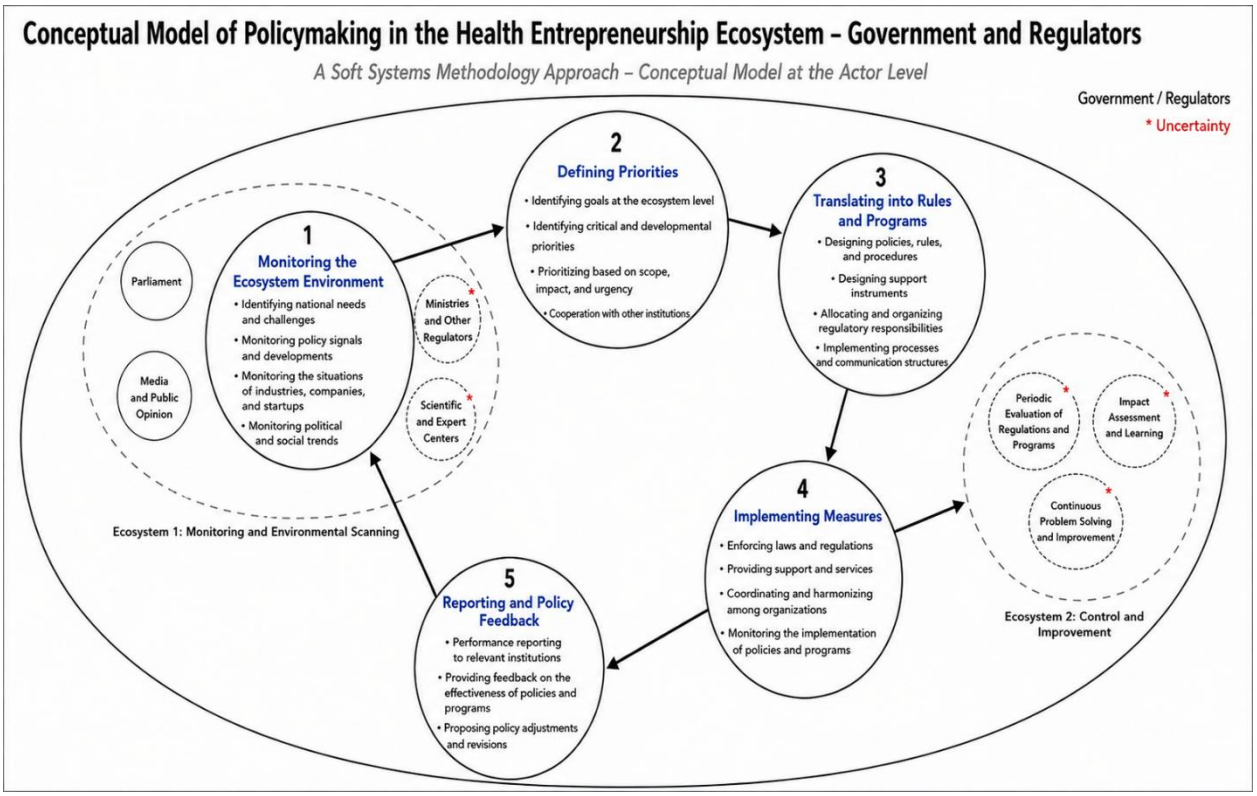

Figure 2. Conceptual Model of Government / Regulatory Core

This model illustrates the role of the government and regulatory bodies in the health entrepreneurial ecosystem as a dynamic and learning-oriented policy cycle. According to the model, the policy-making process begins with "Ecosystem Environment Monitoring", where the government identifies issues by receiving field signals regarding national needs, the status of companies and startups, political and social developments, academic reports, and media pressures. These data are then moved to the "Priority Definition" stage, where developmental and critical objectives and priorities at the ecosystem level are specified. Subsequently, the priorities are translated into rules, programs, supportive tools, and execution responsibilities, reaching the operational level through the "Implementation Requirements Creation" stage. In this phase, the government, in addition to enforcing regulations and providing support, must coordinate among various institutions. The final stage of the model, "Policy Reporting and Feedback", allows for performance evaluation, policy adjustment, and revision within the decision-making cycle. The existence of two supporting subsystems, namely "Monitoring and Environmental Surveillance" and "Control and Adjustment", indicates that policy-making in this domain should not be linear or static; rather, it should be based on continuous learning, institutional feedback, and adaptation to changing conditions. The uncertainty symbols also highlight that, at various points in the model, including interactions with regulatory bodies, academic institutions, and evaluation processes, ambiguity, variability, and instability of decisions may occur.

