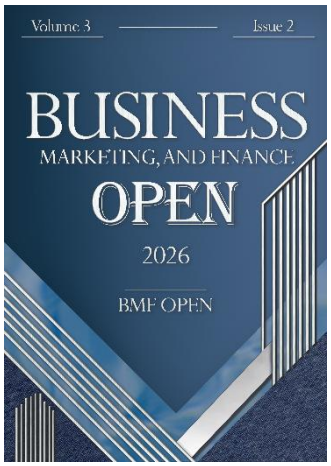
Providing an Appropriate Model for the Commercialization of Entrepreneurial Ideas in Knowledge-Based Companies with an Export-Oriented Approach Using a Mixed-Methods Research Design



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Abstract: In today's global economy, companies that emphasize marketing and innovation are more capable of achieving a sustainable competitive advantage. On the other hand, the core driver of growth and development in the export sector is increasingly knowledge-based. The success of knowledge-based companies depends on their sales performance and market share; the more effective they are in the commercialization of goods and services, the greater their access to national and international markets will be. Accordingly, the present study aimed to propose a model for the commercialization of entrepreneurial ideas in knowledge-based companies with an export-oriented perspective, employing a mixed-methods research design (qualitative–quantitative). In the qualitative phase, the grounded theory approach was applied. Data were collected through semi-structured interviews with 21 experts, including university faculty members, specialists, and practitioners in the service sector, using purposive judgmental and snowball sampling. Data analysis followed the three-step coding procedure of open, axial, and selective coding. The resulting paradigmatic model consists of six causal categories (social factors; individual factors; organizational–technological factors; financial–economic factors; and legal–regulatory factors), an intervening category (mindset and support of transformational managers and leaders, universities and educational organizations, and the government), a contextual category (individual contextual conditions, socio-economic deficiencies, and intra-organizational factors), strategies (customer and market orientation, innovation orientation, international entrepreneurship culture, creativity and innovation training, and structural and industrial transformation), and consequences (individual outcomes, short-term and long-term results, national results, and regional results). In the quantitative phase, structural equation modeling (SEM) using the Partial Least Squares (PLS) technique was applied to test the proposed model. The findings revealed significant and positive reciprocal effects between internal and external latent variables. Considering the R^2 and Q^2 indices, the model demonstrated strong predictive power, and the overall model fit was high with a goodness-of-fit index of 0.659.

Keywords: entrepreneurial ideas; commercialization; knowledge-based companies; structural equation modeling (SEM); grounded theory.

1. Introduction

In the rapidly evolving global economy, knowledge is no longer a peripheral resource but the central axis of sustainable development and competitive advantage. Countries seeking to transition from resource-driven to innovation-driven economies have invested heavily in creating and empowering knowledge-based companies

(KBCs) to transform scientific and technological achievements into commercialized products and services [1]. These companies act as dynamic engines for entrepreneurship, technological renewal, and global market integration, yet their success hinges on their capacity to effectively commercialize entrepreneurial ideas and reach international markets [2]. Despite national policies encouraging a knowledge-based economy, commercialization remains a complex and multifaceted challenge due to structural, institutional, cultural, and market-related barriers [3, 4].

The commercialization of knowledge and technology is widely recognized as the missing link between scientific research and economic value creation [5]. Universities and research centers generate innovative outputs; however, transforming these into competitive products often fails due to weak market orientation, limited business skills, and inadequate support ecosystems [6, 7]. In Iran, as in many developing economies, a paradox persists: while investments in research and innovation are substantial, the rate of conversion of intellectual capital into marketable goods and exports is low [1]. This "commercialization gap" threatens the long-term sustainability of the knowledge-based economy and limits national participation in global value chains [8].

Several studies highlight that the commercialization journey of KBCs is nonlinear, risky, and context-dependent, influenced by internal capabilities and external ecosystem maturity [9, 10]. On the one hand, internal entrepreneurial orientation—including visionary leadership, dynamic capabilities, and innovative culture—is essential for converting inventions into market-ready products [11, 12]. On the other hand, external factors such as regulatory frameworks, capital accessibility, technology market infrastructure, and international partnerships significantly determine commercialization success [13-15].

From a strategic perspective, digital transformation is reshaping the pathways of technology commercialization by enabling new forms of knowledge integration, agile production, and global outreach [14, 16]. The increasing penetration of information and communication technologies (ICTs) strengthens networks between innovators, suppliers, and customers, while data-driven tools support decision-making in commercialization processes [17, 18]. Digitalization reduces transaction costs, accelerates prototyping and market testing, and provides platforms for international entrepreneurship [19, 20]. However, to leverage digital opportunities, KBCs must overcome organizational inertia, low digital financial literacy, and insufficient integration of business process automation [19].

Another key barrier is institutional fragility and regulatory complexity. Research shows that inconsistent intellectual property protection, cumbersome licensing, and fragmented support policies hinder entrepreneurial initiative and discourage investment [13, 21]. Policy frameworks need coherence and a long-term vision to create a robust environment for venture creation and export-oriented commercialization [4, 22]. Institutional learning, policy feedback mechanisms, and inter-organizational collaboration can play a crucial role in strengthening commercialization infrastructure [23].

Human capital and intellectual capital are at the heart of commercialization capability. Entrepreneurial competencies—such as creativity, risk-taking, networking, and international market knowledge—determine whether a KBC can cross the so-called "valley of death" between invention and market introduction [24, 25]. Studies show that companies with adaptive learning cultures and strong absorptive capacity for external knowledge are better positioned to integrate emerging technologies and build competitive business models [12, 18]. Additionally, strategic foresight and scenario planning are increasingly vital in highly volatile and uncertain technological environments [10, 26].

Marketing capability is another critical success factor. As KBCs often originate from technical and scientific backgrounds, they tend to underestimate market research, customer relationship management, and brand-building

[26, 27]. However, international evidence suggests that firms capable of coupling innovation with strong marketing execution outperform their peers in exports and foreign market penetration [28, 29]. Market-oriented entrepreneurship bridges the gap between technology push and market pull by aligning product development with evolving customer needs [2, 9].

