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Entrepreneurship in Higher Education from a Futures Studies Perspective

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A B S T R A C T

Purpose: This study aims to explain entrepreneurship in higher education from a futures studies perspective by identifying key drivers, strategic uncertainties, and possible future scenarios in the transformation of universities into entrepreneurial universities.

Methods and Materials: The present study is qualitative and futures-oriented. The research was conducted using environmental scanning, expert interviews, qualitative Delphi, MICMAC structural analysis, and scenario planning.

Findings: The results indicate that entrepreneurship in higher education is not merely a managerial strategy; rather, it represents an institutional transformation within universities that is closely linked to the knowledge-based economy, innovation development, and university–industry interaction. The most important drivers of this transformation include government support policies, digital transformation, university innovation ecosystems, and entrepreneurship education. In addition, the level of government support, the pace of digital transformation, and the degree of university–industry interaction were identified as strategic uncertainties. Based on these factors, three future scenarios were developed: the Leading Entrepreneurial University, the Adaptive University, and the Traditional University.

Conclusion: The findings show that the future of entrepreneurship in higher education depends on the complex interaction between policymaking, technology, organizational culture, and innovation networks. Achieving the entrepreneurial university requires strengthening innovation infrastructures, fostering an entrepreneurial culture, and expanding university–industry collaboration.

Keywords: *Entrepreneurial university; Entrepreneurship; Futures studies; Higher education; Scenario planning*

1. Introduction

In recent decades, higher education institutions have undergone profound transformations in response to economic globalization, technological advancement, and the emergence of knowledge-based economies. Universities are no longer viewed merely as centers for teaching and research; rather, they are increasingly recognized as strategic actors in innovation systems, regional development, and entrepreneurial ecosystems. The traditional missions of universities have expanded toward a "third mission," which emphasizes economic engagement, social value creation, knowledge commercialization, and collaboration with industry and society (Guerrero & Urbano, 2012; Secundo et al., 2017). This transition has led to the emergence of the entrepreneurial university as one of the dominant paradigms in contemporary higher education policy and practice (Etzkowitz, 2017; Fayolle & Redford, 2014). Within this framework, entrepreneurship in higher education is considered a multidimensional process involving institutional transformation, innovation development, entrepreneurial learning, and ecosystem building.

The increasing significance of entrepreneurship in universities is closely associated with the transition from industrial economies to knowledge-driven economies in which innovation, creativity, and intellectual capital constitute the main sources of competitive advantage. Universities have become central actors in producing scientific knowledge, developing human capital, and facilitating technological innovation (Budyldina, 2018; Guerrero et al., 2015). Entrepreneurial universities contribute not only to economic growth through technology transfer and startup creation but also to social transformation by promoting problem-solving capabilities, innovation culture, and interdisciplinary collaboration. Consequently, higher education institutions are increasingly expected to foster entrepreneurial mindsets among students and faculty while simultaneously strengthening their engagement with external stakeholders (Ratten, 2017; Schmitz et al., 2017).

The concept of the entrepreneurial university has evolved substantially over time. Early conceptualizations emphasized the commercialization of academic knowledge and university-industry collaboration, whereas more recent perspectives highlight ecosystem development, digital entrepreneurship, social innovation, and futures-oriented strategic transformation (Etzkowitz, 2017; Williams & Kluev, 2014). Entrepreneurial universities are characterized by flexible governance structures, innovative educational systems, interdisciplinary collaboration, and active engagement in regional and global innovation networks (Dalmarco et al., 2018; Guerrero et al., 2014). These institutions seek to transform scientific knowledge into economic and social value through entrepreneurial activities, innovation ecosystems, and collaborative partnerships with governments and industries (Allahar & Sookram, 2019; Hayter et al., 2018).

The emergence of entrepreneurial ecosystems within higher education has become one of the central themes in contemporary entrepreneurship research. Entrepreneurial ecosystems refer to interconnected networks of institutions, policies, infrastructures, financial mechanisms, and cultural factors that collectively support entrepreneurial activities and innovation processes (Allahar & Sookram, 2019; Shil et al., 2020). Universities play a pivotal role within these ecosystems by serving as hubs for knowledge generation, talent development, and technology transfer. The effectiveness of university-centered entrepreneurial ecosystems depends on multiple factors, including institutional leadership, government support, entrepreneurial education, innovation infrastructures, and university-industry interaction (Graham, 2014; Salamzadeh et al., 2015). As a result, entrepreneurship in higher education must be understood not merely as an educational initiative but as an institutional and systemic transformation process.

Simultaneously, rapid technological developments associated with the Fourth Industrial Revolution have significantly altered the future landscape of higher education and entrepreneurship. Emerging technologies such as artificial intelligence, blockchain, digital platforms, and non-fungible tokens (NFTs) are reshaping business models, labor markets, educational systems, and innovation dynamics (Chalmers et al., 2020; Chalmers et al., 2021; Chandra, 2022). Digital transformation has enabled universities to expand entrepreneurship education through virtual learning environments, digital incubators, and online innovation networks. Moreover, digital technologies facilitate the development of new forms of academic entrepreneurship and knowledge commercialization that transcend geographical boundaries (Meyer et al., 2023). Consequently, universities must increasingly adapt their institutional structures, curricula, and strategic orientations to the realities of the digital economy.

