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Designing a Model of Accelerating Drivers and Barriers in the Commercialization of Products by Knowledge-Based Health Companies

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Abstract

The commercialization of research outcomes ensures the continuity and sustainability of scholarly inquiry, generates substantial economic value for organizations, and reinforces critical components of the innovation system that accelerate the economic development of knowledge-based societies. Accordingly, the present study aims to design and explain a model of accelerating drivers and barriers in the commercialization of products developed by knowledge-based companies operating in the health sector. This study is an exploratory-applied research employing a mixed-methods approach conducted in both qualitative and quantitative phases. Data collection tools included desk research (library studies), interviews, and questionnaires. The data analysis method involved thematic analysis in the qualitative phase and structural equation modeling (SEM) in the quantitative phase. The statistical population in the qualitative phase consisted of experts familiar with the subject matter and several managers of knowledge-based health companies, selected through non-probability snowball sampling. In the quantitative phase, the statistical population comprised senior managers of knowledge-based health companies located in industrial towns and science and technology parks in the provinces of Tehran and Alborz, selected through convenience sampling. The findings obtained from thematic analysis (qualitative data) revealed that in the domain of commercialization drivers of health-related knowledge-based company products, six dimensions and twenty-two components were identified. Similarly, in the domain of commercialization barriers, six dimensions and nineteen related components were identified, which together formed the basis of the research model.

Keywords: Accelerating Drivers and Barriers, Commercialization, Knowledge-Based Companies.

1. Introduction

Today, the necessity of focusing on the knowledge-based economy—as a modern economic paradigm in which the production, distribution, and utilization of knowledge constitute the primary sources of growth and wealth creation—is widely acknowledged. In such an economy, knowledge-based companies and startups inevitably play a pivotal role. These companies, acting as engines of technological advancement and innovation, are crucial for job creation, fostering innovation, and leveraging new opportunities, significantly contributing to the economic success of a nation (Yang et al., 2022).

According to Wang and Ahmed (2003), knowledge-based firms are often described as learning-oriented and knowledge-generating entities that leverage both tacit and explicit knowledge to develop their products and technologies. Therefore, increasing attention has been directed toward these firms in recent years. However, due to their inherent risks and distinctive characteristics, one of the core challenges faced by such companies is sustaining growth and achieving long-term stability. Despite numerous advantages, such as possessing skilled human resources, agility, and innovativeness, these small and emerging enterprises face various difficulties in realizing the level of growth and expansion achieved by their counterparts in developed countries (Wang et al., 2024).

Among the major factors influencing the success of knowledge-based firms is the commercialization pathway and how effectively they accelerate it in today's competitive markets. Any delay in this critical process can result in substantial losses and even lead to the company's failure (Jjagwe et al., 2024). Ellingsen (2017) emphasizes that a crucial component of innovation lies in the process of commercialization or industrialization of a product or service. Organizations can only overcome significant entry barriers, such as investment requirements and technological infrastructure, by focusing on reducing time-to-market and minimizing non-value-added costs in introducing new offerings (Stubbs et al., 2022).

Indeed, research findings and outcomes are not a source of wealth unless they are operationalized and their benefits are realized by society. Otherwise, they merely lead to resource wastage and pose additional societal problems. This rationale, along with other contributing factors, has directed intense academic and institutional focus toward the issue of research commercialization. As a result, commercialization has now become one of the core pillars in the innovation process and is a strategic priority for many organizations and research institutions (Baláž et al., 2023).

Nevertheless, technology commercialization is not a simple linear process. Rather, it is a complex endeavor influenced by a broad spectrum of factors or "drivers" that play a significant role in expediting commercialization. These include aspects related to innovation, technology, market dynamics, macro-governance, customer behavior, and more (Acebo & Miguel-Dávila, 2024). Therefore, identifying and monitoring the drivers that influence the acceleration of product commercialization—specifically in the health sector—can be a significant step in enhancing managerial awareness in knowledge-based health companies. It can support these firms in implementing more effective commercialization strategies and making informed decisions in this domain (Zolfaqari et al., 2020).

On the other hand, the outcomes and "barriers" of successful product commercialization can include a wide range of impacts, such as increased market share, enhanced customer learning, improved performance, and profitability in new markets. Thus, examining both the barriers and outputs of commercialization alongside the drivers is essential and must not be overlooked. Additionally, in the past two years, the unexpected and widespread outbreak of the COVID-19 virus—an unprecedented global crisis—has had profound effects on the global economy. This pandemic should not be considered solely a health crisis; its emergence is reshaping various global structures, including business models worldwide (Acebo & Miguel-Dávila, 2024). Undoubtedly, the post-COVID world differs significantly from the pre-COVID era in terms of numerous indicators across multiple domains, including political, cultural, technological, and commercial dimensions.