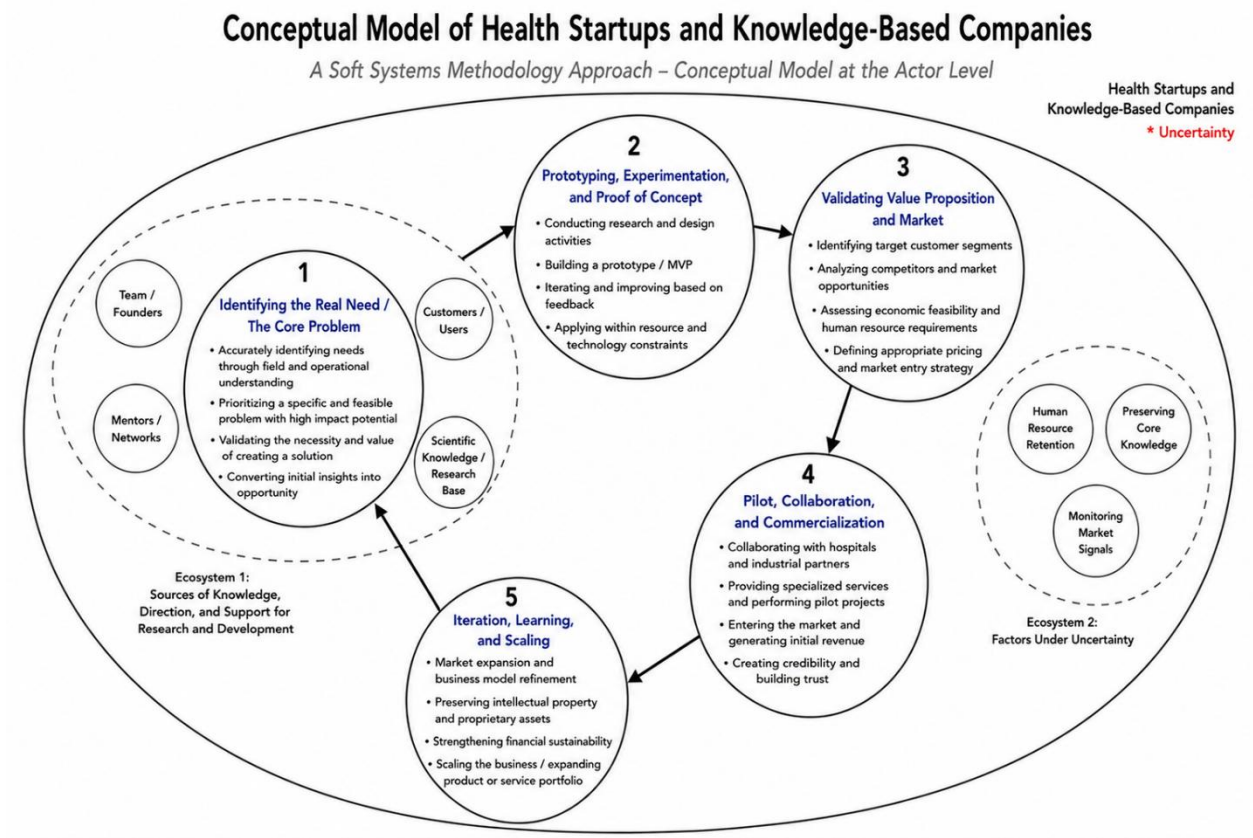

Figure 3. Conceptual Model of Health Startups and Knowledge-Based Firms

This model demonstrates the path of agency for health startups and knowledge-based firms, from idea generation to market entry, learning, and scaling. The starting point of the model is "Identifying the Real Need or Core Problem", meaning the company, with the support of the founding team, mentors, users, customers, and scientific backing, must detect a precise, real problem with impact potential. Next, in the "Prototyping, Testing, and Proof of Concept" stage, the initial idea is transformed into a prototype and iteratively refined based on repeated feedback. The subsequent stage, "Value Proposition and Market Validation", entails evaluating customer segments, competitors, economic feasibility, human resource needs, and market entry strategy. Following this is the "Pilot, Partnership, and Commercialization" stage, where collaboration with hospitals, industrial partners, and pilot projects enables market entry, initial revenue generation, and trust building. Finally, the model culminates in "Iteration, Learning, and Scaling", during which the company, by preserving intellectual assets, enhancing financial sustainability, and redesigning its business model, makes decisions for market expansion or product portfolio growth. Peripheral ecosystems in the model also indicate that the success of these companies depends on knowledge resources, support,

R&D guidance, and managing uncertainties such as retaining personnel, safeguarding key knowledge, and monitoring market signals.

