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Examining the Factors Affecting the Localization of Technology Commercialization with a Focus on Technology-Based and Knowledge-Based Companies

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ABSTRACT

Technology commercialization, as the linking mechanism between knowledge and the market, plays a fundamental role in realizing a knowledge-based economy and creating sustainable value for technology-oriented firms. Despite the significant growth of technological activities in the country, the localization of the technology commercialization process continues to face numerous challenges. The present study was conducted with the aim of identifying and explaining the factors influencing the localization of technology commercialization, with a focus on technology-based and knowledge-based companies. In terms of purpose, this study is applied research, and in terms of methodology, it follows a descriptive–survey design. The statistical population consisted of knowledge-based companies located in the Isfahan Science and Research Town, and data were collected using a researcher-developed questionnaire. Structural equation modeling and SmartPLS software were employed for data analysis. The findings indicated that strong technological capability, market foresight, and customer experience and demands have a positive and significant effect on technology commercialization, whereas market needs recognition and technological innovation did not show a significant effect. Furthermore, technology commercialization has a significant impact on outcomes such as market development, profitability, creation of competitive advantage, customer satisfaction, self-sustaining production, and market leadership, as well as on strategies such as marketing and sales, branding, product standardization, export strategy formulation, and the utilization of emerging technologies. The research findings emphasize the necessity of strengthening technological capabilities and adopting a future-oriented perspective in the localization of technology commercialization.

Keywords: Localization, Commercialization, Technology Commercialization, Knowledge-Based Companies.

Introduction

In the contemporary knowledge-based economy, technology commercialization has emerged as a critical mechanism for transforming scientific knowledge, technological inventions, and research outputs into marketable products, services, and processes that generate economic and social value. The commercialization process serves as the essential bridge between technological development and market deployment, enabling firms, universities, and research institutions to convert intellectual capital into tangible economic returns and competitive advantage. With the growing importance of innovation-driven growth, organizations increasingly recognize that technological

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knowledge alone is insufficient without effective commercialization strategies that align technological capabilities with market demands and strategic objectives (1, 2). Technology commercialization not only enhances firm performance but also contributes to broader national innovation systems by accelerating technological diffusion, strengthening industrial competitiveness, and supporting sustainable economic development. In emerging and developed economies alike, the ability to successfully commercialize technology is now considered a key determinant of organizational survival, growth, and leadership in dynamic and highly competitive markets (3, 4). As innovation cycles shorten and technological complexity increases, organizations must develop structured commercialization models that integrate technological, managerial, and market-oriented capabilities to maximize value creation and minimize commercialization risks.

Technology commercialization is a multidimensional and complex process that involves several interconnected stages, including technology development, feasibility assessment, intellectual property protection, market analysis, product development, and commercialization execution. This process requires coordination among multiple stakeholders, including technology developers, entrepreneurs, investors, suppliers, customers, and regulatory institutions. Previous research has emphasized that effective commercialization depends on a combination of technological readiness, organizational capabilities, and strategic alignment with market opportunities (5, 6). The commercialization pathway is not linear but iterative and dynamic, requiring continuous adaptation to evolving technological, market, and institutional conditions. In this context, firms must develop mechanisms to evaluate technological feasibility, identify customer needs, and align product development with market requirements to ensure successful commercialization outcomes. Moreover, strategic planning and market foresight are essential to anticipate future technological trends and market demands, allowing firms to position themselves effectively in emerging markets and technological domains (7, 8). Without a systematic approach to commercialization, technological innovations may remain confined to laboratories or fail to achieve meaningful market penetration.

Technological capability represents one of the most critical determinants of commercialization success, as it reflects the organization’s ability to develop, adapt, and apply advanced technologies in ways that create competitive advantage and market value. Firms with strong technological capabilities are better positioned to innovate continuously, respond to technological changes, and implement effective commercialization strategies. Technological capability enables organizations to improve product performance, reduce development costs, and accelerate time-to-market, thereby enhancing commercialization effectiveness and overall organizational performance (9). In addition, technological asymmetry between firms can influence innovation outcomes and commercialization effectiveness, as organizations with superior technological capabilities are more likely to achieve sustainable competitive advantages and market leadership. The adoption of advanced technologies and Industry 4.0 solutions further strengthens commercialization potential by enabling firms to enhance production efficiency, improve product quality, and develop innovative business models (10). These technological advancements create new opportunities for value creation but also require firms to develop commercialization strategies that effectively integrate technological innovation with market and organizational capabilities.

Market-oriented capabilities, including market needs recognition, customer engagement, and market foresight, also play a fundamental role in technology commercialization. Successful commercialization requires organizations to understand customer preferences, anticipate market trends, and align technological development with customer demands. Firms that actively monitor market conditions and collect customer feedback are better able to develop products that meet market expectations and achieve higher adoption rates (4, 11). Market foresight enables

organizations to anticipate technological disruptions and emerging opportunities, allowing them to position their innovations strategically and achieve first-mover advantages. Customer involvement in the commercialization process enhances product relevance, improves customer satisfaction, and increases the likelihood of successful market adoption. Moreover, commercialization success depends on the organization's ability to integrate technological innovation with marketing, branding, and strategic positioning activities, ensuring that technological products effectively reach target markets and generate economic returns (6, 12). The alignment between technological capabilities and market orientation is therefore essential for maximizing commercialization effectiveness.