Financial and economic challenges remain a persistent impediment. Limited access to risk capital, risk-averse investors, and macroeconomic instability undermine commercialization potential [4, 30]. Venture capital markets in emerging economies are often underdeveloped, while public funding is insufficiently targeted or delayed [25]. As a result, many promising innovations fail to scale or internationalize due to funding gaps during critical growth phases [31]. Economic reforms and supportive tax and credit policies could strengthen the financial backbone required for sustainable technology-based entrepreneurship [2].

At the global level, sustainable entrepreneurship has emerged as a dominant paradigm linking economic performance with social and environmental responsibility [8, 20]. Knowledge-based companies are increasingly expected not only to innovate but also to contribute to inclusive growth, resilience, and sustainable value chains [1, 7]. International competitiveness depends on integrating sustainability into the business model alongside technological advancement and export orientation [22, 28].

Given these dynamics, scholars have stressed the importance of systemic and multi-dimensional models for commercialization [23, 32]. Such models must account for the interplay between causal factors (social, individual, organizational–technological, financial–economic, and legal–regulatory), contextual conditions (institutional gaps, socio-economic environment, and organizational absorptive capacity), intervening mechanisms (government support, universities' third-generation transformation, and leadership mindset), and strategic actions (customer orientation, innovation focus, international entrepreneurship, creativity training, and structural agility) [21, 32, 33]. These integrated frameworks enable researchers and practitioners to understand the multi-level processes driving the transformation of ideas into global products and services.

Recent Iranian studies indicate a growing policy commitment to fostering knowledge-based production and high-value exports, but they also reveal fragmented initiatives and lack of clear pathways from research to market [4, 25]. To close this gap, it is essential to build on both international experiences and domestic empirical insights, combining best practices from leading ecosystems with localized solutions adapted to the Iranian context [22, 34]. There is also a pressing need to consider digital entrepreneurship and automation as enablers of agility and scalability in export-driven commercialization [16, 19].

Against this background, the present study seeks to develop a comprehensive export-oriented commercialization model for entrepreneurial ideas in Iranian knowledge-based companies.

2. Methodology

The present study employed a mixed-methods design; the first phase was qualitative, and the second phase was quantitative. The qualitative section falls within fundamental–applied research and, in terms of data collection, is non-experimental. To address the research question and develop the paradigmatic model, a qualitative research method was used, and the grounded theory systematic approach was applied to generate theory. Grounded theory, as a systematic qualitative approach, describes a process or reaction in relation to a specific phenomenon.

The statistical population in the qualitative section consisted of 21 experts, including university faculty members, specialists, and practitioners in the service sector, all holding at least a bachelor's degree and with a minimum of ten years of professional experience. Snowball sampling was employed. Qualitative data were collected through

in-depth interviews. After the 19th interview, data saturation was reached; however, to ensure completeness, two additional interviews were conducted. On average, each interview lasted about 50 minutes and was then transcribed for analysis.

In the quantitative phase, the statistical population included senior managers and experts of the Semnan Province Water and Wastewater Company. The minimum required sample size was estimated to be 208 participants. The model derived from the qualitative phase was tested using structural equation modeling (SEM) with SmartPLS 3.0 software. The analysis was conducted in three sections: the measurement model, the structural model, and the overall model fit. Significance coefficients were examined to test the research hypotheses.

3. Findings and Results

Data related to the personal characteristics of the qualitative respondents are presented in Table 2. According to the obtained information, most respondents held a master's degree (52.38%) and the majority had between 26 and 30 years of work experience (42.86%).

Table 1. Personal Characteristics of Qualitative Respondents

Variable	Qualitative Section	Frequency	Percentage
Education	Bachelor's	6	28.57
	Master's	11	52.38
	PhD	4	19.05
Work Experience	15–20 years	6	28.57
	21–25 years	5	23.81
	26–30 years	9	42.86
	More than 30 years	1	4.76
Total		21	100

To develop an appropriate model for the commercialization of entrepreneurial ideas in knowledge-based companies with an export-oriented approach, the researcher continuously and purposefully moved between open coding and axial coding during data analysis to identify categories through open coding and connect them using axial coding. After recognizing and integrating the relationships among propositions (categories), the theoretical model of the study was constructed.

1. Open Coding: Open coding, as part of grounded theory analysis, involves detailed explanation and interpretation of the data, naming, and categorizing them. For categorization, each concept is highlighted after separation, and raw data are extracted and interpreted from interview transcripts. Respondents answered interview protocol questions concerning each dimension of the paradigmatic model and explained the phenomenon of fostering a culture of optimal water resource consumption in the country. From the analysis and coding of participants' responses and perspectives, initial codes were extracted and compiled into a table; common and emphasized codes from all respondents, along with important codes from the researcher's perspective, were identified as final codes and documented with their sources. Participants' explanations regarding causal conditions, contextual conditions, intervening factors, strategies, and consequences resulted in the codes presented in Table 3.

2. Axial Coding: While open coding refers to fragmenting data into distinct categories, axial coding connects categories and subcategories by considering their properties and dimensions. In the present study, the development of the paradigmatic model was emphasized, where the relationships between indicators and categories were reported based on the data. The components of the paradigmatic model of this study are further explained, and Table 3 presents the results of open, axial, and selective coding.

3. Selective Coding: In selective coding, the outputs of previous coding processes (open and axial coding) are used, and the central category is identified and systematically connected to other categories.