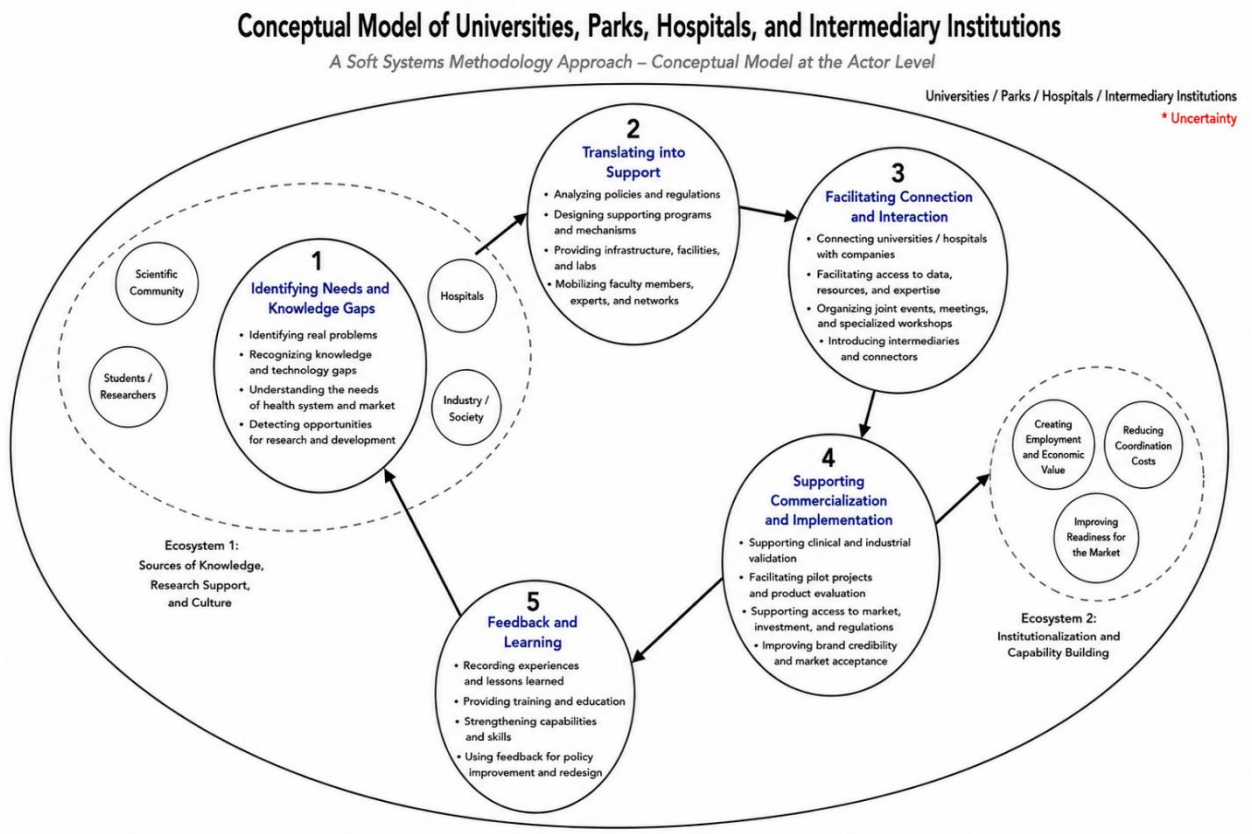

Figure 4. Conceptual Model of Universities and Hospitals

This model portrays the role of universities, science and technology parks, hospitals, and intermediary organizations as linking and facilitating nodes within the health entrepreneurial ecosystem. The model begins with “Sensing Knowledge Gaps and Needs”, where these institutions must identify unresolved issues, real needs of hospitals and the market, academic capabilities, and R&D opportunities. The next stage, “Translation into Practical Support”, converts this understanding into programs, supportive mechanisms, infrastructures, laboratories, expert networks, and targeted events. The model then emphasizes “Validation through the Real Field”, where company interactions with hospitals, real users, data, and specialized resources are established, allowing technologies to be tested and refined. The following stage, “Support for Pilot and Commercialization”, involves intermediary institutions facilitating market entry by connecting firms to industrial partners, supporting pilot projects, issuing certifications or readiness approvals, and increasing the credibility of companies. Finally, “Institutional Feedback and Learning” ensures that experiences gained from pilots, training, failures, and interactions contribute to policy improvement, skill enhancement, and redesign of communication mechanisms. Two peripheral ecosystems indicate that these actors simultaneously serve as sources of knowledge, research, culture, and demand, while also contributing to institutionalization, reducing collaboration friction, building trust, and improving market readiness.

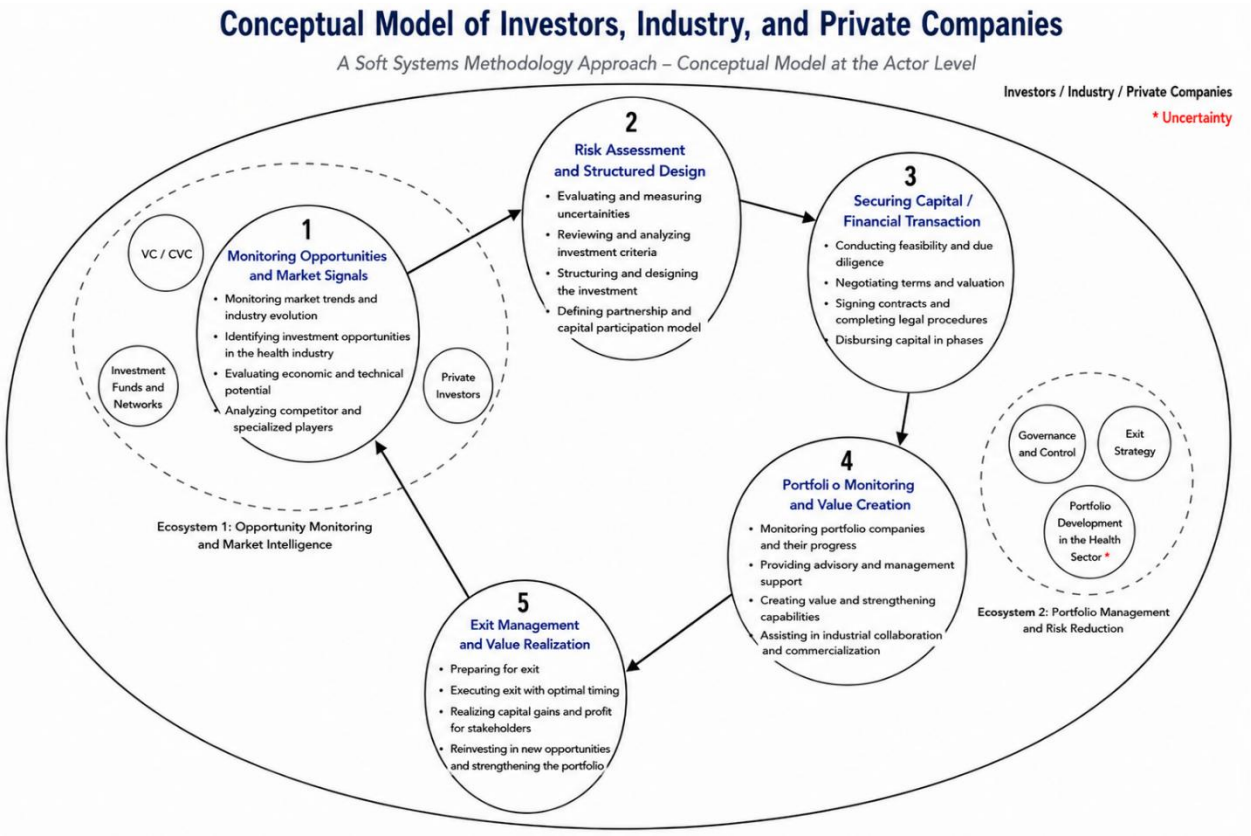

Figure 5. Conceptual Model of Investors and Industry

This model illustrates the role of investors, industry, and private companies within the health entrepreneurial ecosystem as a cycle of opportunity identification, risk assessment, financing, value creation, and exit. In the first stage, these actors identify suitable opportunities by monitoring market trends, industry developments, investment opportunities, technical and economic capabilities of projects, and competitor status. The next stage, "Risk Assessment and Structured Design", evaluates uncertainties, investment criteria, partnership models, and investment entry methods to enable more calculated investments. The third stage, "Capital Provision and Financial Transactions", involves feasibility assessment, valuation, negotiation, contract execution, and staged capital injection. Once capital is provided, the model enters "Portfolio Monitoring and Value Creation", where the investor is not merely a financier but acts as a strategic partner through management consulting, commercialization assistance, industrial collaborations, and capability enhancement of the company. Finally, "Exit Management and Value Realization" highlights the need for planning suitable exits, profit realization, resource redistribution, and reinvestment into new opportunities. Two peripheral ecosystems emphasize that the success of these actors depends on market intelligence, investment networks, governance and control, exit strategy, and portfolio development under conditions of uncertainty.

In the comparison stage, the desirable conceptual models were compared with the real world. The outcome of this comparison was the formation of a macro model for improving the ecosystem. This model includes five main ecosystems or cycles: the problem-definition ecosystem, the scenario-development ecosystem, the pre-implementation control ecosystem, the implementation ecosystem, and the post-implementation control ecosystem. Alongside these five ecosystems, four supporting mechanisms were also identified to complete the cycle: full participation of actors, continuous uncertainty radar, review of the fit between method and problem, and monitoring of international trends.

