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Article

Digital entrepreneurship in higher education: A structural model based on individual, institutional, and environmental factors

Mohsen Akbari[1,*], Milad Hooshmand[1], Alireza Abbasi Gorji[2]

[1] Department of Management, Faculty of Management and Economics, University of Guilan, Rasht 4199613776, Iran
[2] Faculty of Literature & Humanities, University of Birjand, Birjand 9717434765, Iran
*** Corresponding author:** Mohsen Akbari, akbarimohsen@gmail.com

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Abstract: The rise of the digital economy has reshaped the entrepreneurial landscape, offering new opportunities for university students to engage in innovative ventures. However, despite increased digital exposure, the rate of active digital entrepreneurial engagement among students remains suboptimal, particularly in developing contexts. This study aims to identify and model the key determinants of digital entrepreneurship among university students in Iran. Drawing upon extant literature and expert input, a multi-dimensional conceptual framework was developed, comprising individual factors (e.g., achievement orientation, creativity, risk-taking), institutional factors (e.g., curriculum, faculty, leadership), and environmental factors (e.g., government support, ICT infrastructure). A three-stage mixed-method approach was employed. Initially, 26 indicators were identified through literature review and expert consultation. Subsequently, these were refined to 14 key indicators via a pilot survey of 120 students. Finally, a structural equation model was tested using Smart-PLS on data collected from 387 students at the University of Guilan. The validated model confirms the multidimensional nature of digital entrepreneurship, revealing that institutional and environmental factors significantly amplify individual entrepreneurial traits. Unlike prior studies with narrower scopes, this research offers a holistic strategy framework. The findings provide actionable insights for policymakers and educational leaders to foster digital entrepreneurship through coordinated interventions at personal, university, and policy levels.

Keywords: digital entrepreneurship; university entrepreneurship; entrepreneurship enabling factors; knowledge entrepreneurship

1. Introduction

The economic structure of the contemporary world has undergone a paradigm shift, differing significantly from industrial eras of the past. In this new economic landscape, traditional tangible assets are increasingly being exchanged for intangible assets, with creativity, innovation, and software development becoming the primary drivers of value creation. Businesses today face a complex array of opportunities and threats, ranging from the necessity to enhance global competitiveness to adapting to shifting consumption patterns and the emergence of new markets. Central to this transformation is the rapid development of Information and Communication Technologies (ICT) and various media platforms (internet, mobile, etc.). The integration of these technologies into entrepreneurial ecosystems has given rise to the "digital economy" [1]. In this dynamic context, survival and growth depend heavily on an organization's ability to comprehend the digital environment, respond proactively to its volatile changes, and act as a catalyst for digital transformation.

This impact is particularly evident as internet technologies have become deeply embedded in daily human life, creating a virtual environment that parallels the physical world [2]. Consequently, the adoption of advanced technologies has evolved from a mere operational tool into a strategic pillar of competitiveness. This digital acceleration has triggered a global surge in electronic businesses and digital entrepreneurship [3]. Digital entrepreneurship is redefining the operational logic of businesses by eliminating traditional temporal and spatial limitations. This dematerialization of business processes enables entrepreneurs to transcend local market boundaries and access a global customer base with unprecedented ease [4]. Unlike traditional models, today's entrepreneurs are equipped to process vast amounts of data, meticulously interpret market trends, and capitalize on emerging opportunities through real-time digital interactions and rapid knowledge sharing [5].

Recognizing this undeniable transition toward a post-industrial, knowledge-driven, and innovation-centric economy [4], this research focuses on the domain of digital entrepreneurship within the specific context of developing economies. To accomplish this, Iran was selected as the study context. As a developing nation with a significantly increasing rate of internet penetration and IT development, Iran possesses the infrastructural basis for emerging digital entrepreneurship, yet the factors driving its adoption in higher education remain under-explored.

The study specifically targets university students as the primary population for investigation. This selection is grounded in several critical factors derived from the unique position of students in the digital economy. First, students, particularly in developing countries, function as "digital natives"; their acquaintance with the virtual environment is significantly higher than the general societal average, making them more simulated to adopt digital business models. Second, the academic environment is inherently knowledge-oriented, fostering a tendency among students to explore new environments and seek innovation. Third, universities themselves are shifting from purely educational institutions to entrepreneurial hubs, creating a bilateral interaction where professors can nurture entrepreneurial attitudes. Fourth, economic push factors play a crucial role; the high rate of university admissions contrasted with the low capacity of traditional employment pushes graduates toward self-employment. Finally, the financial barrier to entry for digital startups is low, which aligns perfectly with the limited financial strength of students, allowing them to launch ventures in the virtual world with minimal capital.

Despite the growing interest in this field, existing studies have predominantly focused on isolated variables, such as digital competence (e.g., [5]) or specific psychological traits, often overlooking the broader ecosystem. This research bridges this gap by moving beyond single-dimension analyses to propose a holistic structural model. Unlike prior works, this study integrates individual, institutional (university-related), and environmental factors into a unified framework. Furthermore, by examining this model within the context of a developing economy, this research offers novel insights into how higher education institutions can navigate infrastructural and economic constraints to foster a digital entrepreneurial mindset effectively.