The related concepts are as follows:

1. **Core Phenomenon (Central Category):** The central phenomenon is the conceptual label considered in the study. In open coding, after completing data analysis and collection, *"commercialization of entrepreneurial ideas"* was identified as the core category.
2. **Causal Conditions:** These factors lead to the creation and development of the core phenomenon. Based on interviews, five categories—social factors, individual factors, organizational–technological factors, financial–economic factors, and legal–regulatory factors—were identified as causal conditions for commercialization of entrepreneurial ideas.
3. **Strategies:** Strategies for commercialization of entrepreneurial ideas represent the interactions and activities adopted in response to the core phenomenon, influenced by intervening and contextual conditions. These strategies include customer and market orientation, innovation orientation, international entrepreneurship culture, creativity and innovation training, and structural transformation of organizations and industries.
4. **Contextual Conditions:** These consist of specific variables and categories which, along with general conditions (intervening factors), influence strategies for commercialization of entrepreneurial ideas. They include individual contextual conditions, socio-economic deficiencies, and intra-organizational factors.
5. **Intervening Conditions:** These are general conditions that, together with contextual conditions, influence strategies for commercialization of entrepreneurial ideas. In the introduced model, they include the mindset and support of transformational managers and leaders, universities and educational institutions, and the government.
6. **Consequences:** Certain categories represent the outcomes and results of implementing commercialization strategies for entrepreneurial ideas. Based on collected data, commercialization strategies lead to individual outcomes, short-term and long-term results, national results, and regional results.

Table 3. Results of Open, Axial, and Selective Coding

Dimension	Category	Concepts
Causal Conditions	Social Factors	Social capacity building; social responsibility; level of social awareness; growth and improvement of cultural standards in society; mental preparedness; social participation; dissatisfaction in the social domain; dissatisfaction in business; poor workplace conditions; information-oriented society; parenting methods and public policies fostering teamwork; existence of successful role models for individual and national aspirations; culture of using communication and information networks.
	Individual Factors	Optimism; perseverance; tendency for teamwork; flexibility; tolerance of uncertainty; entrepreneurial spirit; desire for wealth and reliance on faith; responsibility; being teachable; encouraging others; personal and family culture-building; level of knowledge and awareness; household income; unfavorable previous work conditions; dissatisfaction in the personal domain; intention and desire for satisfaction; negative attitude toward administrative jobs; ambition for success; positive outlook on human capital; education; relevant experience and knowledge.
	Organizational and Technological Factors	Organizational agility; flexibility; responsiveness to environmental changes; adaptability; elimination of non-value-adding activities; team leadership; ability to respond quickly; process and resource integration; forecasting and managing changes; ability to face unprecedented threats; dynamic changes; reduction of organizational layers; ability to respond effectively to crises; coordination with domestic and international companies; digital knowledge base; digital technologies; internet access; electronic environment; computer facilities; virtual networks; development of communication and information networks; software and hardware infrastructure; IT platforms; creativity being valued;

		cooperative and technological collaboration; support for teamwork; encouragement for improved productivity; risk acceptance; empowerment and mutual trust; idea utilization; strong employees; technology sharing and exchange; support for innovation; changing relational networks; skilled human resources; entrepreneurial acceptance; culture of knowledge transfer and training; digital adaptability; workforce personality traits; importance of research and development and training.
	Financial–Economic Factors	Investors' fear of investment; shortage of financial resources; difficulty in accessing bank facilities; methods of accessing financial resources; economic challenges; economic instability; complexity of tax laws; lack of support from the banking system; inflation and lack of domestic and foreign investors; market situation; economic growth; tax incentives; economic reforms; financial, technical, and managerial consulting; business environment; economic policymaking; economic stability; provision of low-interest loans.
	Legal–Regulatory Factors	Laws and existing gaps; enactment of transparent and facilitative laws; restrictive regulations; gaps in intellectual property rights; incomplete business laws; lengthy licensing processes; lack of protective laws for entrepreneurs; complex company registration regulations; lack of private sector support; specialized service-providing institutions.
Strategies	Customer and Market Orientation	Market orientation by identifying customer needs and focusing on competitors; customer-centricity; customer satisfaction; market adaptation; customer engagement; customer feedback; proper marketing; market focus; consumer need recognition; marketing research; adequate responsiveness; customer interaction.
	Innovation Orientation	Offering unique and innovative products and services based on market needs; service innovation; provision of technology-based products; development of new products and freshness of services using e-commerce; innovative perspective on all aspects; use of advanced and up-to-date technology; innovation in value modification; improvement of innovation processes in communication; technological leadership; innovative advertising.
	International Entrepreneurship Culture	Identifying international market needs; training in international marketing methods; collaboration strategies; product introduction; development of new resources and suppliers at different levels.
	Creativity and Innovation Training	Training from teamwork to creativity, innovation, and entrepreneurship, leading to commercialization of entrepreneurial ideas from secondary education through university and during employment; upgrading industry professionals' skills through related training courses.
	Organizational and Industrial Structural Change	Activating R&D units; production and marketing of products using advanced technologies; value creation; importance of knowledge transfer and experience sharing; technology transfer; localization of knowledge and technology; internationalization of products/services; managerial focus on innovation.
Contextual Conditions	Individual Contextual Conditions	Belief in the subject; cooperation; cultural acceptance; increased awareness and motivation to use modern technology and scientific methods; responsibility; lifestyle; age; education; marital status; occupation; national identity.
	Socio-Economic Deficiencies	Lack of proper training; lack of social commitment and responsibility; weak knowledge-based economy; insufficient attention to culture-building; high cost of using modern technology; absence of supportive tariffs or subsidies; absence of legal requirements; state-dominated economy.
	Intra-Organizational Factors	Organization's capacity for knowledge absorption, skills, and experience; collaboration with other companies, both large and knowledge-based (domestic and international); specialized issues: lack of skilled human resources; weak infrastructure; outdated technologies; lack of specialized knowledge and information; shortage of specialized experience; absence of specialized training programs; low internet speed; lack of entrepreneurial and managerial knowledge.
Intervening Conditions	Mindset and Support of Transformational Managers and Leaders	Presence of positive attitudes among senior managers; adequate attention to cultural development and removal of cultural barriers; fostering a culture of creativity and innovation with attention to cross-cultural differences; fair management of resource allocation; providing tangible statistics; building trust; leveraging previous entrepreneurial successes and failures; addressing low entrepreneurial spirit and poor digital literacy; avoiding traditional business mindsets.
	Universities and Educational Institutions	Transformation of universities into third-generation (research-oriented) institutions; moving beyond theoretical education; making university training more practical.
	Government	Serious attention to the issue by the government; development of comprehensive plans; accountability of state institutions; provision of incentives and facilities for commercialization of entrepreneurial ideas; addressing financial, banking, and tax barriers; inflation control; removal of legal and regulatory obstacles; facilitation of laws and policies;