Given the current situation, where the health sector has become a central concern for all countries, increased attention toward knowledge-based companies in this domain has become even more critical and has attracted the interest of researchers. Considering the existing research gap—especially given that most previous domestic and foreign studies have focused on challenges and obstacles to commercialization, the advantages of commercialization, factors affecting commercialization, and evaluation and modeling of knowledge-based product commercialization (Acebo & Miguel-Dávila, 2024; Baláž et al., 2023; Gong et al., 2021; Jamshidi et al., 2022; Jjagwe et al., 2024; Moon, 2022; Stubbs et al., 2022; Wang et al., 2024; Yang et al., 2022; Zolfaqari et al., 2020)—the topic of accelerating the commercialization of technological products in knowledge-based companies through identification of specific drivers and barriers, particularly in the health sector, has not yet been thoroughly explored.

Therefore, the present study on designing a model of accelerating drivers and barriers in the commercialization of products developed by knowledge-based health companies is of particular importance. This research highlights two core issues: 1) identifying the drivers and barriers that accelerate commercialization and 2) focusing specifically on knowledge-based companies in the health sector. As such, this study aims to answer the fundamental question: What are the accelerating drivers

and barriers in the commercialization of products developed by knowledge-based health companies, and what is their significance?

2. Methods and Materials

This study is categorized as an applied-developmental research in terms of its purpose and employs a mixed-methods (qualitative–quantitative) approach. The adopted mixed-methods design is of the sequential exploratory type. Therefore, the qualitative phase is conducted first, and based on the analysis of its findings, the quantitative phase is designed and implemented. Initially, the research literature was reviewed and examined. Then, through open-ended interviews with subject-matter experts, the dimensions and components related to the model of accelerating drivers and barriers in the commercialization of products by knowledge-based companies were identified using the thematic analysis method.

Subsequently, the research questionnaire was designed based on the findings of the qualitative phase. After assessing its validity and reliability, the questionnaire was used to collect data for testing the research model. The statistical population in the qualitative phase consisted of university experts familiar with the research subject and some managers of knowledge-based health companies (both successful and unsuccessful) with sufficient experience and background. For sampling and conducting interviews in this phase, the snowball sampling method, which is non-probabilistic, was employed, and sampling continued until theoretical saturation was achieved.

The statistical population for the quantitative phase consisted of 240 senior managers of knowledge-based health companies located in industrial parks and science and technology parks in Tehran and Alborz provinces, selected through convenience sampling. To ensure the validity of the qualitative data, the member check method was used. For assessing the reliability, interviews were conducted at two different time intervals, and the resulting codes were compared.

In the quantitative phase, content validity and convergent-divergent validity were used to confirm the validity of the instrument. The reliability of the research instrument was calculated using Cronbach's alpha coefficient, which was above 0.70 for all variables. Data analysis in the qualitative phase was performed using systematic literature review for examining prior research and thematic analysis for interpreting exploratory interviews. In the quantitative phase, structural equation modeling (SEM) was employed, and analyses were conducted using SPSS and SmartPLS 3 software in both descriptive and inferential sections.

3. Findings and Results

In this section, the interviews conducted with the selected participants were analyzed, and subsequently, the conceptual model of the study was developed.

Step 1: Open Coding

This phase began immediately after the first interview. In other words, after each interview, the researcher started identifying concepts, assigning appropriate labels to them, and grouping related concepts. In total, after analyzing 15 interviews with subject-matter experts, 209 initial codes were extracted.

Step 2: Axial Coding

The goal of axial coding is to integrate and organize the data that were broken down during open coding. At this stage, by merging the initial components from open coding, broader categories were formed. The results of axial coding are presented in the Table 1 (axial coding for identifying categories related to the drivers of commercialization of products in knowledge-based health companies) and Table 2 (axial coding for identifying categories related to the barriers to commercialization of products in knowledge-based health companies).