2. Literature review

2.1. Entrepreneurship and digital entrepreneurship

In today's volatile competitive environment, entrepreneurship has emerged as a central driver of sustainable development. Management literature widely recognizes it as a critical engine for economic promotion at both micro (business) and macro (national/international) levels [6]. Unlike earlier interpretations that associated entrepreneurship primarily with physical production, modern perspectives define it as a dynamic process involving opportunity recognition, value creation, and resource mobilization [7,8]. Today, entrepreneurship is viewed not merely as a business activity but as an endless source of societal creativity, where entrepreneurs perceive change not as a threat, but as a norm and an opportunity to be exploited [9].

Innovation lies at the heart of this entrepreneurial process. For infant businesses, the ability to identify new products and production methods is essential for survival [10]. The core of entrepreneurship involves discovering, describing, and testing opportunities [11]. Consequently, the inability to innovate acts as a significant barrier to success, often leading to stunted growth or failure [12]. However, the landscape of innovation has been fundamentally altered by the rapid advancement of Information and Communication Technology (ICT). The advent of modern communication technologies has weakened the dominance of large corporations with massive capital, democratizing the playing field for small entrepreneurial ventures [13].

This technological integration has given rise to a new paradigm known as "Digital Entrepreneurship". Defined as the pursuit of opportunities generated by the Internet, mobile technology, and new media [14], digital entrepreneurship combines traditional entrepreneurial insights with the unique capabilities of the digital economy [15,7]. Key features of this new economy include the ability to process vast amounts of information, digitize physical processes, and eliminate geographical barriers [16,17]. Digital entrepreneurship allows individuals with creative ideas but limited capital to establish scalable ventures that transcend traditional time and space limitations [4].

To better understand the structure of this phenomenon, Davidson and Vaast [18] proposed a comprehensive topology (see **Figure 1**). In their model, digital entrepreneurship is conceptualized as the intersection of three dimensions:

1. Business Entrepreneurship: Focusing on risk-taking, new venture creation, and value design.

2. Knowledge Entrepreneurship: Involving innovation in knowledge production and distribution.

3. Institutional Entrepreneurship: Entailing the transformation of industrial norms and practices via digital methods.

This convergence creates a smart environment where dynamic businesses leverage the Internet to identify unmet market needs and offer innovative solutions through digital platforms [18].

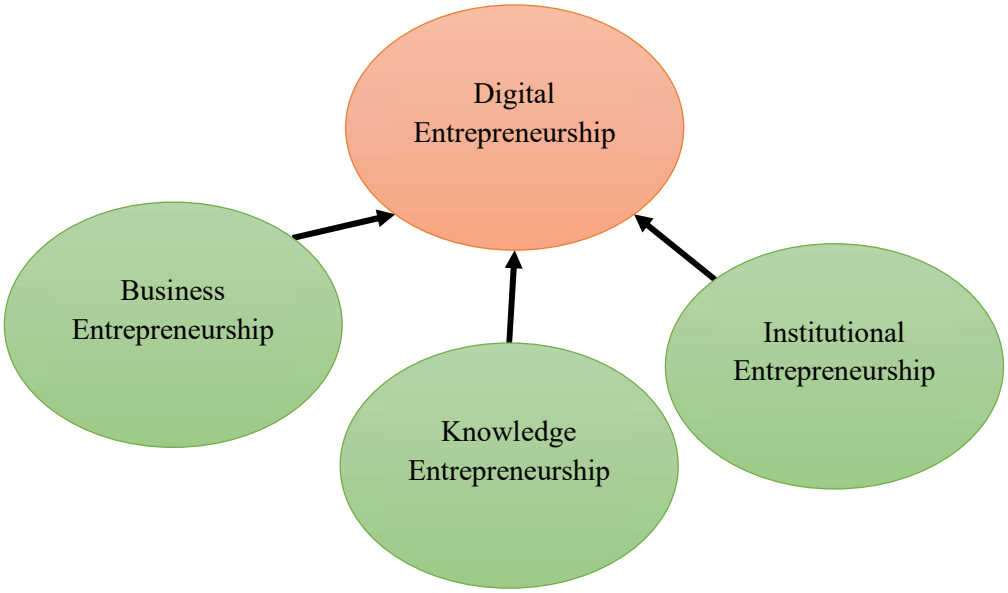

Figure 1. The topology of digital entrepreneurship.

In the post-2022 landscape, the definition of digital entrepreneurship in higher education has expanded globally. Recent international scholarship suggests that digital entrepreneurship is no longer just about e-commerce but involves complex ecosystem interactions. For instance, recent studies (e.g., [19,20]) emphasize that universities must evolve into 'digital hubs' that connect students with global digital platforms and AI-driven tools. Furthermore, research in emerging markets indicates that while students often possess high digital literacy, the lack of integrated institutional frameworks hinders actual venture creation [21]. Consequently, contemporary scholars argue for a shift from merely teaching technical skills to fostering a comprehensive 'digital entrepreneurial mindset' supported by university policy [22].

Core traits such as digital competency, creativity, and virtual networking capability are now foundational for success [23]. Currently, electronic environments and global information databases provide the background for exchanging ideas worldwide. Undoubtedly, entrepreneurship plays a major contribution to the development of new technologies, and reciprocally, these technologies shape the nature of digital entrepreneurship. The critical question, therefore, concerns the factors that effectively drive this phenomenon among the next generation of workforce-university students. The present study attempts to recognize these influencing factors within the academic context.