		government support; improvement of business environment; supportive regulations for companies; legal advisors; implementation of intellectual property rights; facilitation of company registration and patent systems; policy and law coherence; weak diplomacy (Ministry of Foreign Affairs) in science and technology; poor utilization of NGOs and private companies in science and technology diplomacy.
Consequences	Individual Outcomes	Increased knowledge and awareness; enhanced responsibility; teachability; reduced psychological pressures related to sanctions; higher income; improved performance.
	Short-Term Results	Achieving added value; increased productivity; improved product and service quality; increased sales; larger market share; wealth creation; higher efficiency in product/service production; access to new markets; company growth; access to information; cost reduction.
	Long-Term Results	Economic growth; creation of competitive advantage; improved university–industry collaboration; making university education practical and research-oriented; achieving scientific and technological backing; attracting foreign investment; social welfare; opportunities for remote collaboration; technology-oriented job opportunities.
	National Results	Achieving alignment and cooperation of government representatives and institutions in commercialization and exports of ideas; preservation of national capital and scientific–technological resources and elites; societal structural transformation toward creativity and teamwork; social justice.
	Regional Results	Regional growth; community survival and development; becoming a regional model for commercialization of entrepreneurial ideas.

Data related to the demographic characteristics of the respondents in the quantitative section are presented in Table 3. According to the collected information, most respondents held a bachelor's degree (53.85%) and the majority had 11–15 years of work experience (27.88%).

Table 3. Demographic Characteristics of Quantitative Respondents

Variable	Value	Frequency	Percentage
Education	Less than diploma	12	5.77
	Diploma	26	12.50
	Associate degree	22	10.58
	Bachelor's degree	102	53.85
	Master's degree and above	36	17.31
Work Experience (years)	Less than 5	42	20.19
	5–10	48	23.08
	11–15	58	27.88
	16–20	34	16.35
	More than 20	26	12.50
Total		208	100

Initially, the Kolmogorov–Smirnov test was used to examine the normality of the variable distributions. Considering that the calculated Sig value for all variables was 0.000, it can be stated that the data are not normally distributed.

To examine the measurement models' fit, indicator reliability and convergent validity were used. Indicator reliability was evaluated through three criteria: Cronbach's alpha, composite reliability (CR), and factor loadings.

As shown in Table 4, by comparing the obtained Cronbach's alpha and composite reliability values with the reference thresholds for each, the values are acceptable. Additionally, the convergent validity of the measurement model, assessed by comparing the Average Variance Extracted (AVE) with its reference value (> 0.50), is acceptable.

Table 4. Results of Cronbach's Alpha and Composite Reliability

Latent Variables	Model Label	Cronbach's Alpha (α > 0.7)	Composite Reliability (CR > 0.7)	Average Variance Extracted (AVE > 0.5)
Core Phenomenon	AP	0.85	0.90	0.70
Causal Factors	CF	0.88	0.91	0.67
Facilitating/Intervening Factors	FIF	0.86	0.91	0.78
Results	Res	0.83	0.88	0.60
Strategies	Str	0.87	0.90	0.66
Contextual Factors	UF	0.91	0.95	0.85

As shown in Figure 1 (software output), the factor loadings for all items were greater than 0.40, indicating permission to proceed with further calculations.

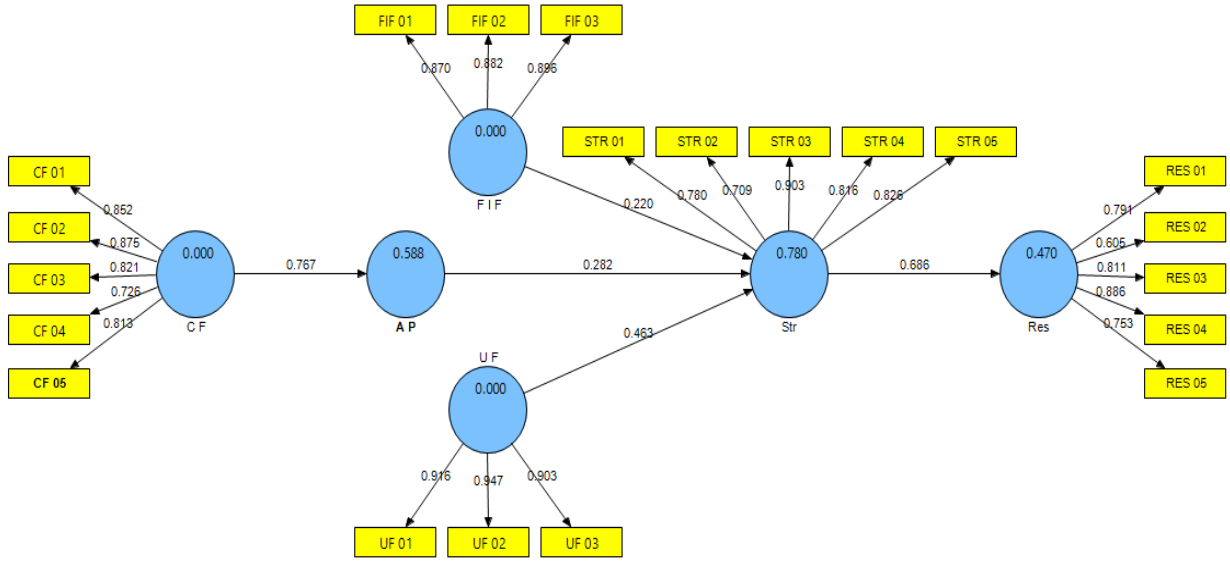

Figure 1. Model with Factor Loadings

Discriminant validity was assessed by comparing the correlation of each construct with its indicators against the correlation of that construct with other constructs (Fornell–Larcker criterion). The discriminant validity of the measurement model, as shown in Table 6, is acceptable.