Table 1. Axial Coding for Drivers of Commercialization in Knowledge-Based Health Companies

Initial Codes	Secondary/Conceptual Codes (Integration of Initial Codes)	Categories (Integration of Concepts)
A11, A64, A112, A109, A79, A124, A52, A137, A125, A140, A173, A4, A49, A158, A117	Monitoring market and customer needs	Environmental Requirements
A81, A82, A85, A123, A144, A145, A159, A160, A147, A162	Feasibility and product testing for market entry	
A191, A135	Speed of product launch	
A18, A179, A134	Managerial knowledge in problem-solving	Managerial Requirements

A30, A51, A6, A31, A32, A108, A95, A17, A114, A116, A163, A199	Manager's belief and commitment	
A70, A80, A83, A149, A44, A141	Policy-making and strategy design	
A28, A25, A139, A148, A190, A24, A97, A23	Managerial encouragement and support	
A22, A56, A93, A41, A3, A172, A197, A198	Possession of systemic (holistic) thinking	
A10, A15, A45, A84, A201	Granting autonomy and authority to employees	
A7, A9, A142	Attention to the entire commercialization process	Process Requirements
A180, A8, A7, A110, A111, A43, A187	Identifying value streams and eliminating waste	
A42, A5, A113, A12, A166	Continuous process improvement	
A26, A14, A101, A46, A127, A138, A165, A174, A200	Internal communication and collaboration	Communication Requirements
A1, A126, A39, A136, A200	External communication and collaboration	
A27, A47, A57, A100, A13, A88, A59, A203	Knowledge transfer and sharing	Knowledge Requirements
A98, A48, A16, A73, A143, A150, A178, A186	Learning-oriented environment	
A63, A128, A161, A202	Research and development activities	
A60, A50, A62, A94	Application of knowledge	
A40, A189	Technological infrastructure of the company	Infrastructure Requirements
A29, A99, A61, A175, A176	Innovation-driven platform	
A72, A164, A177	Change-friendly and transformational platform	
A86, A115, A146	Organizational resources and capacities	

Table 2. Axial Coding for Barriers to Commercialization in Knowledge-Based Health Companies

Initial Codes	Secondary/Conceptual Codes (Integration of Initial Codes)	Categories (Integration of Concepts)
A103, A19, A53, A89	Lack of managerial belief	Individual Barriers
A104, A168, A204	Absence of systemic thinking	
A105, A209, A76, A75	Lack of open mindset	
A36, A37, A54	Employee confusion in task performance	Structural Barriers
A77, A129	Financial barriers	
A156, A157, A74	Lack of access to complementary (e.g., distribution channels, suppliers) and specialized resources (e.g., technical know-how, machinery, skilled workforce)	
A38, A55	Improper use of resources in the commercialization process	Process Barriers
A106, A207	Lack of flexibility in the process	
A130, A208	Lack of strategic support in response to market changes	
A21, A35, A185, A182, A154, A171, A132, A67, A78	Poor understanding of the surrounding environment	Cognitive Barriers
A65, A34, A181, A69, A107	Poor understanding of customer needs	
A66, A131, A90, A68, A155	Product misalignment with predefined standards	
A20, A169, A121, A33	Lack of clear internal communication	Communication and Coordination Barriers
A102, A206	Failure to form cross-functional teams	
A133, A170, A91	Inadequate collaboration with the supply chain	
A184, A183	Lack of strong support for knowledge transfer throughout the organization	
A92, A154	Mismatch between research and commercialization needs	Research and Development Barriers
A151, A153, A152	Lack of conceptual studies and precise feasibility analysis	
A205	Neglect of human resource competencies and capabilities	

Following the identification of these categories, ten overarching theoretical classes were established to guide the ongoing process of theorization.

Step Three: Selective Coding

At this stage, after identifying the categories, it is necessary to determine the relationships and linkages between these categories within the framework of a paradigm model, which is accomplished through selective coding. The objective of this phase is to establish the interconnections among the conceptual classes generated in the previous coding stage.

The results of the reliability testing for various dimensions of the research questionnaire are presented in Table 5. Since all Cronbach's alpha coefficients exceed the threshold of 0.70, the reliability of the research questionnaire and its dimensions is confirmed.

Table 3. Reliability Test of the Dimensions in the Commercialization Drivers Questionnaire Using Cronbach's Alpha

Variable	Number of Components	Cronbach's Alpha	Reliability Result
Process Requirements	3	0.868	Confirmed
Environmental Requirements	3	0.904	Confirmed
Managerial Requirements	6	0.921	Confirmed
Infrastructure Requirements	4	0.891	Confirmed
Communication Requirements	2	0.880	Confirmed
Knowledge Requirements	4	0.896	Confirmed
Total Questionnaire	22	0.967	Confirmed

Table 4. Reliability Test of the Dimensions in the Commercialization Barriers Questionnaire Using Cronbach's Alpha

Variable	Number of Components	Composite Reliability	Reliability Result
Individual Barriers	3	0.892	Confirmed
Cognitive Barriers	3	0.869	Confirmed
Structural Barriers	3	0.819	Confirmed
Process Barriers	3	0.839	Confirmed
Research and Development Barriers	3	0.878	Confirmed
Communication and Coordination Barriers	4	0.748	Confirmed
Total Questionnaire	19	0.892	Confirmed

Discriminant validity in this study was evaluated using the Fornell–Larcker criterion. The results are shown in Table 5 and Table 6.