Artificial intelligence, in particular, has become a transformative force in higher education management and entrepreneurial development. AI technologies provide universities with new opportunities for decision-making,

Iranian Journal of Educational Sociology
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personalized learning, innovation management, and entrepreneurial ecosystem development (Phakamach et al., 2025). The integration of AI into higher education management can enhance organizational efficiency, improve strategic planning, and facilitate entrepreneurial innovation. Furthermore, AI-driven educational environments may strengthen entrepreneurial competencies by supporting adaptive learning systems, predictive analytics, and innovation-oriented collaboration platforms. As technological change accelerates, entrepreneurial universities must develop future-oriented strategies capable of responding to digital disruptions and technological uncertainties.

Entrepreneurship education has also emerged as one of the most important dimensions of university transformation. Contemporary higher education systems increasingly recognize that entrepreneurial competencies such as creativity, innovation, leadership, opportunity recognition, and risk management are essential for graduates in rapidly changing labor markets (Tiberius & Weyland, 2024; Wong & Chan, 2024). Entrepreneurship education is no longer limited to business schools; instead, it has expanded across disciplines, including engineering, arts, sciences, and social sciences. This interdisciplinary expansion reflects the understanding that entrepreneurship represents a broader social and cognitive capability rather than solely an economic activity (Wong & Chan, 2024). Educational leadership also plays a significant role in fostering entrepreneurial learning cultures and supporting innovation-oriented educational reforms within universities (Yasmeen, 2025).

The development of entrepreneurship education is closely linked to advances in information and communication technologies (ICTs). Digital learning environments, online collaboration tools, and virtual entrepreneurial ecosystems have transformed how students acquire entrepreneurial knowledge and skills (Chowdhury et al., 2022). ICT-based learning environments facilitate experiential learning, innovation networking, and global entrepreneurial collaboration. These developments are particularly important in contexts where traditional educational systems face limitations in adapting to changing technological and labor market conditions. Therefore, digital transformation and entrepreneurship education are increasingly interconnected dimensions of university innovation and institutional adaptation.

Despite the growing importance of entrepreneurial universities, higher education institutions face numerous structural and institutional challenges in achieving entrepreneurial transformation. One major challenge concerns the persistence of traditional academic cultures that prioritize conventional teaching and research activities over innovation and entrepreneurial engagement (Lahikainen et al., 2019). Resistance to organizational change, bureaucratic governance systems, limited financial resources, and weak industry collaboration may hinder universities' entrepreneurial development. Furthermore, institutional inequalities among universities create uneven capacities for entrepreneurship and innovation development. Some universities possess advanced research infrastructures and strong industry linkages, while others remain constrained by limited resources and weak institutional support (Dalmarco et al., 2018).

Government policies and institutional frameworks play a crucial role in shaping entrepreneurial transformation within higher education systems. Public support mechanisms such as research funding, innovation policies, intellectual property regulations, and startup incentives significantly influence universities' entrepreneurial capacities (Ghazinoory et al., 2020; Salamzadeh et al., 2015). Governments increasingly view universities as strategic actors in national innovation systems and economic development strategies. However, policy approaches toward academic entrepreneurship vary across countries and institutional contexts, leading to different models of entrepreneurial university development (Guerrero et al., 2015; Williams & Kluev, 2014). Consequently, understanding the future of entrepreneurship in higher education requires examining the interaction between institutional dynamics, technological developments, and policy environments.

Within this context, futures studies provide a valuable theoretical and methodological framework for analyzing entrepreneurship in higher education. Futures studies focus on identifying emerging trends, drivers, uncertainties, and alternative scenarios in order to support strategic planning and decision-making under conditions of complexity and uncertainty (Dator et al., 2015; Miles et al., 2017). Unlike traditional forecasting approaches that emphasize linear extrapolation of past trends, futures studies explore multiple possible futures and emphasize the active shaping of future developments through strategic action (Cook et al., 2014; Saritas et al., 2022). This perspective is particularly relevant for higher education because universities operate within rapidly changing technological, economic, and social environments characterized by uncertainty and disruption.

Iranian Journal of Educational Sociology
E-ISSN: 2645-3460

Strategic foresight has become increasingly important in higher education planning and entrepreneurship development. Futures-oriented approaches enable universities to anticipate emerging opportunities and risks associated with technological change, digital transformation, labor market evolution, and innovation ecosystem development (Gaspar, 2015; Marinkovic et al., 2022). Through environmental scanning, scenario planning, Delphi analysis, and structural analysis, universities can identify strategic drivers that shape their future entrepreneurial capacities. Futures studies also support institutional resilience by encouraging universities to develop adaptive and flexible strategies capable of responding to uncertain future conditions (Bengston et al., 2012; Cook et al., 2014).

The evolution of foresight research demonstrates increasing scholarly interest in the application of futures studies across diverse organizational and policy domains (Amini et al., 2021; Saritas et al., 2022). Technology foresight, strategic foresight, and regional foresight studies have contributed to understanding how organizations and institutions can prepare for long-term transformations (Marinkovic et al., 2022; Miles et al., 2017). In higher education, futures studies approaches can help universities identify emerging entrepreneurial opportunities, adapt to technological disruptions, and develop innovation-oriented institutional strategies (Mehdi, 2015). Consequently, entrepreneurship in higher education should be analyzed not only from managerial and economic perspectives but also from futures-oriented and systemic viewpoints.