Table 5. Results of Average Variance Extracted (AVE) and Correlations

	1	2	3	4	5	6
Core Phenomenon	0.834					
Causal Factors	0.7665	0.8192				
Intervening Factors	0.6858	0.6000	0.8829			
Results	0.5976	0.4940	0.7750	0.7750		
Strategies	0.7942	0.5619	0.7500	0.6856	0.8094	
Contextual Factors	0.7794	0.5594	0.7259	0.7130	0.7429	0.9224

The square root of the AVE for each latent construct (shown on the diagonal) is greater than the correlations between that construct and other constructs (off-diagonal values). This indicates that the constructs have stronger associations with their own indicators than with other constructs, confirming satisfactory discriminant validity and good measurement model fit.

After confirming the measurement model, the structural model—examining relationships among variables—was evaluated.

Because part of the model is formative, collinearity among indicators was assessed to determine whether any items causing high collinearity should be removed. VIF values were calculated. If VIF ≥ 5, the indicator explains at least 80% of the variance also explained by other indicators and may be removed. According to Table 6, all VIF values were below the threshold, confirming acceptable collinearity.

Table 6. Variance Inflation Factor (VIF) Results

Dependent Variable	Model Label	Independent Variable	Model Label	Factor Loading	VIF (<5)
Strategies (Str)	Str	Facilitating/Intervening Factors	FIF	0.220	1.051
		Core Phenomenon	AP	0.282	1.086
		Contextual Factors	UF	0.463	1.273

The first criterion for evaluating structural relationships is the significance of the z (t) statistics. When the t-value exceeds 1.96, the relationship is significant at the 95% confidence level. As shown in Figure 2 (model output), all path significance values exceed the threshold, confirming meaningful relationships among the latent constructs and their observed variables.

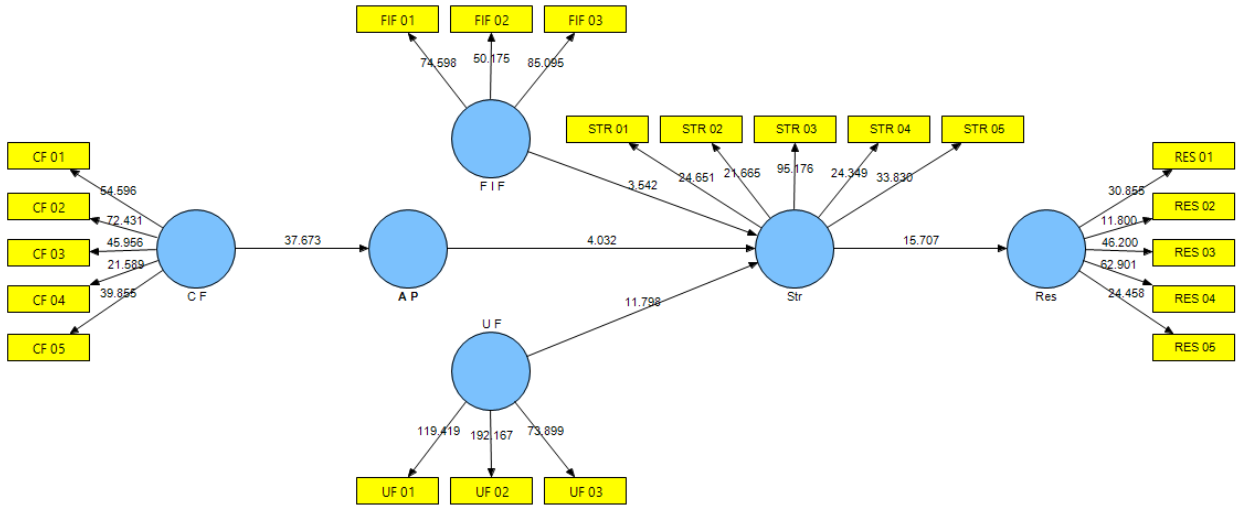

Figure 2. Model with T-Values

The R^2 coefficient assesses how much of the variance in endogenous (dependent) constructs is explained by exogenous (independent) constructs. Reference values for R^2 are 0.19 (weak), 0.33 (moderate), and 0.67 (strong).

Q^2, introduced by Stone–Geisser (1975), evaluates predictive relevance. Henseler et al. (2009) suggest 0.02 (small), 0.15 (medium), and 0.35 (large).

As shown in Table 7, the calculated R^2 and Q^2 values demonstrate strong structural model fit and high predictive power.

Table 7. R^2 and Q^2 Results

Latent Variable	Model Label	R^2	Weak (0.19)	Moderate (0.33)	Strong (0.67)	Q^2	Small (0.02)	Medium (0.15)	Large (0.35)
Core Phenomenon	AP	0.588			*	0.411			*
Results	Res	0.470		*		0.261		*	
Strategies	Str	0.780			*	0.509			*

Effect size (f^2) introduced by Cohen (1988) measures the strength of the relationship between constructs. Reference values are 0.02 (small), 0.15 (medium), and 0.35 (large). The f^2 values were: Contextual Factors = 0.309, Core Phenomenon = 0.114, and Facilitating/Intervening Factors = 0.095. Thus, Contextual Factors had the greatest effect on the endogenous variable "Strategies," confirming the structural model's strong fit.

The Goodness-of-Fit (GOF) index evaluates the overall fit of the structural equation model after confirming the measurement and structural sections. Comparing the calculated GOF value with the thresholds of 0.01 (weak), 0.25 (moderate), and 0.36 (strong) shows a strong overall model fit (Table 8).

Table 8. Goodness-of-Fit (GOF) Calculation

Latent Variables	Model Label	R^2	Communality
Core Phenomenon	AP	0.5875	0.6955
Causal Factors	CF		0.6712
Facilitating/Intervening Factors	FIF		0.7796
Results	Res		0.6007
Strategies	Str	0.4701	0.6552
Contextual Factors	UF		0.8508
Average		0.6124	0.7088

$GOF = \sqrt{(0.6124 \times 0.7088)} \div 2 = 0.659$

The GOF value of 0.659 indicates a strong overall model fit.