Table 5. Discriminant Validity Assessment of the Dimensions of the Commercialization Drivers Questionnaire

Variable	Process	Environmental	Managerial	Infrastructure	Communication	Knowledge
Process Requirements	0.876					
Environmental Requirements	0.732	0.837				
Managerial Requirements	0.738	0.796	0.864			
Infrastructure Requirements	0.624	0.729	0.634	0.855		
Communication Requirements	0.730	0.680	0.790	0.637	0.842	
Knowledge Requirements	0.707	0.514	0.571	0.608	0.682	0.773

Table 6. Discriminant Validity Assessment of the Dimensions of the Commercialization Barriers Questionnaire

Variable	Communication & Coordination	R&D Barriers	Structural	Cognitive	Process	Individual
Communication & Coordination	0.822					
Research and Development Barriers	0.761	0.833				
Structural Barriers	0.748	0.572	0.778			
Cognitive Barriers	0.506	0.684	0.706	0.797		
Process Barriers	0.715	0.638	0.580	0.672	0.841	
Individual Barriers	0.407	0.681	0.558	0.579	0.571	0.724

Table 7. Convergent Validity (AVE) for Dimensions of the Commercialization Drivers Questionnaire

Dimension	AVE
Process Requirements	0.768
Environmental Requirements	0.701
Managerial Requirements	0.746
Infrastructure Requirements	0.731
Communication Requirements	0.709
Knowledge Requirements	0.598

The results in Table 7 indicate that all AVE values exceed the significance threshold of 0.50, thereby confirming the convergent validity of these dimensions.

Table 8. Convergent Validity (AVE) for Dimensions of the Commercialization Barriers Questionnaire

Dimension	AVE
Individual Barriers	0.675
Cognitive Barriers	0.688
Structural Barriers	0.605
Process Barriers	0.635
Research and Development Barriers	0.707
Communication and Coordination Barriers	0.524

The results in Table 8 also confirm that all AVE values are above 0.50, indicating that the questionnaire possesses acceptable convergent validity and reliability.

The model, composed of dimensions and components related to the key drivers influencing the acceleration of commercialization in knowledge-based health companies, was tested using SmartPLS 3 software under both t-statistics and standardized mode.