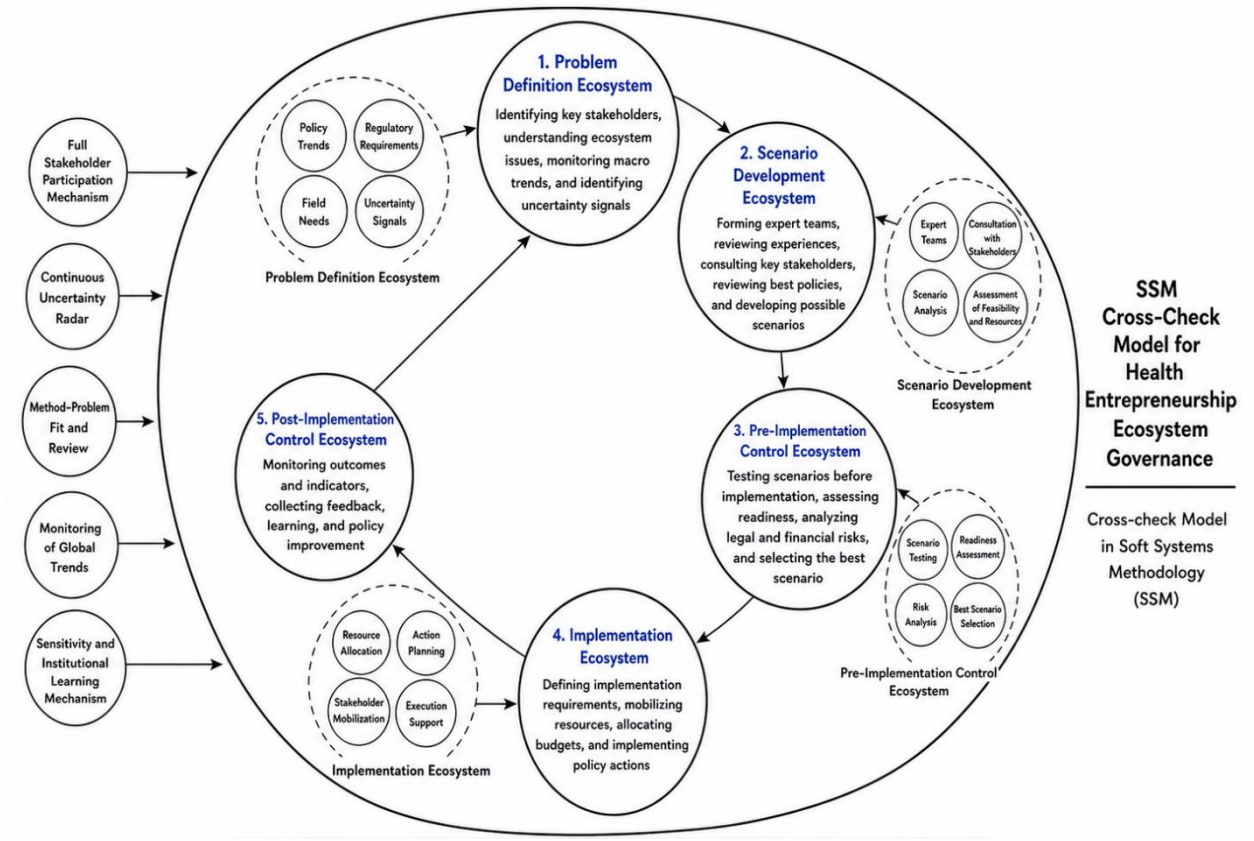

Figure 6. Comparison model of the health entrepreneurial ecosystem

Figure 6 presents the comparison model as the main output of the stage in which the real world and the desirable world were compared. This model indicates that the issue of the health entrepreneurial ecosystem is less a matter of the isolated shortage of resources or absence of actors, and more a matter of the absence of a learning-oriented, participatory, and stage-based institutional architecture. In the current situation, many decisions are made reactively, sectorally, person-centrically, and discontinuously; however, in the desirable model, the ecosystem must first define problems with the participation of actors, then design multiple scenarios based on evidence and experience, assess them before implementation in terms of risk and readiness, mobilize the necessary participation and resources during implementation, and then correct itself after implementation through monitoring, feedback, and institutional learning. In other words, the comparison model provides a learning cycle for ecosystem governance and performance improvement.

Table 4. Required actions for improving governance and policymaking in the health entrepreneurial ecosystem under conditions of uncertainty

Ecosystem	Main actions	Status in the real world	Required direction of change
Problem-definition ecosystem	Receiving the views of governing institutions, receiving field feedback from firms and healthcare centers, identifying and prioritizing problems, forming a joint think tank, creating an uncertainty radar	Existing actions are generally top-down, scattered, reactive, person-centered, and unstable. A continuous uncertainty radar practically does not exist.	Transition from reactive and sectoral problem recognition to institutional, continuous, participatory, and forward-looking problem recognition
Scenario-development ecosystem	Forming an inter-sectoral expert team, adaptive benchmarking, consulting key actors, collecting evidence, reviewing past experiences, developing multiple scenarios, institutional negotiation	Analyses are mainly limited to closed circles or personal networks. Scenario writing and learning from past experiences are highly limited.	Creating sustainable capacity for multidisciplinary analysis, producing alternative scenarios, adaptive learning, and evidence-based decision-making
Pre-implementation control ecosystem	Testing scenarios, evaluating legal, financial, institutional, and market risks, assessing actors' readiness, selecting the preferred scenario	Pre-implementation testing almost does not exist. Risk assessment is intuitive and informal, and actors' readiness usually becomes apparent only after implementation.	Establishing a formal layer of pre-testing, simulation, readiness assessment, and informed selection before policy or program implementation
Implementation ecosystem	Defining implementation requirements, attracting maximum participation of actors, allocating resources, sensitizing managers	Actors' participation is mostly symbolic. Resources are unstable and dependent on individuals.	Transforming implementation into a social, institutional, and participatory process with sufficient resources,

	and the executive body, strengthening innovation in products and processes	Implementation requirements are often vaguely or incompletely defined.	commitment, training, and coordination
Post-implementation control ecosystem	Controlling performance indicators, collecting feedback, learning and revising policies, institutionalizing knowledge and experience	Performance monitoring is highly incomplete. Feedback is often received after crises, and experiences are not transformed into institutional memory.	Creating a complete cycle of monitoring, feedback, revision, institutional learning, and transforming experiences into retrievable knowledge

The interpretation of Table 4 shows that the gap between the real situation and the desirable situation is not a minor or merely operational gap, but rather a structural, cognitive, and institutional one. In the problem-definition ecosystem, the data showed that problem reception from actors exists, but it is often scattered, non-systematic, and reactive. Therefore, the first required change is to create a mechanism that identifies and prioritizes problems before they turn into crises. In the scenario-development ecosystem, the main weakness is that decisions are usually single-option, poorly supported, and dependent on personal relationships, whereas the condition of uncertainty requires the production of several comparable scenarios and evidence-based decision-making.