Business model innovation is another important dimension of entrepreneurial transformation within universities. The expansion of digital economies and innovation ecosystems has created new opportunities for universities to develop innovative organizational and financial models (Wirtz et al., 2015). Entrepreneurial universities increasingly adopt hybrid organizational structures that combine academic, commercial, and social functions. These transformations require universities to rethink traditional governance models and develop more flexible and adaptive institutional arrangements capable of supporting innovation and entrepreneurship (Brown & Barnard, 2019). Strategic foresight and futures studies can facilitate this transformation by enabling universities to explore alternative institutional models and anticipate future environmental changes.

Moreover, the relationship between entrepreneurship and regional development has become increasingly significant in higher education research. Universities contribute to regional innovation systems by supporting knowledge transfer, startup development, technological innovation, and human capital formation (Budyldina, 2018; Meng et al., 2019). Entrepreneurial universities often function as anchor institutions within regional ecosystems, facilitating collaboration among governments, industries, investors, and civil society organizations. This regional dimension of academic entrepreneurship highlights the broader social and economic role of universities in fostering sustainable development and innovation capacity.

Although a substantial body of literature has examined entrepreneurial universities, entrepreneurship education, and university innovation ecosystems, relatively limited attention has been devoted to analyzing entrepreneurship in higher education from a comprehensive futures studies perspective. Existing studies frequently focus on managerial practices, technological commercialization, or entrepreneurship education while overlooking the role of strategic uncertainties, emerging trends, and alternative future scenarios in shaping university transformation (Marinkovic et al., 2022; Schmitz et al., 2017). Furthermore, the accelerating pace of technological disruption and digital transformation requires more future-oriented analytical frameworks capable of addressing uncertainty and complexity in higher education systems.

Therefore, there is a significant need for research that integrates entrepreneurship studies with futures studies approaches in order to better understand the long-term transformation of universities and the future dynamics of entrepreneurial higher education. Such research can provide policymakers, university leaders, and researchers with strategic insights regarding the drivers, uncertainties, and possible trajectories shaping the future of academic entrepreneurship. Accordingly, the present study aims to explain entrepreneurship in higher education from a futures studies perspective by identifying the key drivers, strategic uncertainties, and possible future scenarios influencing the transformation of universities toward entrepreneurial institutions.

2. Methods and Materials

2.1. Study Design and Participants

The present study was conducted as an applied and exploratory futures-oriented research project aimed at analyzing the future dimensions of entrepreneurship in higher education and identifying the major drivers, uncertainties, and potential scenarios influencing the

Iranian Journal of Educational Sociology
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transformation of universities into entrepreneurial institutions. From a methodological perspective, the study adopted a qualitative multi-method foresight approach grounded in futures studies methodology. Futures studies focus on the systematic exploration of probable, possible, and preferable futures through the analysis of emerging trends, environmental changes, strategic drivers, and uncertainties. This approach is particularly appropriate for examining entrepreneurship in higher education because universities are currently experiencing rapid institutional, technological, and socio-economic transformations associated with digitalization, innovation ecosystems, and knowledge-based economies. In recent decades, higher education institutions have evolved from traditional teaching and research organizations into multifunctional entities that play significant roles in innovation development, economic growth, entrepreneurial ecosystem formation, and university-industry-government interaction. Consequently, entrepreneurship in higher education represents a dynamic and uncertain field that requires future-oriented and systemic analytical approaches capable of addressing complexity and long-term transformation processes.

The research population consisted of experts, scholars, and practitioners with specialized knowledge and professional experience in the fields of entrepreneurship, higher education, futures studies, innovation policy, and university ecosystem development. Participants included university faculty members, researchers in entrepreneurship and innovation studies, specialists in strategic foresight and futures research, policymakers associated with higher education systems, and managers involved in science, technology, and innovation ecosystems. The inclusion of experts in futures-oriented research is particularly important because expert participants possess the conceptual and practical knowledge necessary for analyzing long-term trends, strategic uncertainties, and alternative future developments. Participants were selected using purposive sampling in order to identify individuals with the highest degree of expertise and relevance to the research topic. To increase diversity of perspectives and improve the comprehensiveness of the analysis, snowball sampling was subsequently employed, allowing initial participants to recommend additional experts with relevant experience and knowledge.

A total of 20 experts participated in the study. This sample size was considered appropriate for qualitative Delphi-based futures studies because it allowed for analytical depth, diversity of viewpoints, and conceptual richness while maintaining the feasibility of iterative expert evaluation. The selection criteria for participation included academic or professional experience in entrepreneurship and higher education, familiarity with innovation ecosystems and entrepreneurial universities, participation in strategic planning or futures studies projects, and involvement in policy or managerial activities related to university transformation and innovation development. The diversity of participants contributed to a broader understanding of the institutional, technological, and policy-related dimensions shaping the future of entrepreneurship in higher education.

2.2. Data Collection Tools

Data collection was conducted through a sequential and integrated futures studies process consisting of environmental scanning, semi-structured expert interviews, qualitative Delphi rounds, and cross-impact assessment procedures. In the first phase, environmental scanning was performed to identify macro-level trends, emerging developments, and contextual factors influencing entrepreneurship in higher education. During this stage, scholarly literature related to entrepreneurial universities, university-based innovation ecosystems, strategic foresight, digital transformation, and higher education entrepreneurship was systematically reviewed. In addition, international policy reports, strategic documents, and foresight studies concerning the future of universities, innovation systems, and knowledge economies were analyzed in order to identify the most significant trends and structural transformations affecting academic entrepreneurship. This stage provided the conceptual foundation for identifying major drivers and uncertainties associated with the future of entrepreneurship in higher education.