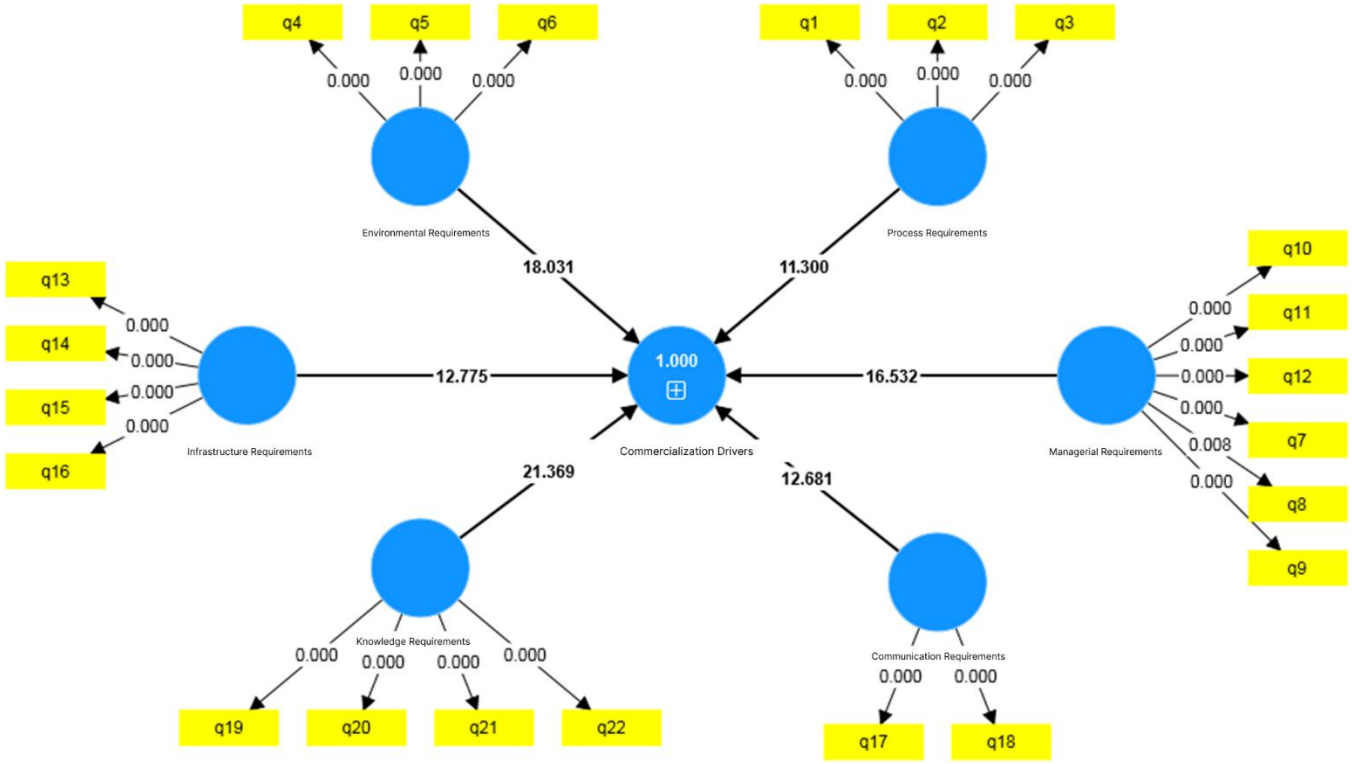

Figure 1. t-Statistics Diagram for the Model of Key Drivers Influencing Commercialization Acceleration in Knowledge-Based Health Companies

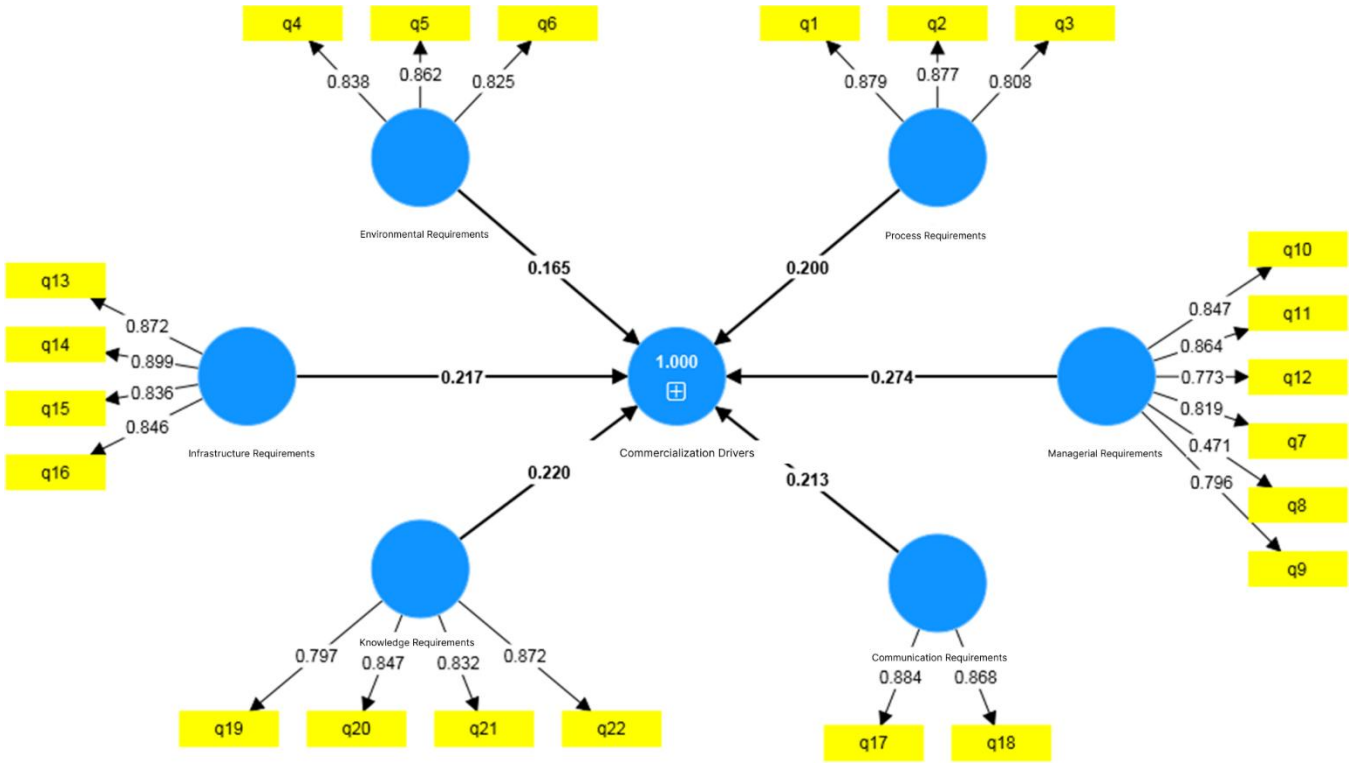

Figure 2. Standardized Mode Diagram for the Model of Key Drivers Influencing Commercialization Acceleration in Knowledge-Based Health Companies