4. Discussion and Conclusion

The purpose of this study was to design and empirically validate a comprehensive model for the commercialization of entrepreneurial ideas in knowledge-based companies (KBCs) with an export-oriented perspective. Using a mixed-methods approach grounded in qualitative coding and structural equation modeling, the findings revealed that commercialization is a multidimensional and interactive process. The proposed model integrates five causal conditions—social, individual, organizational–technological, financial–economic, and legal–regulatory—supported by contextual and intervening factors, and implemented through strategic actions that together lead to meaningful short-term and long-term outcomes at individual, organizational, national, and regional levels. This complex configuration explains why many commercialization efforts fail to scale and why successful KBCs are those that simultaneously align internal competencies with ecosystem support and global market demands.

One of the most striking findings was the strong role of social and individual factors in initiating and sustaining commercialization. Respondents emphasized that entrepreneurial optimism, perseverance, responsibility, and openness to teamwork provide the cognitive and motivational foundations for transforming ideas into marketable offerings. These personal attributes were shown to interact with social capacity building and the presence of success role models to create a risk-tolerant and innovation-oriented mindset. This is consistent with prior work suggesting that entrepreneurial human capital is the first catalyst in bridging research and market application [1, 11]. Research in the Iranian context confirms that deficiencies in entrepreneurial self-efficacy and lack of cultural preparation hinder commercialization despite technological capability [3, 30]. At the same time, global studies highlight that passion, perseverance, and openness to external knowledge enhance the likelihood of moving beyond the "valley of death" [11, 18].

Equally important were organizational and technological enablers. The model showed that organizational agility, adaptability to environmental change, and strong digital infrastructure significantly shape a company's ability to integrate knowledge into exportable innovations. Companies that rapidly reconfigure resources, adopt digital platforms, and leverage virtual networks are better positioned to access international markets. These findings reinforce global research on digital transformation as a key strategic driver for entrepreneurship and scaling [14, 16, 19]. Prior Iranian studies also underscore that limited access to digital ecosystems and weak internal R&D units impede timely market entry [32, 33]. By validating these factors quantitatively, our model confirms that technology enablement is not just supportive but foundational for KBCs aiming to globalize their offerings.

Another central dimension is marketing capability and international orientation. The strategies tested—including customer-centric market research, adaptive marketing, and building international entrepreneurship culture—had significant positive paths to commercialization outcomes. This aligns with evidence that KBCs are often founded by technical experts but fail to internationalize due to weak market intelligence and branding [26, 27]. Conversely, firms that combine strong innovation with targeted market exploration outperform in export growth [28, 29]. Our findings reinforce the argument that commercialization success requires balanced coupling of technology push and market pull, rather than a singular focus on technical novelty [2, 9].

Institutional and regulatory conditions were also found to have a direct and indirect influence on commercialization. Legal barriers—including complex intellectual property (IP) registration, slow licensing, and inadequate support for private sector ventures—were frequently mentioned by experts and shown to impact the model's performance. This result strongly aligns with studies criticizing fragmented and ambiguous regulatory frameworks in Iran and other developing contexts [13, 21]. Our quantitative testing confirms that stable, transparent, and supportive regulations significantly facilitate strategies like organizational restructuring, creativity training, and global expansion. Comparative international research similarly shows that countries with strong IP enforcement and streamlined technology transfer policies achieve higher rates of innovation-driven exports [6, 8].

Financial and economic constraints emerged as one of the most critical blocking points in commercialization. The scarcity of risk capital, inflation, and macroeconomic volatility reduce investor confidence and threaten early-stage growth. This is in line with the observation that Iranian KBCs suffer from financing gaps, as venture capital systems are underdeveloped and banking structures are risk-averse [4, 30]. Our structural equation model confirms that when companies gain access to diversified funding channels—including low-interest loans, tax incentives, and financial consulting—the probability of successful product-market fit and export readiness increases significantly. International comparisons reveal similar patterns; for example, in East Asian ecosystems, targeted state-backed funds and strategic credit policies have supported commercialization at scale [18, 28].

An important theoretical contribution of this study is the demonstration that contextual and intervening factors mediate the impact of causal variables. For instance, while individual and organizational capabilities are necessary, they are insufficient without supportive leadership mindsets and proactive government programs. Our qualitative analysis identified transformational leadership and the move of universities toward third-generation entrepreneurial institutions as key levers. These findings echo calls for stronger university–industry–government collaboration, often framed as the "triple helix model," to close the commercialization gap [22-24]. Moreover, our model reflects how government digital and export promotion policies can shape market conditions and reduce entry barriers [14, 17].

The validated model thus advances both academic theory and managerial practice by integrating diverse strands of research—entrepreneurial behavior, technology adoption, digital transformation, marketing orientation, institutional policy, and sustainable entrepreneurship—into a single coherent structure. By linking causal mechanisms to strategic actions and measurable outcomes, it offers a road map that policymakers and managers can use to move beyond isolated interventions and develop systemic commercialization capacity [16, 20, 32].

At the outcome level, the model's predictive power was strong (GOF = 0.659), indicating robust explanation of both individual and macro-level results. This includes increased entrepreneurial learning, productivity, export growth, and long-term competitive advantage, as well as regional and national benefits such as sustainable economic development and social welfare. These findings confirm theoretical expectations that knowledge-based entrepreneurship, when systematically supported, contributes to inclusive innovation-driven growth [1, 8]. Furthermore, the emphasis on sustainability and social responsibility in our data parallels recent global research showing that integrating green and ethical considerations enhances long-term competitiveness and resilience [7, 20].

By combining qualitative grounded insights with quantitative validation, the present study addresses a long-standing gap in Iranian commercialization literature, which has often been descriptive and lacked predictive models. It also complements international work by contextualizing digital and institutional enablers in emerging economies, where economic turbulence and fragmented policy ecosystems present unique challenges [4, 25].