In the second phase, semi-structured interviews were conducted with the selected experts. The interviews were designed to deepen and contextualize the findings obtained from environmental scanning and to explore participants' interpretations regarding future developments, institutional transformations, and strategic uncertainties in entrepreneurial higher education. The semi-structured format allowed flexibility in discussing complex and emerging issues while ensuring consistency across interviews. Interview questions focused on topics such as the future role of universities within innovation ecosystems, the influence of digital transformation on entrepreneurial activities, the importance of policy support mechanisms,

Iranian Journal of Educational Sociology
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emerging technological developments, university-industry collaboration, entrepreneurship education, and future scenarios of higher education transformation. The interviews encouraged participants to discuss both current realities and long-term future possibilities, thereby generating rich qualitative insights regarding the evolution of entrepreneurial universities.

The third phase involved the implementation of a qualitative Delphi process. In this stage, the preliminary list of drivers, themes, and uncertainties extracted from environmental scanning and interviews was presented to the expert panel across several iterative rounds. Experts were asked to evaluate, revise, prioritize, and refine the identified factors and provide additional perspectives regarding their significance and future implications. The Delphi process emphasized qualitative interpretation and conceptual consensus rather than statistical aggregation. Through successive rounds, the participants gradually reached agreement concerning the most influential drivers shaping the future of entrepreneurship in higher education. Particular attention was devoted to identifying strategic uncertainties and variables with high influence on future university transformation.

In the final phase of data collection, a cross-impact assessment matrix was developed based on the factors confirmed through the Delphi process. Experts evaluated the degree of influence and interdependence among the identified variables in order to clarify the structural relationships within the university entrepreneurship system. The cross-impact matrix served as the foundation for subsequent structural analysis and facilitated the identification of driving variables, dependent variables, linkage variables, and relatively autonomous factors affecting the future of entrepreneurship in higher education.

To ensure the trustworthiness and rigor of the study, several qualitative validity criteria were applied throughout the research process. Credibility was strengthened through member checking, whereby participants reviewed and confirmed the interpretations and findings derived from interviews and Delphi discussions. Data triangulation was also employed by integrating information from multiple sources, including literature reviews, policy documents, expert interviews, and Delphi evaluations. Dependability was enhanced through detailed documentation of research procedures, coding processes, analytical decisions, and methodological steps. Transferability was supported by providing extensive descriptions of the institutional context, expert characteristics, and higher education environment relevant to the study. Confirmability was ensured through systematic recording of analytical notes, coding procedures, and intermediate findings, thereby enabling transparency and auditability throughout the research process.

2.3. Data Analysis

Data analysis was conducted in several interconnected stages using qualitative futures studies methods. Initially, the interview data were analyzed through thematic analysis. This process involved open coding, axial coding, and selective coding procedures aimed at identifying key themes, conceptual categories, and interpretive patterns related to the future of entrepreneurship in higher education. During open coding, meaningful statements and concepts were extracted from the interview transcripts. In the axial coding stage, relationships among categories and themes were identified and organized into broader conceptual structures. Finally, selective coding was used to integrate the themes into coherent interpretive frameworks explaining the transformation of universities toward entrepreneurial institutions. Thematic analysis enabled the identification of major institutional, technological, cultural, and policy-related dimensions influencing entrepreneurial transformation in higher education.

Following thematic analysis, the extracted themes and expert perspectives were synthesized to identify key drivers and strategic uncertainties shaping the future of entrepreneurship in higher education. These drivers represented factors with the greatest potential influence on future developments within universities and innovation ecosystems. Particular attention was devoted to identifying variables associated with digital transformation, entrepreneurship education, policy support, innovation infrastructure, university-industry interaction, and ecosystem development. Strategic uncertainties were identified based on their high impact and uncertain future trajectories.

Subsequently, qualitative structural analysis was conducted using the MICMAC method. In this stage, the variables identified during the Delphi process were analyzed according to their levels of influence and dependence within the cross-impact matrix. MICMAC analysis facilitated the classification of variables into driving variables, dependent variables, linkage variables, and relatively autonomous variables. This analytical approach enabled a deeper understanding of the structural dynamics governing entrepreneurship in higher education and clarified which

Iranian Journal of Educational Sociology
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factors function as primary drivers of transformation within the system.

In the final stage of analysis, exploratory future scenarios were developed based on the interaction between key drivers and strategic uncertainties. Scenario development was employed as a futures studies tool for constructing alternative and plausible future pathways regarding entrepreneurship in higher education. The scenarios were not intended as deterministic predictions; rather, they were designed to explore different configurations of technological, institutional, and policy conditions affecting universities' entrepreneurial transformation. The resulting scenarios illustrated possible futures ranging from highly entrepreneurial and innovation-oriented universities to more traditional and adaptive institutional models. These scenarios provided a multidimensional framework for understanding the future trajectories of entrepreneurship in higher education and offered strategic insights for policymakers, university leaders, and researchers concerned with the long-term transformation of universities.

3. Findings and Results

This section presents the findings obtained through the exploratory futures research process on entrepreneurship in higher education. The findings were generated through a sequential analytical procedure that included environmental scanning, thematic analysis of semi-structured interviews, qualitative Delphi analysis with 20 experts, MICMAC structural analysis, and exploratory scenario development. Each stage informed the next stage; therefore, the findings reflect an integrated analytical process moving from the identification of macro-level trends to the extraction of core themes, key drivers, structural relationships, strategic uncertainties, and possible future scenarios.