The following table presents a summary of the results in this section:

Table 9. Path Analysis Results for Key Drivers Affecting the Acceleration of Commercialization in Knowledge-Based Health Companies

Causal Path	Standardized Path Coefficient (β)	t-Statistic	Significance Level	Test Result
Communication Requirements → Drivers of Commercialization	0.213	12.681	0.000	Confirmed
Knowledge Requirements → Drivers of Commercialization	0.220	21.369	0.000	Confirmed
Infrastructure Requirements → Drivers of Commercialization	0.217	12.775	0.000	Confirmed
Environmental Requirements → Drivers of Commercialization	0.165	18.031	0.000	Confirmed
Managerial Requirements → Drivers of Commercialization	0.274	16.532	0.000	Confirmed
Process Requirements → Drivers of Commercialization	0.200	11.300	0.000	Confirmed

Given the results in the above table and considering that the t-statistics exceed 1.96 (at a 95% confidence level), all paths between the variables are statistically significant. Furthermore, the significance levels are all less than 0.05, indicating that all proposed relationships in the research model are supported with 95% confidence.

Table 10. Model Fit Results for Key Drivers Affecting the Acceleration of Commercialization in Knowledge-Based Health Companies

Index	Description	Standard Threshold	Obtained Value
NFI (Normed Fit Index)	Normalized model fit index	> 0.90	0.91
SRMR (Standardized Root Mean Square Residual)	Must be < 0.10 or ideally < 0.08	0.099	

These indicators confirm that the proposed model has a good overall fit.

The next section, based on Figure 3, presents the model of dimensions and components related to key barriers affecting the acceleration of commercialization in knowledge-based health companies. This model was tested using SmartPLS 3 under both t-statistics and standardized conditions.