2.2. Determinants of digital entrepreneurship in higher education

Digital entrepreneurship has emerged as a transformative force in modern economies, amalgamating traditional entrepreneurial principles with advanced digital technologies. The theoretical foundation of this study is anchored in the Theory of Planned Behavior (TPB) [24] and Social Cognitive Theory (SCT) [25], alongside models of Digital Competency [26]. TPB posits that entrepreneurial intention is driven by attitudes toward the behavior, subjective norms, and perceived behavioral control—factors that recent studies have effectively used to explain students'

inclination toward digital ventures [27]. Simultaneously, SCT emphasizes the reciprocal interactions among personal, environmental, and behavioral factors, suggesting that entrepreneurial behavior can be actively shaped through digital learning and environmental exposure [5].

In this context, universities play a pivotal role. In developed countries, higher education institutions have undergone a fundamental structural shift, evolving from traditional centers of education and research into "entrepreneurial universities" [28]. This transformation, particularly evident in the United States and Europe, is driven by legislative frameworks and economic mandates that view universities as key engines of economic development [29]. Owing to their vast knowledge repositories, universities are now recognized as primary sources of innovation [30], capable of fostering economic growth through patenting, licensing, and creating spin-off companies. Furthermore, academic entrepreneurship is increasingly intertwined with the identification and exploitation of knowledge-based opportunities [10]. In the modern era, digital competency-encompassing data analysis, content creation, and online communication-is viewed as a critical enabler of this success. Access to mobile technologies, robust internet infrastructure, and social media platforms further reinforces students' potential to engage in digital entrepreneurship [1,2].

The interaction between digital advancements and academic entrepreneurship is driven by the market's demand for elasticity and rapid innovation. To navigate this complex landscape, it is essential to identify the factors influencing entrepreneurial movement within universities. Research by Rothaermel et al. [29] and Debackere and Veugelers [31] suggests that these factors can be categorized into two primary dimensions:

1. Internal (University-Related) Factors: These include organizational design elements such as incentive-based systems, decentralized management styles, university culture, faculty characteristics, and the availability of active management policies for research contracts.

2. External (Environmental) Factors: These encompass the broader ecosystem, including government policies, federal laws, industry conditions, and the legal framework supporting innovation.

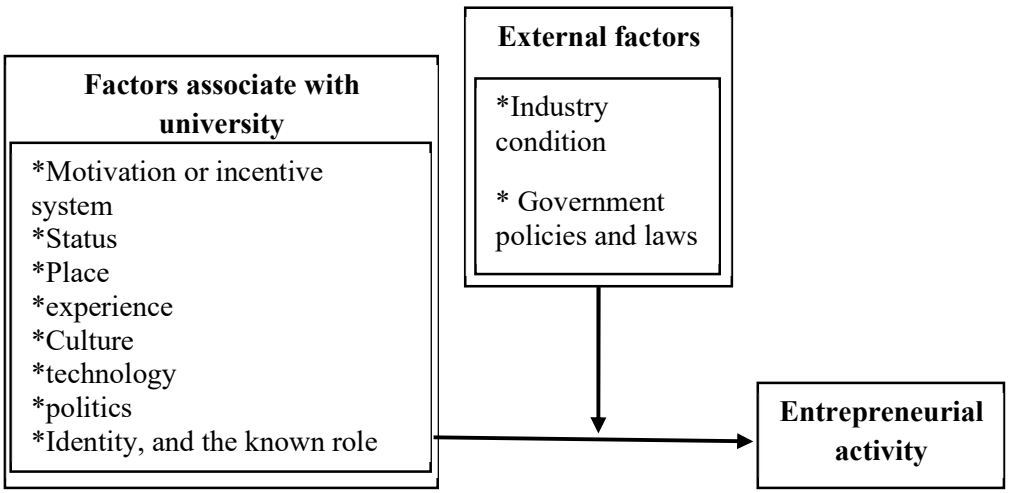

Figure 2. Factors influencing on academic entrepreneurship [31].

As illustrated in **Figure 2**, these factors collectively shape the environment for academic entrepreneurship.

Beyond the enabling factors, scholars have also scrutinized the obstacles hindering academic entrepreneurship. For instance, in the context of Technology Transfer, Collins and Wakoh [32] identified critical barriers such as limited management experience in technology transfer processes and the absence of facilitating institutions to bridge the gap between universities and industry. Furthermore, institutional policies regarding intellectual property (IP) are paramount; if students and faculty lack confidence in the protection of their innovations, the transition toward an entrepreneurial university is likely to stall.

While institutional and external factors provide the context, the core of entrepreneurship ultimately resides in the individual. Amiri and Moradi [33] emphasize that interpersonal factors and psychological attributes play a decisive role in shaping entrepreneurial behaviors. Specifically, they argue that a student's entrepreneurial attitude-composed of traits such as risk-taking, creativity, independence, and self-confidence-serves as a primary predictor of actual entrepreneurial action. As depicted in **Figure 3**, these individual attitudes act as a bridge, translating the university's internal environment (courses, instructors, facilities) into tangible entrepreneurial behavior.