In the pre-implementation control ecosystem, the findings showed that many policies and programs enter implementation without sufficient testing, risk assessment, and evaluation of actors' readiness. This causes resistance, resource shortages, and institutional conflicts to emerge during implementation and increases the cost of correction. In the implementation ecosystem, the main issue is the gap between design and execution. In many cases, actors' participation is neither real nor influential, resources are not allocated sustainably, and the executive body is not sufficiently prepared for implementing change. In the post-implementation control ecosystem, the main weakness is the incompleteness of the learning cycle; that is, even when a program is implemented, common performance indicators, continuous feedback, policy revision, and recording of experiences are not institutionally pursued.

In summarizing the findings, it can be stated that the health entrepreneurial ecosystem, in its current state, has considerable capabilities in terms of human, technological, scientific, and market-need capacities; however, these capacities are not fully actualized due to the absence of a learning-oriented institutional architecture, weak coordination among actors, instability of rules, absence of patient capital, weakness of intermediary institutions, and inability to manage uncertainties. The output of the soft systems analysis showed that the path to ecosystem improvement is not possible through isolated and case-based interventions, but rather through redesigning the governance cycle and ecosystem interactions. Accordingly, the desirable ecosystem must be able to define problems participatorily, design alternative scenarios for them, assess consequences and actors' readiness before implementation, carry out implementation with real participation and sufficient resources, and correct itself after implementation through monitoring and institutional learning. This finding constitutes the core of the proposed model of the article and shows that improving the performance of health startups and knowledge-based firms requires, above all, a transition from reactive, sectoral, and person-centered governance to forward-looking, participatory, data-driven, and learning-oriented governance.

4. Discussion and Conclusion

The findings of the present study demonstrated that the performance of knowledge-based startups is not merely determined by internal organizational capabilities, technical expertise, or entrepreneurial motivation, but is strongly shaped by the quality and functionality of the entrepreneurial ecosystem surrounding them. The results indicated that ecosystem dimensions such as institutional support, financial accessibility, network interactions, technological infrastructures, entrepreneurial capabilities, and adaptive governance significantly influence startup sustainability, innovation capability, and market performance. These findings are aligned with the contemporary ecosystem perspective, which conceptualizes entrepreneurial performance as an emergent outcome of dynamic interactions among actors, institutions, and contextual conditions rather than as an isolated organizational phenomenon (Ferreira et al., 2023; Spigel & Harrison, 2018). In this regard, the findings reinforce the argument that startups operate within complex systems in which ecosystem coordination, institutional alignment, and collaborative learning play central roles in shaping entrepreneurial outcomes.

One of the central findings of the study was the critical role of institutional and governmental support in improving startup performance. The results showed that regulatory stability, supportive policymaking, facilitative infrastructures, and coordinated

institutional mechanisms significantly contribute to entrepreneurial growth and sustainability. This finding is consistent with studies emphasizing the importance of government support and ecosystem governance in entrepreneurial development (Jan et al., 2025; Lee & Kim, 2025). The findings also support the work of Jalilian et al., who argued that entrepreneurial ecosystems require coordinated institutional frameworks to facilitate the development of knowledge-based businesses (Jalilian et al., 2024). Similarly, Khajeh Pourshirvan et al. highlighted that entrepreneurial ecosystems become more effective when institutional actors provide integrated support mechanisms, innovation infrastructures, and collaborative capacities (Khajeh Pourshirvan et al., 2024). The present study extends these findings by demonstrating that institutional support should not merely involve financial incentives or licensing procedures, but must also include adaptive governance, ecosystem coordination, and long-term strategic facilitation capable of reducing uncertainty for startups.

The findings further revealed that entrepreneurial ecosystem performance depends heavily on the quality of network relationships and collaborative interactions among ecosystem actors. Startups that had stronger relationships with universities, investors, intermediary institutions, mentors, and industrial partners demonstrated better innovation capacity, market adaptability, and organizational resilience. These findings are strongly aligned with the relational ecosystem perspective proposed by Gueguen et al., who emphasized the importance of relational capacity in entrepreneurial ecosystems (Gueguen et al., 2021). Likewise, Chaudhary et al. highlighted that innovation within entrepreneurial ecosystems emerges through interactive and collaborative relationships among universities, entrepreneurs, and institutional actors (Chaudhary et al., 2024). The present study confirms these perspectives and additionally shows that collaborative networks are especially important for knowledge-based startups operating in uncertain and technology-intensive environments because such firms rely heavily on external learning, legitimacy acquisition, and ecosystem support for survival and scalability.

Another important finding concerned the role of entrepreneurial capabilities and human capital in startup performance. The results demonstrated that entrepreneurial skills such as networking ability, strategic thinking, innovation management, negotiation capability, and opportunity recognition significantly affect startup growth and sustainability. This finding is consistent with the study of Botella-Carrubi et al., who identified entrepreneurial competencies as key determinants of startup financial performance (Botella-Carrubi et al., 2025). The findings also support Irannejad Parizi et al., who emphasized the role of team entrepreneurial passion and collective self-efficacy in improving startup outcomes (Irannejad Parizi et al., 2024). In the present study, entrepreneurial capabilities were not limited to technical expertise alone; rather, successful startups demonstrated higher capacities for uncertainty management, ecosystem interaction, institutional communication, and adaptive learning. This indicates that entrepreneurial ecosystems do not merely provide external resources but also shape the development of entrepreneurial behaviors and organizational learning capacities.

The study additionally showed that financial accessibility and investment quality are among the most influential determinants of startup performance. Access to patient capital, smart investment, venture financing, and supportive financial institutions significantly contributed to innovation continuity and market expansion. These findings are aligned with previous research emphasizing the importance of financial resources in entrepreneurial ecosystems (Faizi et al., 2025; Lee & Kim, 2025). However, the present study further demonstrated that the quality and nature of investment are more important than the mere availability of capital. Startups that benefited from strategic investors with ecosystem knowledge, mentorship capacity, and long-term perspectives performed better than those receiving purely financial support. This finding supports the argument that smart money, rather than traditional financing alone, plays a crucial role in entrepreneurial ecosystem development. Moreover, the results reinforce the observations of Mohebbi Amirhosseini et al., who emphasized the need for coordinated growth-support mechanisms for industrial SMEs and startups (Mohebbi Amirhosseini et al., 2025).