Environmental scanning was first conducted to identify the major trends and structural forces influencing the future of entrepreneurship in higher education. The findings showed that the transition toward a knowledge-based economy, the emergence of fourth industrial revolution technologies, digital transformation, the expansion of innovation ecosystems, and the internationalization of higher education are among the most important trends affecting universities. These trends indicate that universities are increasingly expected to move beyond traditional teaching and research functions and participate more actively in innovation, knowledge commercialization, technology transfer, and entrepreneurial value creation.

Table 1

Macro-level trends affecting entrepreneurship in higher education

Trend	Description	Impact on university entrepreneurship
Knowledge-based economy	Increased importance of knowledge and innovation in economic growth	Strengthening universities' role in producing technology and knowledge-based firms
Fourth industrial revolution	Development of technologies such as artificial intelligence and blockchain	Creating new opportunities for technology-based entrepreneurship
Expansion of innovation ecosystems	Formation of collaboration networks among universities, industry, and government	Facilitating knowledge commercialization and the development of university startups
Digital transformation	Expansion of digital technologies in education and business	Enabling new business models for universities
Internationalization of higher education	Intensifying global competition and collaboration among universities	Strengthening scientific entrepreneurship and technology transfer

The findings from environmental scanning show that these trends simultaneously create opportunities and pressures for universities. On the one hand, they enable universities to become more active in technology development, entrepreneurial education, and innovation networks. On the other hand, they require universities to redesign their institutional structures, educational models, and external collaborations. The results indicate that universities that fail to respond to these trends may remain limited to traditional academic roles, while those that adapt effectively may become central actors in entrepreneurial ecosystems.

In the next stage, semi-structured interviews with experts were analyzed through open, axial, and selective coding. The interview findings revealed four main themes: entrepreneurial culture in higher education, innovation infrastructures, university–industry interaction, and support policies. These themes demonstrate that entrepreneurship in higher education is not formed through a single factor; rather, it emerges through the interaction of cultural, structural, institutional, and policy-related conditions.

Iranian Journal of Educational Sociology
E-ISSN: 2645-3460

Table 2

Themes extracted from the interview analysis

Core theme	Axial codes	Open codes	Expert quotation (example)
Entrepreneurial culture in higher education	Positive attitudes toward entrepreneurship	Entrepreneurship education; student motivation	"Universities should strengthen a culture of risk-taking and innovation among students."
Innovation infrastructures	Incubators and accelerators	Innovation labs; entrepreneurship centers	"The existence of university incubators plays an important role in turning ideas into businesses."
University–industry interaction	Research collaborations	Joint projects; technology transfer	"Without real communication with industry, university entrepreneurship cannot take shape."
Support policies	Financial and legal support	Intellectual property rules; investment funds	"Government support for knowledge-based companies plays a determining role."

The interview findings indicate that entrepreneurial culture functions as the internal foundation of university entrepreneurship. Experts emphasized that without values and attitudes that encourage innovation, risk-taking, and opportunity recognition, formal structures alone cannot produce entrepreneurial outcomes. Innovation infrastructures were also identified as necessary operational mechanisms for transforming academic ideas into practical and commercial outputs. University–industry interaction was found to be the main channel through which scientific knowledge can enter real economic and technological contexts. Support policies were described as an enabling framework that can either accelerate or restrict entrepreneurial transformation in universities.

After integrating the findings of environmental scanning and interview analysis, a preliminary list of drivers was extracted and submitted to the experts through the qualitative Delphi process. Across three Delphi rounds, the experts reviewed, revised, and prioritized the identified drivers. The results showed that four drivers received the strongest expert consensus: digital transformation in higher education, government support policies, university innovation ecosystem, and entrepreneurship education.

Table 3

Key drivers extracted through the Delphi process

Proposed driver	Changes across Delphi rounds	Level of consensus	Conceptual description
Digital transformation in higher education	Increased emphasis in rounds two and three	High	Using advanced technologies to develop entrepreneurship
Government support policies	Consolidated in round three	High	Financial and legal support for university entrepreneurship
University innovation ecosystem	Definition revised in round two	High	Interaction network among university, industry, and government
Entrepreneurship education	No change	Medium to high	Developing entrepreneurial skills among students

The Delphi findings show that digital transformation was increasingly emphasized by experts during later rounds and was finally recognized as an independent and highly influential driver. Government support policies were also consolidated as a central driver because experts considered legal, financial, and institutional support essential for the expansion of university entrepreneurship. The university innovation ecosystem was refined conceptually during the Delphi process and was defined as the interaction network among universities, industries, governments, investors, and entrepreneurial actors. Entrepreneurship education remained stable across the rounds and was recognized as a key mechanism for developing entrepreneurial capabilities among students and faculty members.

To examine the structural relationships among the identified drivers, MICMAC analysis was conducted using a cross-impact matrix. Experts assessed the influence of each variable on the others. The summarized cross-impact matrix is presented below.