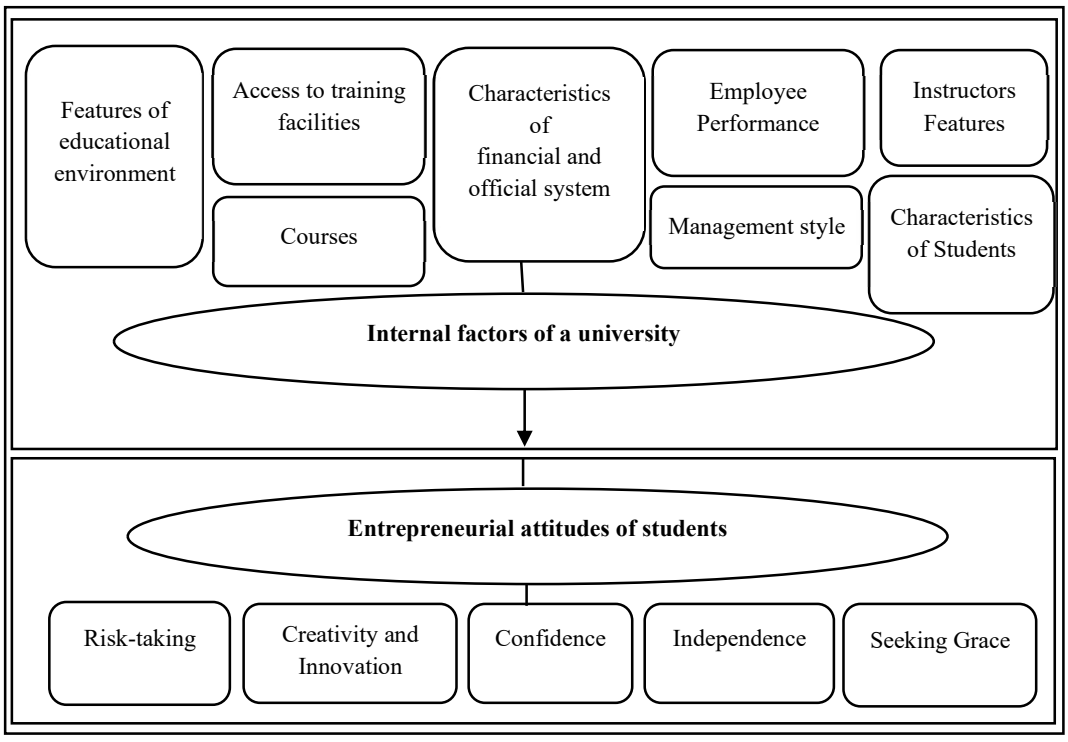

Figure 3. The relationship between the academic and entrepreneurial attitudes of students [33].

Expanding on the individual dimension, D'Este et al. [34] demonstrated that individuals differ significantly in their ability to recognize environmental opportunities based on their prior industrial experience, networking capabilities, and knowledge integration skills. These individual differences are fundamental to the

discovery and exploitation of entrepreneurial opportunities. However, in the digital era, these traditional traits are complemented by new competencies.

Recent literature has increasingly highlighted the interplay of psychological, technical, and environmental enablers in digital entrepreneurship. For instance, Lam et al. [5] found that digital competence acts as a crucial mediator between entrepreneurial knowledge and students' intentions. Similarly, Fuzi et al. [23] showed that demographic factors and access to digital devices (e.g., device ownership) significantly impact engagement levels. The role of social media is also pivotal; Setiawati et al. [4] revealed that active participation in social platforms shapes entrepreneurial aspirations, while Nasri [35] demonstrated its mediating role in enhancing positive attitudes among students. Furthermore, Cogollo Dueñas et al. [36–38] developed a model assessing entrepreneurial potential via digital tools, noting that barriers such as lack of hands-on training and weak digital infrastructure in developing contexts remain significant hurdles.

Drawing upon this extensive literature review, it becomes evident that digital entrepreneurship cannot be explained by a single factor. Instead, it requires a multidimensional approach. Consequently, this study conceptualizes a holistic framework comprising three primary dimensions to identify the effective factors on digital entrepreneurship in universities:

1. Individual Factors (e.g., creativity, risk-taking, digital competence).
2. Institutional (University) Factors: (e.g., course content, faculty support, culture).
3. External Environmental Factors: (e.g., government support, IT infrastructure).

To empirically test this framework, measures for each of these dimensions were developed and validated among students at Tehran University and the University of Guilan. The following section details the methodology employed to achieve this objective.

3. Materials and methods

The selection of the target population was driven by a purposive sampling strategy to ensure a representative cross-section of the Iranian higher education landscape. The University of Tehran was selected as the nation's leading comprehensive institution located in the capital, representing a mature academic ecosystem with established industry links. In contrast, the University of Guilan was chosen as a major provincial hub, representing regional universities with developing digital infrastructures. This dual-context approach—covering both the metropolitan center and a key regional province—allows for a more balanced perspective and enhances the representativeness of the findings compared to single-site studies.

This study employed a three-stage mixed-method approach to identify and validate the dimensions of digital entrepreneurship.

Phase 1 (Item Generation): Initially, dimensions and measures of digital entrepreneurship were extracted from a comprehensive review of existing literature. This process yielded 21 sub-criteria categorized into three dimensions: individual, university, and environmental factors. To ensure content validity, open-ended interviews were conducted with field experts, resulting in the addition of 5 further

criteria, bringing the total to 26 items.

Phase 2 (Screening): The identified criteria were distributed via a questionnaire to 120 students for screening. Respondents rated items on a seven-point Likert scale (1 = "not at all" to 7 = "very good"). Items with an average score of 4 or less were deemed less critical; consequently, 12 criteria were omitted, leaving 14 key indicators for further analysis.

Phase 3 (Validation and Testing): Specific questionnaire items were designed for the remaining criteria. A pilot study was conducted with 100 students at the University of Tehran to assess reliability and refine the instrument based on expert feedback. In the final stage, the validated questionnaire was distributed to 410 students at the University of Guilan. A total of 387 valid responses were received (94.4% response rate). The data were analyzed using Structural Equation Modeling (SEM) with Smart-PLS software to test the proposed model and evaluate the relationships between effective measures of digital entrepreneurship.