Technological capability and digital transformation also emerged as major contributors to startup performance. The findings demonstrated that startups capable of leveraging digital technologies, artificial intelligence, and advanced innovation systems achieved higher levels of operational flexibility, innovation speed, and competitive advantage. These findings are consistent with the work of Fayezi and Karimi, who demonstrated that artificial intelligence utilization accelerates startup development and organizational growth (Fayezi & Karimi, 2024). Likewise, Taherzadeh highlighted the strategic role of digital twins and digital transformation in entrepreneurial operations management (Taherzadeh, 2026). The present study confirms these

perspectives and suggests that digital transformation strengthens startup performance not only by improving efficiency but also by enabling ecosystem connectivity, knowledge sharing, and adaptive responsiveness under uncertain conditions. Consequently, entrepreneurial ecosystems must increasingly incorporate digital infrastructures and innovation-oriented technologies to support startup sustainability.

The findings further indicated that entrepreneurial ecosystems significantly influence startup internationalization and global competitiveness. Startups embedded in supportive ecosystems with stronger institutional networks, collaborative infrastructures, and international linkages demonstrated higher capacities for entering foreign markets and sustaining international growth. This finding aligns with Ferreira et al., who argued that entrepreneurial ecosystems facilitate SME internationalization by enhancing network access and institutional support (Ferreira et al., 2023). Similarly, Razavi and Tajpour emphasized that internationalization in digital and knowledge-based startups depends heavily on ecosystem conditions and entrepreneurial support mechanisms (Razavi & Tajpour, 2023; Tajpour & Razavi, 2023). The present study extends these findings by showing that internationalization is not solely dependent on firm-level strategic capabilities but also requires ecosystem-level legitimacy, policy support, and knowledge infrastructures capable of facilitating global integration.

Another important result of the study concerned the role of uncertainty management within entrepreneurial ecosystems. The findings revealed that startups operating under conditions of economic instability, regulatory ambiguity, technological change, and market unpredictability face substantial operational challenges. However, startups embedded within adaptive and learning-oriented ecosystems demonstrated greater resilience and strategic flexibility. These findings support the phenomenological perspective proposed by Yadollahi Farsi et al., who emphasized that entrepreneurial action is fundamentally shaped by interpretations of uncertainty and opportunity (Yadollahi Farsi et al., 2025). The results are also consistent with Ratten's analysis of entrepreneurial ecosystems during crisis conditions, which demonstrated the importance of ecosystem adaptability and collaborative resilience (Ratten, 2020). The present study expands these perspectives by suggesting that uncertainty management should become an institutionalized ecosystem capability rather than a reactive organizational response. Ecosystems capable of continuous learning, scenario planning, adaptive policymaking, and collaborative problem-solving provide startups with greater opportunities for sustainable performance.

The findings additionally demonstrated the importance of intermediary institutions such as universities, science parks, accelerators, incubators, and innovation centers within entrepreneurial ecosystems. These institutions were found to facilitate knowledge transfer, collaborative innovation, market validation, and entrepreneurial capability development. This finding is aligned with Baharestan et al., who emphasized the role of university entrepreneurial ecosystems in supporting spin-off firms and knowledge commercialization (Baharestan et al., 2023). Likewise, Sartipi et al. highlighted the importance of service design frameworks and intermediary mechanisms in ICT startup ecosystems (Sartipi et al., 2023). The present study further indicates that intermediary institutions play a mediating role between startups, governments, investors, and markets, thereby reducing institutional fragmentation and enhancing ecosystem coherence.

The results also support the argument that entrepreneurial ecosystems should be understood as dynamic and evolutionary systems rather than static institutional arrangements. The findings showed that startup performance improves when ecosystems demonstrate adaptability, learning orientation, and collaborative governance. This perspective strongly aligns with Spigel and Harrison's process-based theory of entrepreneurial ecosystems (Spigel & Harrison, 2018). Similarly, Tekic and Kurnosova argued that ecosystem performance varies across different economic contexts due to institutional and environmental differences (Tekic & Kurnosova, 2024). The present study reinforces this contextual perspective and demonstrates that entrepreneurial ecosystems in emerging economies face unique challenges such as institutional instability, financial uncertainty, and infrastructural limitations. Therefore, ecosystem development strategies must be context-sensitive rather than based on direct imitation of successful international models.

Furthermore, the findings demonstrated that ecosystem sustainability requires participatory and learning-oriented governance mechanisms. Entrepreneurial ecosystems characterized by fragmented policymaking, weak institutional coordination, and reactive interventions experienced lower startup performance and reduced innovation capacity. In contrast, ecosystems emphasizing collaboration, strategic alignment, evidence-based policymaking, and continuous institutional learning produced more sustainable entrepreneurial outcomes. These findings are consistent with the systemic and collaborative

logic underlying Soft Systems Methodology approaches (Dewi et al., 2024; Tayebnia et al., 2023). The study therefore suggests that entrepreneurial ecosystem governance should move beyond isolated support programs toward integrated, participatory, and adaptive ecosystem management.

From a theoretical perspective, the present study contributes to entrepreneurial ecosystem literature by emphasizing the systemic and relational nature of startup performance. Unlike traditional approaches that focus primarily on organizational-level variables, the findings demonstrate that startup outcomes emerge from interactions among institutional actors, governance structures, financial systems, technological infrastructures, and collaborative networks. This systemic understanding is also consistent with the ecosystem formation models proposed by Faizi et al. and Sanagoo Motlagh et al., who emphasized the interconnectedness of ecosystem components and institutional supports (Faizi et al., 2025; Sanagoo Motlagh et al., 2021). The present study advances these perspectives by highlighting the importance of uncertainty management, ecosystem learning, and institutional coordination as core mechanisms shaping entrepreneurial sustainability.