Iranian Journal of Educational Sociology
E-ISSN: 2645-3460

Table 4

Cross-impact matrix: summary example

Variable	Digital transformation	Support policies	Innovation ecosystem	Entrepreneurship education
Digital transformation	—	3	2	2
Support policies	2	—	3	2
Innovation ecosystem	3	2	—	2
Entrepreneurship education	2	2	2	—

The cross-impact matrix shows that the variables are mutually connected and that none of the major drivers acts in isolation. Support policies strongly influence the innovation ecosystem, while digital transformation is strongly connected to both support policies and innovation ecosystems. Entrepreneurship education has medium-level relationships with all other variables, indicating that it contributes to the system but does not dominate the structural configuration.

Based on the MICMAC analysis, variables were classified according to their levels of influence and dependence. This classification clarified the structural role of each variable in shaping the future of entrepreneurship in higher education.

Table 5

Classification of variables in MICMAC analysis

Variable	Level of influence	Level of dependence	Type of variable
Government support policies	High	Medium	Driving driver
Digital transformation	High	High	Linkage variable
University innovation ecosystem	Medium	High	Dependent variable
Entrepreneurship education	Medium	Medium	Relatively autonomous variable

The MICMAC results show that government support policies function as the main driving factor in the system because they have a high level of influence and a medium level of dependence. Digital transformation was classified as a linkage variable because it has both high influence and high dependence, meaning that it both shapes and is shaped by other variables. The university innovation ecosystem was identified as a dependent variable, indicating that its development depends strongly on other drivers, particularly policy support and digital transformation. Entrepreneurship education was classified as a relatively autonomous variable, with medium levels of both influence and dependence.

Following the structural analysis, the study identified key strategic uncertainties that could shape different future pathways for entrepreneurship in higher education. The most important uncertainties were the level of government policy support, the speed of digital transformation in universities, and the level of university–industry interaction.

Table 6

Strategic uncertainties

Uncertainty	Why is it strategic?	Possible implications
Level of government policy support	A determining role in providing resources and infrastructure	Development or stagnation of university entrepreneurship
Speed of digital transformation in universities	Determines innovation capacity and competitiveness	Formation of new education and business models
Level of university–industry interaction	A key factor in technology transfer	Increase or decrease in knowledge commercialization

The findings show that each of these uncertainties may lead to different future conditions for universities. Strong government policy support may accelerate the formation of entrepreneurial universities, while weak or unstable support may slow down transformation. Rapid digital transformation may enable universities to create new models of entrepreneurship, education, and innovation, while slow transformation may reduce their competitiveness. Similarly, strong university–industry interaction may increase commercialization and startup development, whereas weak

Iranian Journal of Educational Sociology
E-ISSN: 2645-3460

interaction may limit the practical application of university knowledge.

In the final stage, exploratory scenarios were developed based on the interaction among the main drivers and strategic uncertainties. Three possible future scenarios were identified: the Leading Entrepreneurial University, the Adaptive University, and the Traditional University.

Table 7

Future scenarios for entrepreneurship in higher education

Scenario title	Driver status	Uncertainty status	Key features of the future of higher education	Descriptive summary
Leading entrepreneurial university	Strong drivers	Positive uncertainties	Active innovation ecosystems	Universities become central hubs of innovation and startups
Adaptive university	Medium drivers	Balanced uncertainties	Gradual development of entrepreneurship	Gradual transformation in entrepreneurship education and engagement with industry
Traditional university	Weak drivers	Negative uncertainties	Limitation of entrepreneurial activities	Universities largely revert to traditional educational roles

The first scenario, the Leading Entrepreneurial University, represents a future in which policy support is strong, digital transformation occurs rapidly, and university–industry collaboration is highly developed. In this scenario, universities become active centers of innovation, technology transfer, startup creation, and entrepreneurial education. The second scenario, the Adaptive University, reflects a moderate pathway in which universities gradually develop entrepreneurial capacities but remain constrained by partial support, uneven digital transformation, and limited collaboration with industry. The third scenario, the Traditional University, represents a future in which weak drivers and negative uncertainty conditions limit entrepreneurial activities and universities remain largely focused on conventional teaching and research roles.

Overall, the findings indicate that the future of entrepreneurship in higher education is shaped by the interaction among digital transformation, government support policies, university innovation ecosystems, and entrepreneurship education. Government support policies emerged as the most important structural driver, digital transformation appeared as a central linkage variable, and the university innovation ecosystem was found to depend heavily on other enabling factors. The scenario results further show that the future of entrepreneurial universities is not fixed; rather, it may follow different pathways depending on the strength of drivers and the direction of strategic uncertainties.

4. Discussion and Conclusion

The findings of the present study indicate that entrepreneurship in higher education is a multidimensional and future-oriented phenomenon shaped by the interaction among institutional structures, technological transformations, policy environments, innovation ecosystems, and organizational culture. The results derived from environmental scanning, expert interviews, Delphi analysis, MICMAC structural analysis, and scenario development demonstrate that entrepreneurial transformation within universities cannot be reduced to isolated managerial reforms or economic strategies. Rather, it reflects a broader institutional transition in which universities redefine their social, economic, and technological roles within knowledge-based societies. These findings are aligned with the growing body of literature emphasizing that contemporary universities are increasingly expected to function as entrepreneurial actors capable of generating innovation, facilitating technology transfer, and contributing to regional and national development (Etzkowitz, 2017; Guerrero & Urbano, 2012).