The research process is summarized in the following three detailed studies.

3-1. Study 1: Identification of factors

To identify the influential factors on digital entrepreneurship in universities, a systematic review of existing literature was conducted. Based on prior studies [18,29–34,39–41], three primary dimensions were identified, each comprising specific sub-criteria:

University-Related Factors: Motivation/incentive systems, management style, financial/administrative features, employee performance, training facilities, policy, location, university experience, culture, educational environment, course content, and faculty characteristics (identity and role).

External Factors: Industry status, state/provincial laws, and policies.

Individual-Related Factors: Achievement orientation, independence, self-confidence, creativity, and risk-taking.

Following the literature review, expert consultations were conducted to refine the model. Based on expert input, five additional criteria were incorporated: field of study, IT infrastructure, prior student experience, government support, and market demand status. This process resulted in a preliminary list of 26 potential factors.

3.2. Study 2: Screening and refinement

In this phase, following the screening method proposed by Thompsonet al. [42], the 26 identified criteria were evaluated for relevance. A survey was distributed to 120 students at the University of Guilan, who were asked to rate the importance of each sub-criterion on a seven-point Likert scale (1 = "not at all" to 7 = "very well"). To ensure the model's parsimony, criteria with an average rating of 4 or less were eliminated. This screening process resulted in the removal of 12 less critical factors, retaining 14 key indicators for the final model.

3.3. Study 3: Model validation

In the final stage, a comprehensive research instrument was developed for the remaining 14 criteria. The questionnaire consisted of 61 items designed to measure

constructs such as cultural conditions (3 items), demand status (4), course content (5), faculty characteristics (5), independence (5), IT infrastructure (3), legal environment (5), self-confidence (6), risk-taking (3), government support (4), achievement orientation (7), student experience (3), creativity (4), and leadership style (4).

To ensure content validity and reliability, a pilot study was conducted with 100 students at the University of Tehran, incorporating feedback from entrepreneurship professors. Subsequently, the main survey was distributed to 410 students at the University of Guilan, yielding 387 valid responses. Demographic characteristics of the sample are presented in **Table 1**.

Table 1. demographic characteristics of the research sample.

	dimension	**Frequency**	**Percentage**
Gender	Male	176	45.5
	Female	211	54.5
Education	BA	155	40.1
	MA	216	55.8
	PHD	16	4.1
age	>20	12	3.1
	20–25	294	76
	25–30	74	19.1
	≥30	7	1.8

The collected data were analyzed using Structural Equation Modeling (SEM) with a Partial Least Squares (PLS) approach using SmartPLS 2 software. As noted by Diamantopoulos et al. [43], PLS-SEM is particularly suitable for predictive models with non-normal data distributions and complex relationships between variables. The analysis was conducted in two stages: Measurement Model Evaluation: To assess the reliability and validity of the constructs (latent variables) and their indicators (manifest variables); Structural Model Evaluation: To test the hypothesized relationships between the constructs.

4. Results and discussion

4.1. Demographic profile of respondents

The final dataset comprised 387 valid responses from students at the University of Guilan. **Table 1** presents the demographic characteristics of the participants, detailing gender, age, education level, and field of study. These data provide a clear overview of the sample composition before proceeding to the structural analysis.

4.2. Evaluating the measurement model

The measurement model was evaluated using three key criteria: internal consistency reliability, convergent validity, and discriminant (divergent) validity.

Internal Consistency Reliability was assessed using Cronbach's alpha and Composite Reliability (CR). Both metrics indicate the degree to which a set of items consistently measures the same latent construct. Convergent Validity examines the correlation between a construct and its indicators, ensuring that items designed to measure the same construct share a high proportion of variance. This was evaluated using Factor Loadings and Average Variance Extracted (AVE). Discriminant Validity ensures that a construct is empirically distinct from other constructs in the model. This implies that a latent variable should correlate more strongly with its own indicators than with any other latent variable in the structural model.

4.2.1. Reliability and Convergent Validity Analysis

Cronbach's Reliability was first assessed using Cronbach's alpha, a classical index for internal consistency [44]. However, to overcome the limitations of Cronbach's alpha—which assumes equal factor loadings for all indicators—Composite Reliability (CR) was also employed. CR provides a more robust measure by accounting for the varying factor loadings of individual indicators within the structural model. Following the guidelines of [45], a threshold value of 0.7 or higher is considered acceptable for both Cronbach's alpha and Composite Reliability.

Table 2. Reports; Cronbach's alpha, composite reliability and convergent validity.

Title in the model	Latent variables	Cronbach's alpha coefficient (Alpha ≥0.7)	Composite reliability coefficient (Alpha ≥0.7)	Average variance extracted (AVE ≥0.5)	Title in the model	Latent variables	Cronbach's alpha coefficient (Alpha ≥0.7)	Composite reliability coefficient (Alpha ≥0.7)	Average variance extracted (AVE ≥0.5)
In	Independence	0.74	0.85	0.66	Te	Teacher character	0/93	0/94	0.78
Ach	Achievement	0.88	0.91	0.68	Le	Leadership style	0.92	0.95	0.82
SC	Self-Confidence	0.82	0.87	0.59	University	University dimension	0.92	0.83	0.50
Ri	Risk-taking	0.76	0.89	0.80	Leg	Legal environment	0.79	0.86	0.61
Cr	Creativity	0.79	0.87	0.70	IT	IT infrastructure	0.71	0.83	0.63
Ex	Experience	0.84	0.90	0.75	Go	Government support	0.89	0.92	0.75
Personal	Personal dimension	0.89	0.84	0.51	De	Demand status	0.86	0.92	0.80
Cu	Cultural environment	0.75	0.86	0.67	External	External environment dimension	0.86	0.80	0.50
Co	Course content	0.94	0.95	0.80					

Convergent validity was evaluated using the Average Variance Extracted (AVE) criterion proposed by Fornell and Larcker [46]. AVE measures the amount of variance a latent construct captures from its indicators relative to the amount due to measurement error. An AVE value of 0.5 or higher indicates adequate convergent validity, implying that the construct explains more than half of the variance of its indicators.