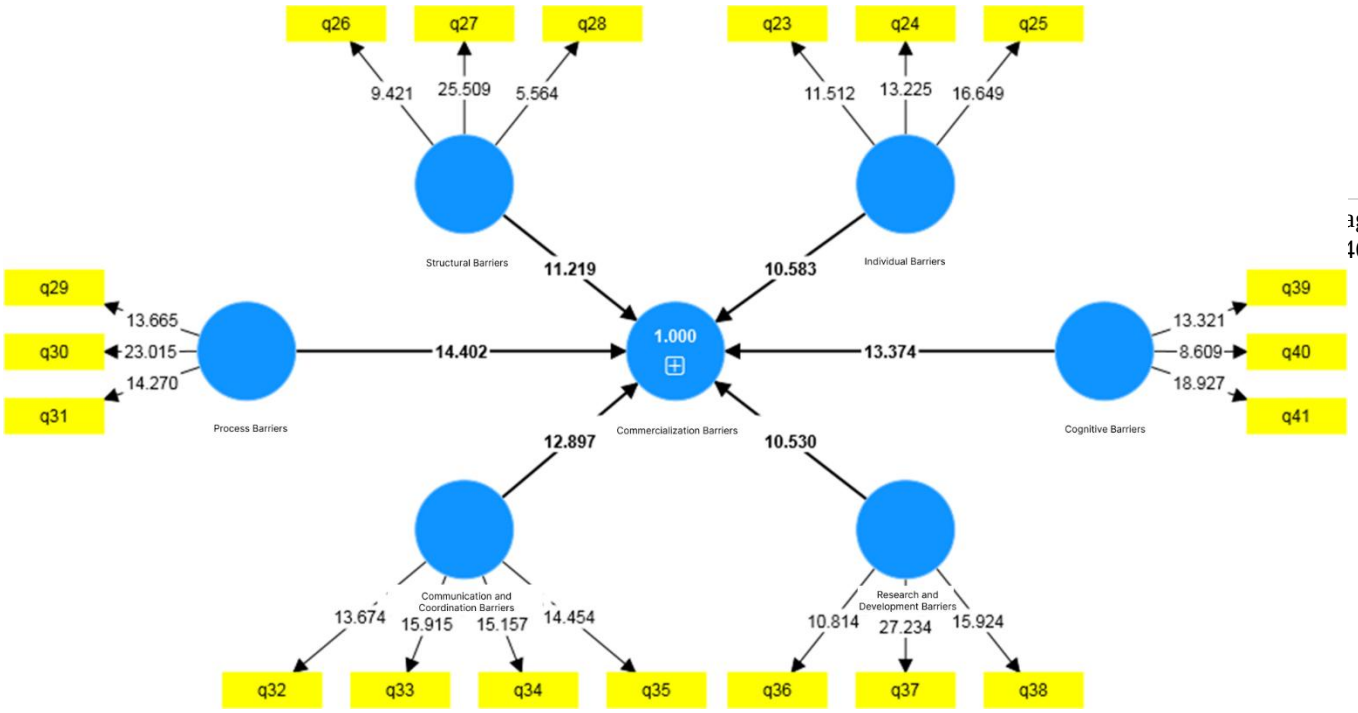

Figure 3. t-Statistic Model of Key Barriers Affecting Commercialization Acceleration in Knowledge-Based Health Companies

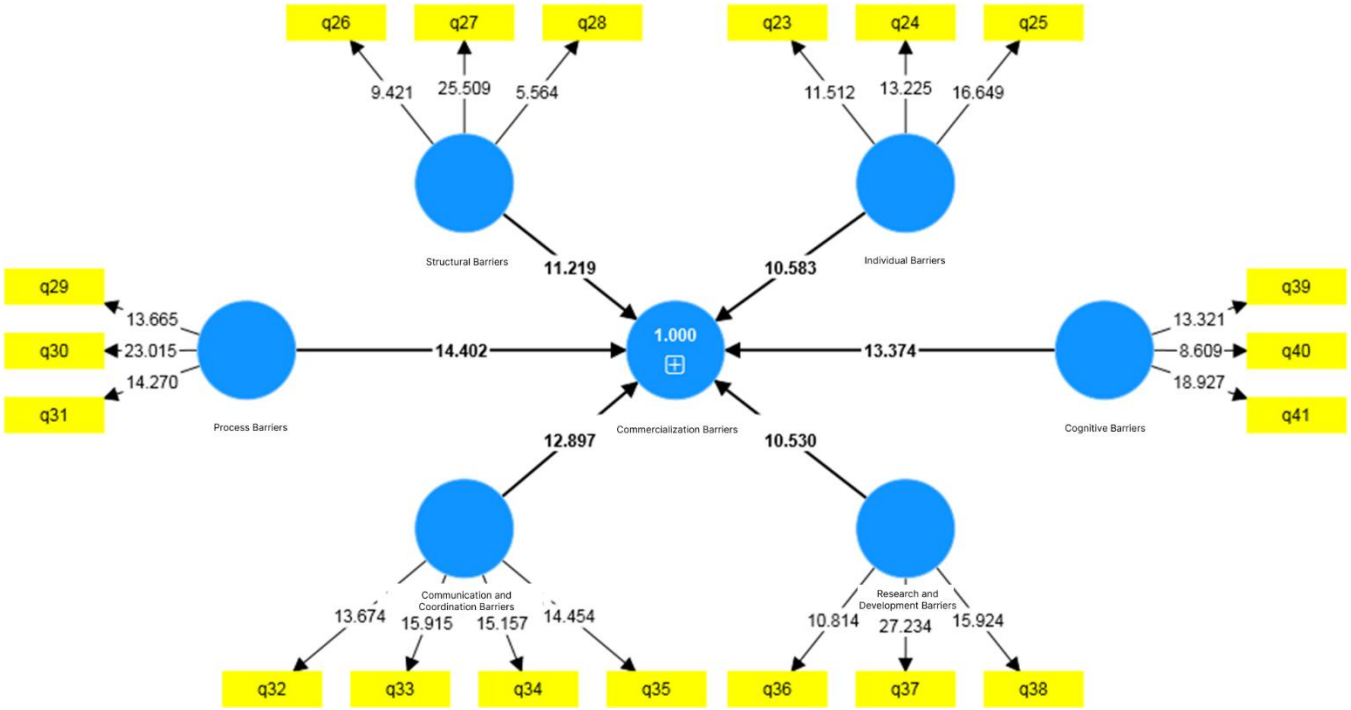

Figure 4. Standardized Model of Key Barriers Affecting Commercialization Acceleration in Knowledge-Based Health Companies

Table 11. Path Analysis Results for Key Barriers Affecting the Acceleration of Commercialization in Knowledge-Based Health Companies