One of the central findings of this study concerns the importance of entrepreneurial culture in facilitating university transformation. The results suggest that entrepreneurial universities require more than physical infrastructure or financial investment; they depend fundamentally on the emergence of organizational values that support innovation, creativity, opportunity recognition, and risk-taking among faculty members, students, and university leaders. This finding is highly consistent with previous studies indicating that entrepreneurial orientation within universities is deeply influenced by institutional culture and internal organizational dynamics (Ratten, 2017; Schmitz et al., 2017). Entrepreneurial culture functions as the social and cognitive foundation through which universities adapt to changing technological and economic environments. Without such a culture, even advanced

Iranian Journal of Educational Sociology
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innovation infrastructures may fail to generate sustainable entrepreneurial outcomes.

The findings also reveal that entrepreneurial culture is closely connected to educational transformation. Universities that integrate entrepreneurship into teaching practices, interdisciplinary collaboration, and experiential learning environments are more likely to foster entrepreneurial competencies among students and faculty. This result aligns with research emphasizing the importance of entrepreneurship education in preparing graduates for uncertain and rapidly changing labor markets (Tiberius & Weyland, 2024; Wong & Chan, 2024). Entrepreneurship education contributes not only to business creation but also to the development of creativity, adaptability, leadership, and problem-solving capabilities. In this regard, educational leadership becomes a significant factor influencing universities' entrepreneurial transformation because leaders shape institutional priorities, innovation strategies, and organizational learning processes (Yasmeen, 2025).

Another important finding concerns the role of innovation infrastructures and entrepreneurial ecosystems in supporting academic entrepreneurship. The study identified university incubators, accelerators, innovation laboratories, entrepreneurship centers, and technology transfer offices as crucial mechanisms facilitating the commercialization of knowledge and the development of university-based startups. These findings are consistent with previous studies emphasizing the significance of entrepreneurial ecosystems in promoting innovation and university-industry collaboration (Allahar & Sookram, 2019; Shil et al., 2020). Entrepreneurial ecosystems provide collaborative networks that connect universities with industries, governments, investors, and society, thereby facilitating knowledge exchange, resource mobilization, and innovation development.

The importance of university-industry interaction was also strongly emphasized in the findings. The results indicate that effective communication between universities and industries enhances the practical application of scientific knowledge, increases opportunities for technology transfer, and supports the development of entrepreneurial initiatives. This finding is aligned with the Triple Helix perspective, which conceptualizes innovation as the outcome of dynamic interactions among universities, industries, and governments (Etzkowitz, 2017). Previous research has similarly demonstrated that universities with stronger external collaboration networks tend to exhibit higher levels of innovation and entrepreneurial performance (Hayter et al., 2018; Meng et al., 2019). The findings therefore suggest that entrepreneurial universities must actively position themselves within broader innovation ecosystems rather than functioning as isolated academic institutions.

A particularly significant result of this study is the identification of digital transformation as one of the most influential drivers shaping the future of entrepreneurship in higher education. The findings indicate that digital technologies such as artificial intelligence, blockchain, digital platforms, and emerging online business models are profoundly reshaping university entrepreneurship, educational systems, and innovation processes. This result supports prior research highlighting the transformative effects of digital technologies on entrepreneurship and organizational innovation (Chalmers et al., 2020; Meyer et al., 2023). Digital transformation not only alters educational delivery systems but also creates entirely new entrepreneurial opportunities within higher education institutions.

Artificial intelligence was identified as especially important in transforming higher education management and entrepreneurial capacities. AI technologies enable universities to improve decision-making processes, enhance organizational efficiency, support innovation management, and facilitate adaptive learning systems. These findings align with recent studies emphasizing the strategic importance of AI implementation in higher education institutions (Phakamach et al., 2025). Universities capable of effectively integrating AI into educational, managerial, and entrepreneurial systems are more likely to maintain competitiveness within rapidly evolving knowledge economies. Moreover, AI-driven transformation contributes to the emergence of more flexible and data-oriented university business models.

The findings also suggest that blockchain technologies and digital entrepreneurship models are becoming increasingly relevant within entrepreneurial universities. Emerging technologies such as blockchain and NFTs create new possibilities for decentralized innovation systems, digital intellectual property management, and online entrepreneurial ecosystems (Chalmers et al., 2021; Chandra, 2022). These technological developments challenge traditional organizational models within higher education and require universities to rethink governance systems, innovation strategies, and institutional structures. Consequently, entrepreneurial universities must increasingly adopt futures-oriented perspectives capable of anticipating and responding to technological disruptions.

Iranian Journal of Educational Sociology
E-ISSN: 2645-3460

The results of the Delphi analysis and MICMAC structural analysis further revealed that government support policies constitute one of the most influential structural drivers shaping the future of university entrepreneurship. Government policies related to research funding, innovation incentives, intellectual property regulations, startup support, and higher education governance significantly influence universities' entrepreneurial capacities. This finding is strongly supported by previous studies emphasizing the role of institutional and policy environments in facilitating entrepreneurial university transformation (Ghazinoory et al., 2020; Salamzadeh et al., 2015). Supportive policy frameworks create the institutional stability necessary for long-term innovation investment and entrepreneurial ecosystem development.

At the same time, the findings indicate that the future of entrepreneurship in higher education is characterized by substantial uncertainty. Strategic uncertainties identified in this study include the level of government support, the pace of digital transformation, and the intensity of university-industry collaboration. These uncertainties suggest that the future trajectories of entrepreneurial universities are not predetermined but depend on complex interactions among technological, political, institutional, and economic factors. This perspective is consistent with futures studies literature emphasizing the importance of uncertainty analysis and scenario development in strategic planning (Cook et al., 2014; Dator et al., 2015). Universities therefore require adaptive and flexible strategies capable of responding to multiple possible futures.