Overall, the findings indicate that improving startup performance requires more than financial support or isolated entrepreneurial interventions. Sustainable entrepreneurial development depends on the formation of adaptive, collaborative, learning-oriented, and institutionally aligned ecosystems capable of facilitating innovation, reducing uncertainty, and strengthening entrepreneurial resilience. Entrepreneurial ecosystems must therefore evolve toward integrated governance structures that support technological innovation, knowledge transfer, collaborative networks, strategic investment, and ecosystem-wide learning processes. Such transformation is particularly important for knowledge-based startups operating within dynamic and uncertain economic environments.

One limitation of the present study is that the research was conducted within a specific entrepreneurial and institutional context, which may limit the generalizability of the findings to other geographical regions or industries. Additionally, the study primarily relied on qualitative and interpretive perspectives, and therefore some findings may reflect contextual and subjective interpretations of ecosystem actors. Another limitation concerns the complexity and dynamic nature of entrepreneurial ecosystems themselves, as ecosystem structures continuously evolve over time and may change under different economic, political, and technological conditions. Furthermore, the study focused mainly on knowledge-based and startup-oriented ecosystems and did not extensively examine traditional entrepreneurial sectors or informal entrepreneurial environments.

Future studies should investigate entrepreneurial ecosystems across different industries, countries, and institutional settings in order to compare ecosystem structures and identify context-specific and universal ecosystem mechanisms. Researchers are also encouraged to employ mixed-method and quantitative approaches to empirically validate the relationships among ecosystem dimensions, entrepreneurial capabilities, institutional supports, and startup performance outcomes. Future research could further examine the role of emerging technologies such as artificial intelligence, blockchain, digital platforms, and smart infrastructures in transforming entrepreneurial ecosystems. Additionally, longitudinal studies investigating ecosystem evolution, institutional learning, and startup scalability over time could provide deeper insights into the dynamic nature of entrepreneurial ecosystems and sustainable entrepreneurial development.

From a practical perspective, policymakers should focus on creating integrated and adaptive entrepreneurial ecosystems rather than fragmented and short-term support programs. Governments and institutional actors should strengthen collaboration among universities, investors, startups, science parks, and intermediary organizations in order to improve ecosystem coordination and innovation capacity. Financial institutions should move toward smart investment models that combine financial support with mentorship, strategic guidance, and ecosystem networking. Universities and innovation centers should enhance knowledge transfer and entrepreneurial education mechanisms capable of preparing entrepreneurs for uncertain and technology-intensive environments. Finally, entrepreneurial ecosystem governance should emphasize institutional learning, participatory policymaking, uncertainty management, and continuous ecosystem evaluation in order to strengthen startup sustainability and long-term economic development.

Ethical Considerations

All procedures performed in this study were under the ethical standards.

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Conflict of Interest

The authors report no conflict of interest.

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References

Antunes, L. G. R., Vasconcelos, F. F., Oliveira, C. M. D., & Corrêa, H. L. (2021). Dynamic Framework of Performance Assessment for Startups. *International Journal of Productivity and Performance Management*, *71*(7), 2723-2742. https://doi.org/10.1108/IJPPM-07-2020-0382

Baharestan, O., Zare Ahmadabadi, H., Mirghafouri, S. H., & Zanjirchi, M. (2023). An Excellence Model for Spin-Off Companies in the Context of University Entrepreneurial Ecosystems. *Public Policy in Management*, *3*, 55-72. https://www.magiran.com/p2688152

Botella-Carrubi, D., Ulrich-Berenguer, K., & Ribeiro Soriano, D. E. (2025). What Entrepreneurial Skills Are the Key to Startup Finance Performance? *Venture Capital*, *27*(1), 21-41. https://doi.org/10.1080/13691066.2023.2240019

Chaudhary, S., Kaur, P., Ferraris, A., Bresciani, S., & Dhir, A. (2024). Connecting Entrepreneurial Ecosystem and Innovation: Grasping at Straws or Hitting a Home Run? *Technovation*, *130*, 102942. https://doi.org/10.1016/j.technovation.2023.102942

Dewi, H., Fitriati, R., & Salsabila, R. (2024). Designing Entrepreneurial Intention with Personal Values Using Soft Systems Methodology-Based Action Research. *Journal of Economics, Business, and Accountancy Ventura*, *27*(1), 46-61. https://doi.org/10.14414/jebav.v27i1.3937

Faizi, Y., Saeedi, H., Taherikia, F., & Lotfi Zadeh, F. (2025). Presenting the Model of Enablers for the Formation of Knowledge-Based Ecosystem. *Journal of Entrepreneurship Development*, *18*(1), 1-27. https://doi.org/10.22059/jed.2025.387756.654471

Fayezi, S., & Karimi, M. T. (2024). A Meta-Analytic Examination of the Antecedents and Outcomes of Artificial Intelligence Utilization in Accelerating Development in Startup Businesses. *Digital Transformation and Administration Innovation*, *2*(1), 101-112.

Ferreira, J. J., Fernandes, A. J., & Ramírez-Pasillas, M. (2024). Start-Ups and Entrepreneurial Ecosystems in the Circular Economy: A Multi-Level Approach for Safe and Just Planetary Boundaries. *International Small Business Journal*, *42*(4), 416-445. https://doi.org/10.1177/02662426231210765

Ferreira, J. J. M., Fernandes, C. I., & Veiga, P. M. (2023). The Role of Entrepreneurial Ecosystems in the SMEs Internationalization. *Journal of Business Research*, *157*, 113603. https://doi.org/10.1016/j.jbusres.2022.113603

Fotovat Eskandari, A., Mohammadkazemi, R., Razavi, S. M., & Tayebnia, M. R. (2025). Examining Research Trends in International Business Performance and Entrepreneurial Ecosystems Using a Bibliometric Method. *Industrial Technology Development Quarterly*, *23*(61), 97-126. https://doi.org/10.22034/jtd.2025.2037297.1952

Gueguen, G., Delanoë-Gueguen, S., & Lechner, C. (2021). Start-Ups in Entrepreneurial Ecosystems: The Role of Relational Capacity. *Management Decision*, *59*(13), 115-135. https://doi.org/10.1108/MD-06-2020-0692

Irannejad Parizi, E., Talebi, K., Yadollahi Farsi, J., & Rashadatjoo, H. (2024). Designing a Model of Team Entrepreneurial Passion on Startup Performance with a Team Self-Efficacy Approach. *Strategic Management Research*, *30*(93). https://sanad.iau.ir/Journal/smr/Article/1184865/FullText