As presented in **Table 2**, the Cronbach's alpha and Composite Reliability (CR) values for all latent variables exceed the threshold of 0.7, indicating that the model possesses strong internal consistency and reliability. Furthermore, the Average Variance Extracted (AVE) for all constructs is greater than 0.5, confirming satisfactory convergent validity.

Discriminant Validity was assessed using the Fornell-Larcker criterion [46]. According to this criterion, discriminant validity is established if the square root of the AVE for each construct is greater than its correlation with any other construct in the model. As shown in **Table 3** (Correlation Matrix), the bold values on the diagonal represent the square roots of the AVEs. In all cases, these diagonal values are higher than the off-diagonal correlation coefficients in the corresponding rows and columns. This confirms that each construct is empirically distinct from the others, thereby establishing the discriminant validity of the structural model.

Table 3. Coefficients between latent variables and AVE amounts.

	Ach	**SC**	**Co**	**Cr**	**Cu**	**De**	**Ex**	**External**	**Go**	**In**	**IT**	**Le**	**Leg**	**Personal**	**Ri**	**Te**	**University**	**Digital Entrepreneurship**
Ach	0.82																	
SC	0.51	0.77																
Co	0.12	0.14	0.89															
Cr	0.37	0.40	0.20	0.84														
Cu	0.06	0.15	0.58	0.14	0.82													
De	0.10	0.15	0.41	0.16	0.50	0.89												
Ex	0.07	0.13	0.25	0.29	0.26	0.29	0.87											
External	0.08	0.06	0.52	0.12	0.58	0.64	0.35	0.71										
Go	0.03	0.01	0.40	0.01	0.42	0.29	0.29	0.70	0.87									
In	0.40	0.36	−0.02	0.32	0.08	0.11	0.08	0.03	−0.04	0.81								
IT	0.05	−0.05	0.31	0.03	0.31	0.19	0.18	0.66	0.33	0.03	0.79							
Le	0.04	0.05	0.41	0.15	0.38	0.17	0.27	0.50	0.50	−0.07	0.31	0.90						
Leg	0.02	0.01	0.30	0.11	0.35	0.22	0.21	0.71	0.52	−0.04	0.40	0.43	0.78					
Personal	0.74	0.76	0.17	0.71	0.15	0.21	0.24	0.13	0.03	0.65	0.04	0.05	0.04	0.71				
Ri	0.34	0.49	0.09	0.37	0.03	0.16	0.19	0.07	0.01	0.34	0.02	−0.09	−0.02	0.70	0.89			
Te	0.13	0.13	0.67	0.13	0.49	0.37	0.17	0.51	0.44	−0.01	0.28	0.38	0.30	0.14	0.06	0.88		
University	0.13	0.19	0.84	0.25	0.78	0.53	0.56	0.66	0.52	0.05	0.37	0.49	0.39	0.24	0.12	0.79	0.71	
digital	0.39	0.42	0.77	0.43	0.69	0.59	0.47	0.70	0.61	0.23	0.44	0.53	0.52	0.53	0/31	0.73	0.72	0.70

4.3. Evaluation of the structural model

Following the validation of the measurement model, the structural model was evaluated to test the hypothesized relationships among latent variables. This evaluation relied on three primary criteria: significance of path coefficients (T-values), the coefficient of determination (R^2), and predictive relevance (Q^2).

4.3.1. Coefficient of determination (R^2) and predictive relevance (Q^2)

The predictive power of the structural model was assessed using the R^2 values for endogenous latent variables, as presented in **Table 4**. According to the guidelines by [47], the R^2 values indicate that the structural model demonstrates a substantial level of explanatory power. Furthermore, the Stone-Geisser Q^2 criterion was calculated to evaluate predictive relevance. As shown in **Table 4**, all Q^2 values are positive, which, according to [48], confirms that the model possesses strong predictive relevance regarding the endogenous constructs.

Table 4. R2 (R Squares) and Q2 (Stone-Geisser Criterion).

	In	Ach	SC	Ri	Co	Cu	Cr	Te	Ex	Le	Leg	IT	Go	De	Digital Entrepreneurship
R2	0.42	0.54	0.60	0.48	0.50	0.61	0.71	0.62	0.31	0.24	0.55	0.43	0.59	0.41	0.98
Q2	0.27	0.37	0.35	0.38	0.34	0.40	0.57	0.49	0.23	0.20	0.33	0.26	0.44	0.32	0.20

Additionally, to assess collinearity issues within the structural model, the Variance Inflation Factor (VIF) criterion was examined. The calculated VIF values for the three primary dimensions-individual, university, and external environmental factors-were 1.14, 1.50, and 1.15, respectively. Since all VIF values are well below the threshold of 5 (or strict threshold of 3.3) suggested by [49], it can be concluded that multicollinearity is not a concern in this study.