The scenario analysis conducted in this research provides important insights into alternative pathways for the future development of entrepreneurial universities. The "Leading Entrepreneurial University" scenario represents a future characterized by strong policy support, advanced digital transformation, active innovation ecosystems, and extensive university-industry interaction. In this scenario, universities become central actors in innovation systems and knowledge-based economies. This future aligns with literature describing entrepreneurial universities as hubs of technological innovation, startup development, and interdisciplinary collaboration (Fayolle & Redford, 2014; Graham, 2014). Such universities play transformative roles not only in economic development but also in social innovation and regional competitiveness.

The "Adaptive University" scenario reflects a more moderate transformation pathway in which universities gradually integrate entrepreneurial activities into their structures and missions. This scenario highlights the possibility that entrepreneurial transformation may occur incrementally due to institutional constraints, resource limitations, or partial policy support. Such gradual adaptation has been discussed in previous research examining the uneven pace of entrepreneurial development across higher education systems (Dalmarco et al., 2018; Lahikainen et al., 2019). In this pathway, universities partially engage with innovation ecosystems while maintaining significant elements of traditional academic structures.

Conversely, the "Traditional University" scenario illustrates a future in which weak policy support, limited digital transformation, and insufficient university-industry interaction hinder entrepreneurial development. In this scenario, universities remain primarily focused on conventional teaching and research functions and play limited roles in innovation ecosystems. This finding highlights the risks associated with institutional stagnation and resistance to organizational change. Universities that fail to adapt to emerging technological and economic conditions may lose relevance within increasingly innovation-driven societies.

From a broader theoretical perspective, the findings of this study reinforce the argument that entrepreneurship in higher education should be understood as a systemic and futures-oriented transformation process rather than merely an administrative reform initiative. Entrepreneurial universities emerge through the interaction of organizational culture, technological innovation, policy environments, digital transformation, and ecosystem collaboration. This multidimensional perspective extends existing literature by integrating entrepreneurship studies with futures studies approaches (Marinkovic et al., 2022; Saritas et al., 2022). The use of foresight methodologies in this study demonstrates the value of futures-oriented analysis for understanding the long-term transformation of higher education institutions.

Moreover, the findings indicate that strategic foresight can play an essential role in supporting university adaptation under conditions of uncertainty and rapid technological change. Futures studies approaches such as environmental scanning, Delphi analysis, scenario planning, and structural analysis enable universities to identify emerging opportunities, anticipate disruptions, and develop resilient innovation strategies (Gaspar, 2015; Miles et al., 2017). This is particularly important in contemporary higher education environments characterized by accelerating digital

Iranian Journal of Educational Sociology
E-ISSN: 2645-3460

transformation, global competition, and evolving societal expectations.

Overall, the study demonstrates that the future of entrepreneurship in higher education depends on the interaction among entrepreneurial culture, digital transformation, innovation ecosystems, university-industry collaboration, and supportive policy frameworks. Universities that successfully integrate these dimensions are more likely to emerge as leading entrepreneurial institutions capable of contributing to innovation, technological development, and social progress. In contrast, institutions that fail to adapt to changing environmental conditions may experience declining relevance within knowledge-based economies.

Despite providing a comprehensive futures-oriented analysis of entrepreneurship in higher education, this study has several limitations. First, the research relied primarily on qualitative methods and expert-based judgments, which may be influenced by participants' subjective experiences and institutional perspectives. Second, the sample of experts, although selected purposively to maximize expertise, may not fully represent all perspectives within higher education systems and innovation ecosystems. Third, the structural relationships identified through MICMAC analysis reflect contextual perceptions at the time of the study and may evolve as technological, political, and economic conditions change. Additionally, the exploratory scenarios developed in this study should not be interpreted as deterministic predictions but rather as plausible future pathways designed to support strategic thinking and planning.

Future studies should conduct comparative analyses across different higher education systems and national contexts in order to identify how cultural, institutional, and policy differences shape entrepreneurial university development. Longitudinal studies examining the evolution of entrepreneurial ecosystems over time could provide deeper insights into the processes of institutional transformation and organizational adaptation. Quantitative research methods such as structural equation modeling and social network analysis may also strengthen empirical understanding of the relationships among entrepreneurial culture, innovation ecosystems, digital transformation, and university performance. Furthermore, future research should investigate the ethical, social, and educational implications of digital entrepreneurship and artificial intelligence within universities, particularly regarding academic identity, educational equity, and institutional autonomy.

Universities should prioritize the development of entrepreneurial cultures that encourage creativity, interdisciplinary collaboration, innovation, and risk-taking among students and faculty members. Policymakers should strengthen support mechanisms for entrepreneurial universities through innovation funding, startup incentives, digital infrastructure investment, and flexible governance policies. Higher education institutions should also expand partnerships with industries, governments, and innovation ecosystems in order to facilitate knowledge transfer and entrepreneurial collaboration. Investment in digital transformation and AI-driven educational systems is essential for improving universities' adaptive capacities and long-term competitiveness. Finally, university leaders should integrate strategic foresight and scenario planning into institutional decision-making processes to better prepare for future uncertainties and technological disruptions.

Authors' Contributions

Authors equally contributed to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

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All procedures performed in studies involving human participants were under the ethical standards of the

institutional and, or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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