Jalilian, I., Kabaran-Zadeh Ghadim, M. R., Shadnoosh, N., & Edalatian Shahriari, J. (2024). Developing an Entrepreneurial Ecosystem Model with an Employment Capability Approach for Knowledge-Based Businesses. *Business Management Quarterly*, *16*(61), 17-38. https://sanad.iau.ir/fa/Article/1105503?FullText=FullText

Jan, S. Q., Junfeng, J., Iqbal, M. B., Raza, A., Naz, M., & Bhatt, T. K. (2025). The Impact of Entrepreneurial Ecosystems and Sustainable Digital Innovation on Business Performance: A Study of Gilgit-Baltistan Pakistan. *Frontiers in Sustainability*, *6*, 1485680. https://doi.org/10.3389/frsus.2025.1485680

Khajeh Pourshirvan, N., Saketi, P., & Timournejad, K. (2024). Validation of an Entrepreneurial Ecosystem Evaluation Framework for Khorasan Razavi Science and Technology Park. *Productivity Management Quarterly*, *18*(2), 209-241. https://sanad.iau.ir/Journal/jpm/Article/1125866

Lee, J., & Kim, J. (2025). Analyzing Determinants' Priorities of Entrepreneurial Ecosystems for ICT Start-Ups in Sub-Saharan Africa: A Path toward Sustainable Development. *Sustainability*, *17*(5), 2044. https://doi.org/10.3390/su17052044

Mohammadkazemi, R., & Gholizadeh, S. (2022). International Entrepreneurial Opportunity: A Systematic Review, Meta-Synthesis, and Future Research Agenda. *Journal of International Entrepreneurship*, *20*(2), 218-254. https://doi.org/10.1007/s10843-021-00306-7

Mohammadkazemi, R., Talebi, K., Davari, A., & Dehghan Najmabadi, A. (2021). Designing an Empowerment Model for Knowledge-Based Small and Medium-Sized Enterprises Using the DEMATEL Approach. *Quarterly Journal of Iranian Association of Management Sciences*, *16*(61).

Mohebbi Amirhosseini, A., Mohammadkazemi, R., & Talebi, K. (2025). Scientific Mapping of the Growth of Industrial Small and Medium-Sized Enterprises in Iran's Industrial Estates: A Scientometric Study. *Karafan Scientific Journal*. https://doi.org/10.48301/kssa.2026.511626.3168

Ratten, V. (2020). Coronavirus and International Business: An Entrepreneurial Ecosystem Perspective. *Thunderbird International Business Review*, *62*(3), 629-634. https://doi.org/10.1002/tie.22161

Razavi, S. M., & Tajpour, M. (2023). Designing a Model for the Internationalization of Knowledge-Based Companies. Second International Congress on Management, Economics, Humanities and Business Development, https://civilica.com/doc/1712459

Sanagoo Motlagh, N., Mousakhani, M., Sakhdari, K., & Rahmani, H. (2021). Identifying the Components of the Entrepreneurial Ecosystem: A Study of National and International Research and the Policies of Payam Special Economic Zone. *Public Policy in Management*, *12*(41), 1-25. https://sanad.iau.ir/Journal/ijpa/Article/790231

Sartipi, S., Mohammadkazemi, R., Ahmadpour Daryani, M., & Sokhadri, K. (2023). Identifying a Service Design Framework in ICT Startups Using Thematic Analysis. *Karafan Scientific Journal*, *20*(Special Issue, No. 63), 521-543. https://doi.org/10.48301/kssa.2023.392447.2511

Shahraki-Moghadam, S., & Farsijani, H. (2022). Promotion and Growth of Startups in Iran's Startup Ecosystem. *Elites of Science and Engineering*, *7*(2). https://civilica.com/doc/1483503

Soukhtanlou, A., Rastgar, A., & Sanaeipour, H. (2023). Identifying and Prioritizing the Dimensions of the Technological Entrepreneurial Ecosystem in the Processing Industries of Golestan Province Using a Combined Fuzzy Delphi and SWARA Method. *Technology Development Journal*, *19*(76), 40-46. https://doi.org/10.61186/jstpi.36385.19.76.40

Spigel, B., & Harrison, R. T. (2018). Towards a Process Theory of Entrepreneurial Ecosystems. *Strategic Entrepreneurship Journal*, *12*(1), 151-168. https://doi.org/10.1002/sej.1268

Strielkowski, W., Kuzmin, E., Suvorova, A., Nikitina, N., & Gorlova, O. (2023). Organizational Economic Sustainability via Process Optimization and Human Capital: A Soft Systems Methodology (SSM) Approach. *ArXiv*. https://doi.org/10.48550/arXiv.2311.17882

Taherzadeh, A. H. (2026). Digital Twins as Enablers of Entrepreneurial Operations Management: A Mixed-Methods Study. *Digital Transformation and Administration Innovation*, *4*(2), 1-10.

Tajpour, M., & Razavi, S. (2023). The Effect of Team Performance on the Internationalization of Digital Startups: The Mediating Role of Entrepreneurship. *International Journal of Human Capital in Urban Management*, *8*(1), 17-30. https://doi.org/10.22034/IJHCUM.2023.01.02

Tayebnia, M., Karimi, A., Padash, H., & Yazdani, H. (2023). Developing the Framework of Entrepreneurship Education Ecosystem in Iranian Schools Using Soft System Methodology. *Journal of Systems Thinking in Practice*, *2*(2), 1-32. https://doi.org/10.22067/JSTINP.2023.81499.1052

Tekic, A., & Kurnosova, E. (2024). Entrepreneurial Ecosystem Performance in Advanced and Emerging Economies: The Role of Contextual Factors. *International Journal of Emerging Markets*. https://doi.org/10.1108/IJOEM-08-2023-1322

Trabskaia, I., Gorgadze, A., Raudsaar, M., & Myyryläinen, H. (2023). A Bibliometric Analysis of Social Entrepreneurship and Entrepreneurial Ecosystems. *Administrative Sciences*, *13*(3), 75. https://doi.org/10.3390/admsci13030075

Yadollahi Farsi, J., Mohammadkazemi, R., & Khademolreza, A. (2025). A Phenomenological Study of Existential Roots and Themes in Entrepreneurship. *Journal of Entrepreneurship Development*, *18*(1), 144-174. https://doi.org/10.22059/JED.2025.388589.654476