Despite its contributions, this study has several limitations that should be considered when interpreting the findings. First, the research was conducted within a specific regional and institutional context and primarily focused on Iranian KBCs. While this provides rich local insights, the generalizability of the model to other emerging economies with different institutional infrastructures may be limited. Second, the sample size, although adequate for structural equation modeling, may not capture the full diversity of sectors within the knowledge-based economy, such as deep-tech, biotechnology, or creative industries. Third, the cross-sectional nature of the quantitative phase restricts the ability to draw causal inferences over time. Longitudinal studies could reveal how commercialization strategies evolve as companies scale and enter international markets. Fourth, data were based on self-reported perceptions from managers and experts, which may be subject to optimism or recall bias.

Future research should expand the scope of this model by applying it to diverse national contexts and comparing results across countries with varying levels of digital maturity and regulatory stability. Longitudinal studies could explore how external shocks such as economic crises, sanctions, or pandemics influence the dynamics of commercialization and the resilience of KBCs. Further, integrating advanced analytics such as machine learning could refine the predictive capabilities of the model by identifying non-linear interactions among factors. There is also room to explore the micro-foundations of entrepreneurial capability development, particularly how digital skills, leadership style, and learning orientation interact to support sustained export success. Comparative sectoral studies can illuminate how commercialization pathways differ across industries like ICT, health tech, and renewable energy.

For practitioners and policymakers, the findings underscore the necessity of a holistic commercialization support system. Managers of KBCs should invest simultaneously in developing entrepreneurial human capital, agile digital infrastructure, and international marketing competencies rather than focusing narrowly on technology development. Government agencies can accelerate commercialization by simplifying IP protection, streamlining licensing, and providing targeted financial incentives, while universities should move toward entrepreneurial and applied research models that connect talent pipelines to industry needs. Finally, ecosystem builders should foster

networks and mentorship opportunities to connect emerging KBCs with experienced entrepreneurs, investors, and global markets, ensuring that promising innovations transition successfully from laboratories to international commercialization.

Authors' Contributions

Authors equally contributed to this article.

Ethical Considerations

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

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Conflict of Interest

The authors report no conflict of interest.

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References

[1] S. Rahimi, "The Role of Intellectual Capital in Educational Development and Its Impact on Iran's Knowledge-Based Economy," in *1st National Conference on Teaching Skills*, Masjed Soleyman, 2024.

[2] A. Ja'fari Samimi and F. Ja'fari Salahdar Kolaei, "Investigation and Ranking of Factors Affecting Commercialization of Export Products in Knowledge-Based Companies of Mazandaran Province," in *1st National Conference on Applied Research in Dynamic Economics, Modern Management, and Accounting*, Babol, 2020.

[3] F. Papi, Z. Rezaei Ashiyani, and A. E. Zahedi, "Analysis of Barriers to Innovation and Technology Commercialization in Iranian Knowledge-Based Companies," in *4th Scientific Conference on New Achievements in Management Sciences, Accounting, and Economics of Iran*, Ilam, 2020.

[4] H. Safar Zād, F. Āzmā, P. Saeidi, and H. Aghājāni, "Presenting a Commercialization Model for Knowledge-Based Products with an Emphasis on Resistance Economy Policies," *Quarterly Journal of Strategic and Macro Policies,* vol. 8, no. 29, pp. 1-21, 2020.

[5] A. Shahrabi, S. Tahmasebi Limooni, and S. A. A. Razavi, "Research Commercialization in Iranian Medical Universities," 2019.

[6] A. John, G. M. Kivengea, and G. A. Ombakho, "Initiatives to Promote Commercialization of ResearchOutputs by Kenyan Universities," *Elixir International Journal,* vol. 100, no. 5, pp. 512-529, 2019.

[7] B. Anthoonsd, Karamichalia, A. Schrøder- Nielsenb, A. Drouzase, D. B. H, and P. Madesi, "Metabarcoding reveals low fidelity and presence of toxic species in short chain-of-commercialization of herbal products," *J Food Compos Analys,* vol. 97, no. 10, pp. 37-67, 2022, doi: 10.1016/j.jfca.2020.103767.

[8] G. Secundo, V. Ndou, P. Vecchio, and G. D. Pascale, "Sustainable Development, Intellectual Capital and Technology Policies," *J Technol Forecast Soc Chang,* vol. 153, pp. 911-917, 2020, doi: 10.1016/j.techfore.2020.119917.

[9] M. Kim, H. Park, Y.-w. Sawng, and S.-y. Park, "Bridging the Gap in the Technology Commercialization Process: Using a Three-Stage Technology-Product-Market Model," *Sustainability,* vol. 11, no. 22, 2019, doi: 10.3390/su11226267.

[10] A. Karīmi Yazdi, M. Haghighi, and T. Nāteq, "Identifying and Ranking the Future Strategies for Commercialization of New Technologies in Startup Knowledge-Based Companies," *Management Futures Studies (Management Research),* vol. 31, no. 124, pp. 30-44, 2021.

[11] O. Krätzig and N. Sick, "Exploring the role of entrepreneurial passion for facilitating university technology commercialization: Insights from battery research as an interdisciplinary field," *Journal of Engineering and Technology Management,* vol. 60, p. 101627, 2021, doi: 10.1016/j.jengtecman.2021.101627.