Table 3 presents the correlation matrix between latent variables. The diagonal elements (in bold) represent the square root of the AVE for each construct, which, as discussed in section 4.2, confirms the discriminant validity of the model.

4.3.2. Hypothesis testing and path analysis

The results of the structural path analysis are presented in **Table 5**. This analysis tests the hypothesized relationships between the three main dimensions (External, Personal, and University) and their respective sub-constructs, as well as their direct impact on Digital Entrepreneurship. As illustrated in the table, all T-statistics exceed the critical threshold of 2.58 (significant at $p < 0.01$) and even 3.29 (significant at $p < 0.001$). This confirms that all proposed relationships in the structural model are statistically significant at the 99.9% confidence level.

As visualized in the final structural model (**Figure 4**), the relationships among the three primary dimensions (Individual, University, and External Environment) and Digital Entrepreneurship are statistically robust. The path coefficients reveal the relative strength of each dimension's impact: University Factors exhibit the strongest influence on digital entrepreneurship ($\beta = 0.57$), highlighting the critical role of the academic ecosystem. External Environmental Factors follow closely ($\beta = 0.36$), underscoring the importance of infrastructure and government support. Individual Factors also show a significant positive impact ($\beta = 0.35$), confirming that personal

traits are vital but are heavily reliant on the supporting context.

Table 5. Summary of model results (path coefficients and T-Statistics).

Effect			T Statistics (t-value)	Result	Effect			T Statistics (t-value)	Result
External	−>	De	22.48***	Supported	Personal	−>	SC	31.65***	Supported
External	−>	Go	35.46***	Supported	Personal	−>	Ex	6.86***	Supported
External	−>	IT	20.67***	Supported	Personal	−>	digital entrepreneurship	13.48***	Supported
External	−>	Le	29.84***	Supported	University	−>	Co	68.45***	Supported
External	−>	digital entrepreneurship	18.38***	Supported	University	−>	Cu	38.36***	Supported
Personal	−>	Ach	18.57***	Supported	University	−>	Le	9.97***	Supported
Personal	−>	Cr	27.42***	Supported	University	−>	Te	43.92***	Supported
Personal	−>	In	17.08***	Supported	University	−>	digital entrepreneurship	24.20***	Supported
Personal	−>	Ri	20.43***	Supported					

(ns = no significant, *$p < .05$, **$p < .01$, ***$p < .001$)

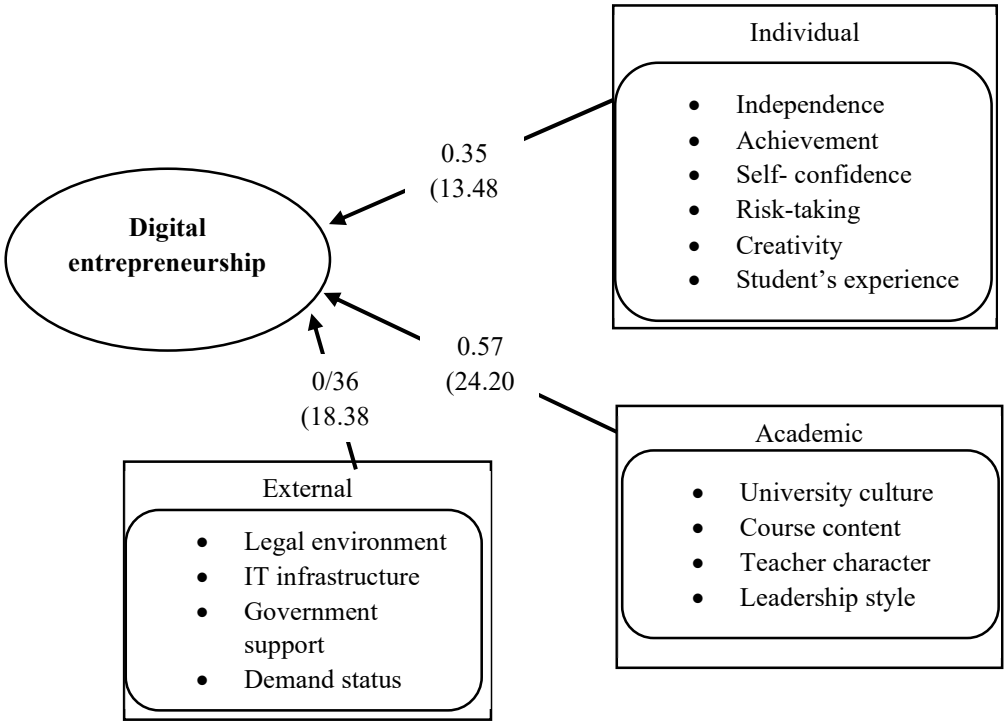

Figure 4. Final research model.

Since all T-values associated with these paths exceed the threshold of 3.29, it can be concluded with 99.9% confidence that all three dimensions significantly drive digital entrepreneurship among students. These findings align with the statistical summary provided in **Table 5**, confirming that the proposed multidimensional model offers a powerful explanation for the phenomenon under study.

5. Conclusion

As competition across industries accelerates, transitioning toward digital entrepreneurship has shifted from an option to a necessity. Universities, as central hubs for human capital development, play a pivotal role in shaping the workforce capable of navigating this digital shift. This study aimed to identify the drivers of digital entrepreneurship within the higher education context. Through a rigorous three-stage mixed-method approach-progressing from expert interviews to a pilot study and finally a structural equation model tested on 387 students at the University of Guilan—a comprehensive framework was validated. The results confirm that student digital entrepreneurship is a multidimensional construct influenced by individual factors (e.g., achievement orientation, creativity, risk-taking), academic factors (e.g., course content, leadership style, faculty characteristics), and external environmental factors (e.g., government support, IT infrastructure).