Causal Path	Standardized Path Coefficient (β)	t-Statistic	Significance Level	Test Result
Communication and Coordination Barriers → Commercialization Barriers	0.257	12.897	0.000	Confirmed
Research Barriers → Commercialization Barriers	0.180	10.530	0.000	Confirmed
Structural Barriers → Commercialization Barriers	0.166	11.219	0.000	Confirmed
Cognitive Barriers → Commercialization Barriers	0.183	13.374	0.000	Confirmed
Process Barriers → Commercialization Barriers	0.194	14.402	0.000	Confirmed
Individual Barriers → Commercialization Barriers	0.142	10.583	0.000	Confirmed

As shown in Table 11, all path coefficients are statistically significant with t-statistics exceeding 1.96 (at the 95% confidence level), and significance levels are less than 0.05. Thus, all proposed relationships in the model for barriers to commercialization are confirmed at the 95% confidence level.

Table 12. Model Fit Results for Key Barriers Affecting the Acceleration of Commercialization in Knowledge-Based Health Companies

Index	Description	Standard Threshold	Obtained Value
NFI (Normed Fit Index)	Normalized model fit index	> 0.90	0.913
SRMR (Standardized Root Mean Square Residual)	< 0.10 or ideally < 0.08	0.082	

These results indicate that the model for barriers to commercialization is also well-fitted and statistically valid.

4. Discussion and Conclusion

This study was conducted with the objective of designing and explaining a model of key drivers and barriers accelerating the commercialization of products by knowledge-based companies operating in the health sector. The qualitative data analysis using thematic analysis revealed that the key drivers influencing the acceleration of commercialization in these companies include: process requirements, environmental requirements, infrastructure requirements, managerial requirements, communication requirements, and knowledge requirements. These findings align with previous studies (Acebo & Miguel-Dávila, 2024; Baláž et al., 2023; Gong et al., 2021; Jamshidi et al., 2022; Jjagwe et al., 2024; Moon, 2022; Stubbs et al., 2022; Wang et al., 2024; Yang et al., 2022; Zolfaqari et al., 2020).

In interpreting these findings, it can be stated that as emphasized by scholars in the field of commercialization, the product commercialization process is inherently a journey that must be approached holistically and with a thorough understanding of its intricate details. It is essential for managers to accurately comprehend changes in market and customer demands to achieve optimal commercialization performance. Given the critical importance of the health sector in today's society, both in terms of product timeliness and quality, this domain requires sophisticated managerial attention. Health-oriented knowledge-based companies, especially those with smaller scale and specific operational attributes compared to large enterprises, must commercialize their innovations rapidly to benefit from market opportunities and ensure the continuity of operations.

The thematic analysis also revealed the key barriers to commercialization acceleration, which include: individual barriers, structural barriers, cognitive barriers, research barriers, communication and coordination barriers, and process barriers. The results showed that all hypothesized paths among the variables were statistically significant ($p < 0.05$). Model fit indices (including NFI and SRMR) also confirmed that the proposed model fits the data well. These results are consistent with prior studies (Baláž et al., 2023; Gong et al., 2021; Jamshidi et al., 2022; Jjagwe et al., 2024; Moon, 2022; Stubbs et al., 2022; Wang et al., 2024).

These findings suggest that various barriers can significantly impede the commercialization trajectory in health-sector knowledge-based firms. For instance, individual barriers may arise when company managers, despite being aware of the benefits of commercialization, lack the necessary skills or capacities, slowing down the process. Structural barriers might emerge from poorly organized internal structures that are not conducive to streamlined commercialization.

Based on the findings of this research, the following practical recommendations are proposed:

– Establish a committee comprising senior managers and external stakeholders to identify internal and external strengths, weaknesses, opportunities, and threats (SWOT) to develop acceleration strategies for commercialization.

– Implement participatory management practices in decision-making related to commercialization, offering incentive packages to encourage constructive participation.

– Create collaborative infrastructures within the company to support the expansion of cross-functional and knowledge-based teams aimed at accelerating commercialization.

– Form a working group to continuously monitor evolving market demands and customer expectations.

– Institutionalize a step-by-step and continuous improvement approach across departments to identify and address bottlenecks and problematic areas in the commercialization pathway.

– Expand the company's flexible production and product development capabilities to meet changing market and customer needs, thereby enhancing commercialization speed.

– Leverage the expertise of holistic-thinking managers to build organizational trust, involve employees in decision-making, and align them with product development from ideation to market launch.

– Utilize the capacity of experienced consultants to foster positive beliefs among top managers about strategic product commercialization, and improve managerial risk tolerance in making critical decisions throughout the commercialization process.

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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