[12] A. Azīmzādeh, H. Sanā'īpūr, M. Ashrafi, and S. Shojā'i, "Presenting a Structural Equation Model for International Entrepreneurship Development in Knowledge-Based Businesses," *Quarterly Journal of Business Management,* vol. 13, no. 50, pp. 150-172, 2021.
[13] M. Alikhāni and M. Alikhāni, "Investigating Legislative Problems and Barriers in the Field of Commercialization of Knowledge-Based Products," in *5th International Conference on Management, Accounting, and Economic Development*, 2020, pp. 1-12.
[14] S. Albukhitan, "Developing Digital Transformation Strategy for Manufacturing," *J Proced Comput Sci,* vol. 170, pp. 664-671, 2020, doi: 10.1016/j.procs.2020.03.173.
[15] S. Ghiyābi and M. Ghiyābi, "The Role of Markets in the Commercialization Process of Knowledge-Based Company Products and a Study of the Role of Technology Units Located in Science and Technology Parks," in *3rd International Conference on Modern Management Tricks, Accounting, Economics, and Banking with a Business Growth Approach*, Tehran, 2020.
[16] R. Zare, M. Abedian Khorasani, V. Khashei, and M. Haghighi Kafash, "Strategic Control Model Based on Digital Transformation, Technology in Entrepreneurship, and Strategic Management," 2025.
[17] T. Rabbani and H. Mirzaei, "Explaining the Impact of Information and Communication Technology (ICT) Development Indices on the Regional Knowledge-Based Economy with a Comparative Approach," 2024.
[18] C. Cao, M. Chen, X. Tang, and H. Liu, "Linking information technology use with corporate entrepreneurship: The mediation role of openness to external knowledge," *Information Systems Journal,* vol. 35, no. 1, pp. 71-96, 2025, doi: 10.1111/isj.12529.
[19] M. Tukiran, Y. Indrianti, S. L. Bramaputri, W. S. Dewobroto, and M. D. G. Prathivi, "Business Process Automation as a Strategic Enabler for Entrepreneurial Digital Transformation: A Systematic Literature Review," in *APSKI International Conference on Association of Indonesian Entrepreneurship Study Programs*, 2025, pp. 43-54.
[20] S. Urooj, A. Ullah, S. Ullah, and H. Nobanee, "Sustainable Entrepreneurship in the Digital Era: The Role of Digital Financial Capability and Anti-Money Laundering Compliance," *Business Strategy & Development,* vol. 8, no. 3, p. e70147, 2025, doi: 10.1002/bsd2.70147.
[21] F. Hesābi Vīshkaei and S. Kheradmandnia, *In the Path of Knowledge-Based Production and Job Creation: Institutional Pathology of the System of Science and Technology Commercialization in the Country*. Tehran: Islamic Consultative Assembly Research Center, 2022.
[22] A. Arabi, M. R. Cheraghali, M. Sharifzadeh, and M. B. Gorji, "Identifying and Evaluating Knowledge Commercialization Indicators with an International Approach in Knowledge-Based Companies of Tehran City," *Quarterly Journal of Business Management,* no. 49, pp. 432-448, 2021.
[23] F. Hesābi, S. Elahi, M. Hasanzadeh, and A. Shayan, "An Analytical Framework for Science and Technology Commercialization with a Meta-Synthesis Approach: Investigating Analytical Dimensions, Actors, and Functions," *Entrepreneurship Development,* vol. 14, no. 3, pp. 401-420, 2021.
[24] A. R. Shirvani, H. R. Tavalaei, and M. R. Delvi, "Design and Testing Human Capital Strategies Model Based on Digital Technology Vision and Transformation: Recognition of Cognitive, Behavioral and Performance Consequences," *Research in Cognitive and Behavioral Sciences,* vol. 11, no. 1, pp. 55-70, 2021, doi: 10.22108/cbs.2021.127513.1499.
[25] S. Maleki Far, "The Role and Position of the Innovation and Prosperity Fund in the Development of the Knowledge-Based Economy," 2021.
[26] M. Nasrīni and S. Qāzi Nūri, "Investigating the Moderating Role of Marketing Capability on the Relationship Between Innovation Capability and Performance in Knowledge-Based Companies," *Quarterly Journal of Innovation Strategy and Operations Excellence,* vol. 1, no. 1, 2024.
[27] A. Nīkzād and M. R. Kābārān Zādqadīm, "Investigating the Impact of Applying the Blue Ocean Strategy with a Strategic Thinking Approach on Innovative Production Commercialization and Systematic Innovative Production in Kaleh Amol Company," *Quarterly Journal of Business Management,* vol. 12, no. 47, pp. 473-493, 2020.
[28] I. Kalinic and K. D. Brouthers, "Entrepreneurial orientation, export channel selection, and export performance of SMEs," *International Business Review,* p. 101901, 2021, doi: 10.1016/j.ibusrev.2021.101901.
[29] K. Daneshjoo Vash, P. Ja'fari, and A. Khamseh, "The Commercialization Cycle of Entrepreneurial Ideas in Advanced Technology-Based Companies," vol. 10, no. 3, pp. 41-68, 2021.
[30] E. Masma' Khosrowshāhi and J. Soltanzadeh, "A Historical Analysis of the Challenges of Development and Commercialization in a Knowledge-Based Company in the Field of Medical Equipment," *Quarterly Journal of Management Improvement,* vol. 15, no. 3, pp. 1-21, 2021.
[31] M. A'Zami, "Analysis of the Dimensions and Components of Product Commercialization of Knowledge-Based Companies in the Context of Technology Markets," *Quarterly Journal of Strategic Management Studies,* vol. 11, no. 42, pp. 1-14, 2020.
[32] H. Didehkhani, R. Alizadeh, M. Sharifzadeh, and R. Samiei, "Designing a Digital Entrepreneurship Model in Knowledge-Based Companies with a Grounded Theory Approach," *Technology Development,* vol. 19, no. 75, pp. 1-11, 2023, doi: 10.61186/jstpi.21038.19.75.1.

[33] J. Khani Jazani, S. Ja'fari, and A. Azar Far, "Business Process Modeling of Knowledge-Based Companies," *Decision Making and Operations Research,* vol. 7, no. 2, pp. 277-298, 2022.

[34] M. Alizadeh Seyyedābādi, E. Chīrāni, M. R. Āzāde del, and S. M. Shabgou Monsef, "Commercialization of Medical Goods in Knowledge-Based Companies," *Razi Journal of Medical Sciences (Journal of Iran University of Medical Sciences),* vol. 29, no. 12, pp. 162-170, 2022.