The findings align with and extend prior research significantly. While studies like [8] and [27] identified digital competence and psychological traits as determinants, this research offers a more holistic advancement. Unlike Lam et al. [5], who focused narrowly on digital competence, this study integrates a broader framework that includes university-specific and external institutional factors. Furthermore, while [23] emphasized device ownership, this research employs a deeper empirical validation. Compared to [37], this study introduces a comparative cultural dimension by examining distinct sociocultural regions (Tehran and Guilan), thereby enhancing contextual applicability.

Moreover, the study's insights into individual traits engage with recent scholarship. For instance, [4,35] emphasized the role of trust and motivation in digital engagement; our findings reinforce this by identifying self-confidence and risk-taking as key enablers of proactive entrepreneurial behavior in students. Similarly, our results regarding academic factors echo [19], who highlighted supportive leadership and participatory culture as foundations for digital transformation in firms. We expand on this by demonstrating how universities serve as catalysts for individual capacity building, bridging the gap between educational innovation and strategic transformation. Finally, aligning with the concept of business democracy proposed by [20], our model positions the university as a participatory platform. This extends the notion of democratic engagement into the realm of student-driven digital entrepreneurship, suggesting that shared decision-making and transparency in academic ecosystems can actively co-create entrepreneurial opportunities.

5.1. Limitations and future research directions

Despite the robust structural model presented, this study acknowledges certain limitations regarding generalizability. As data collection was restricted to two public universities in Iran, the findings may not fully capture the dynamics present in private institutions or universities operating within different economic and cultural contexts. To enhance external validity, future researchers are encouraged to validate this model across a broader spectrum of higher education institutions, including through cross-country comparative studies.

Furthermore, this research opens several pathways for longitudinal and expansive inquiries. Future studies could measure the actual rate of digital venture creation among graduates to assess the long-term impact of the identified factors. Additionally, exploring the role of mediating variables-such as university organizational culture, family support systems, and engagement in digital social networks-would provide a deeper understanding of the mechanisms driving digital entrepreneurial behavior.

5.2. Strategic and practical recommendations for promoting digital entrepreneurship

The findings of this study offer actionable insights not only for Iranian universities but also for policymakers in other developing economies facing similar digital transition challenges. To foster a thriving digital entrepreneurship ecosystem, a coordinated multi-level strategy is recommended:

1. Policy Level (Government & Beyond): Policymakers in emerging markets should prioritize creating a 'digital safety net' for student startups. This entails reducing regulatory hurdles for business registration and offering tax incentives for student-led tech ventures. furthermore, governments must invest in upgrading national ICT infrastructure to bridge the digital divide that disproportionately hampers regional universities.

2. Institutional Level (Universities): Higher education leaders should move beyond traditional curriculum updates to position universities as active 'incubators.' This involves integrating practical digital platforms across all disciplines—not just engineering or business. Establishing "Digital Innovation Labs" that encourage collaboration between students from diverse fields (e.g., humanities and engineering) can effectively simulate real-world digital market dynamics.

3. Individual Level (Student Empowerment): To strengthen key individual traits such as creativity, risk-taking, and self-confidence, universities should implement non-formal skills development programs. These can take the form of interactive workshops on design thinking, resilience, and risk management. Additionally, providing experiential learning opportunities-through hackathons, ideation festivals, and digital startup challenges-will immerse students in real-world contexts. Finally, establishing structured mentorship programs that connect students with successful digital entrepreneurs and alumni is crucial for cultivating a resilient entrepreneurial mindset.

This study concludes that advancing digital entrepreneurship within higher education cannot be achieved through isolated initiatives. Instead, a systemic, multi-level intervention is required—one that aligns individual capacity-building with institutional support mechanisms and external stakeholder engagement. When executed in tandem, these strategies have the potential to transform university innovation ecosystems, fostering a generation of digitally empowered entrepreneurs equipped to thrive in a rapidly evolving global economy.

5.3. Theoretical implications

Theoretically, this study extends the body of knowledge by distinguishing between the *determinants* of digital entrepreneurship and the act of venture creation

itself. Unlike prior research that often examined digital competence in isolation, this study validates a holistic structural model, demonstrating that digital entrepreneurship is a multi-dimensional construct dependent on the interplay of individual traits, institutional support, and environmental factors. This implies that analyzing student entrepreneurship requires moving beyond single-variable assessments to a more comprehensive ecosystem approach.

Furthermore, the findings challenge the assumption that individual digital literacy alone drives entrepreneurship in developing economies. Instead, the model highlights the mediating role of the university ecosystem, suggesting that institutional factors are critical catalysts that convert individual potential into entrepreneurial intent. This sets a theoretical precedent for future scholarship to employ hybrid models that account for contextual variables-such as regional culture and university infrastructure-when conceptualizing digital entrepreneurship in higher education. Cultural factor can be included in the future studies, where the tendency towards digital entrepreneurship among students studying at two universities in two different cultural areas will be reviewed and evaluated since different countries with different conditions can have various impacts on innovation and entrepreneurship [50]. University social responsibility also can impact students' innovation and their entrepreneurship intentions since corporate social responsibility can impact their innovation [51], thus it is important to take this item into consideration as well.

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