Organizational and institutional factors, including strategic alliances, university–industry collaboration, and innovation ecosystem integration, also significantly influence technology commercialization outcomes. Collaboration between universities and industry facilitates knowledge transfer, enhances technological innovation, and accelerates commercialization processes by combining scientific expertise with market knowledge and industrial capabilities (13, 14). Technology transfer offices, innovation centers, and science and technology parks play critical roles in supporting commercialization by providing infrastructure, intellectual property support, and commercialization expertise. Strategic alliances and partnerships enable organizations to share resources, reduce commercialization risks, and enhance market access, thereby improving commercialization success rates (15). Furthermore, institutional support mechanisms, including intellectual property protection, government policies, and financial incentives, contribute to commercialization effectiveness by creating favorable environments for innovation and technology transfer. Organizations operating within strong innovation ecosystems are better positioned to commercialize technologies successfully due to access to financial resources, market networks, and commercialization expertise.

Technology commercialization also generates significant organizational and economic outcomes, including increased profitability, market expansion, competitive advantage, and innovation-driven growth. Successful commercialization enhances organizational performance by increasing revenue streams, improving market positioning, and strengthening competitive capabilities. Firms that effectively commercialize technology can differentiate themselves from competitors, enter new markets, and establish leadership positions in emerging technological domains (2, 16). Commercialization also contributes to sustainable production and operational efficiency by enabling organizations to implement advanced technologies that improve productivity and resource utilization. In addition, commercialization plays a crucial role in strengthening national and regional innovation systems by promoting technological diffusion, supporting industrial development, and enhancing economic competitiveness (3, 17). Despite these benefits, many organizations face challenges in commercializing technology due to limited technological capabilities, inadequate market understanding, insufficient institutional support, and lack of structured commercialization strategies. These challenges highlight the need for comprehensive models that identify and integrate the key factors influencing technology commercialization success.

Given the increasing importance of technology commercialization in knowledge-based economies and the complex interplay of technological, market, organizational, and strategic factors influencing commercialization outcomes, there is a critical need to identify and explain the key determinants that facilitate successful commercialization in technology-based and knowledge-based firms. Accordingly, the aim of this study is to identify and explain the factors affecting the localization of technology commercialization with a focus on technology-based and knowledge-based companies.

Methods and Materials

In this study, a researcher-developed questionnaire was designed to examine the most important components and variables related to technology commercialization. In this section, a survey method was used for data collection; therefore, the study can be classified as field research. The data collection method consisted of both library-based and field studies. The primary data collection instrument was a questionnaire. The data analysis method was conducted at two levels: descriptive and inferential. Considering the level of measurement and distribution of the data, appropriate statistical tests and structural equation modeling (SEM) were employed.

The statistical population in the quantitative section consisted of knowledge-based companies located in the Isfahan Science and Research Town, which, according to official records obtained from the Science and Research Town headquarters, included 330 companies. Given the size of the statistical population, sampling was required in the present study, and the sample size was calculated using Cochran's formula:

$N = 330, \quad P = 0.5, \quad q = 0.5, \quad z = 1.96, \quad d = 0.05$

$n = (z^2pq / d^2) / (1 + (1/N)(z^2pq / d^2 - 1)) = 384.16 / (1 + (1/330)(383.16)) = 177.27 \approx 177$

Considering the composition and distribution of knowledge-based companies located in the Isfahan Science and Research Town, an appropriate sample size was selected. The sampling method used in this quantitative section was convenience random sampling.

Based on the type of information required in this study, the data collection instrument used to test the hypotheses was a researcher-developed questionnaire, which was administered to managers of knowledge-based companies located in the Isfahan Science and Research Town.

The operational questions of the questionnaire consisted of four sections. The first section included causal factors such as market needs recognition, technological innovation, market foresight, customer experience and demands, and technological capability. The second section included the central phenomenon, namely technology commercialization. The third section included outcomes with dimensions such as profitability, market development, customer satisfaction, creation of competitive advantage, self-sustaining production, and market leadership. The fourth section included strategies with dimensions such as marketing and sales, branding, networking, collaboration with universities, product standardization, export strategy formulation, utilization of emerging technologies, and feasibility assessment. Overall, the questionnaire consisted of 100 items or questions, which were designed to be as clear and understandable as possible.

The questionnaire was developed based on valid and reliable sources; therefore, it possessed minimum validity requirements. In addition, face validity and content validity methods were used to confirm its validity. For content validity assessment, the questionnaire was distributed among university professors, including the academic supervisor and several faculty members, and after reaching theoretical saturation, the validity of the questionnaire was confirmed. Furthermore, to confirm face validity, the questionnaire was distributed among members of the statistical population, and their feedback was incorporated into the final version of the questionnaire.

To assess reliability, Cronbach's alpha coefficient was used, and the value obtained for the entire questionnaire was 0.877. Furthermore, all variables examined in this study had Cronbach's alpha coefficients higher than 0.70 and were measured with statistical significance. Therefore, the questionnaire demonstrated acceptable reliability.

Findings and Results

The first factor that must be considered in evaluating the model is the unidimensionality of the model indicators. This means that each indicator, among the set of indicators, must load significantly on only one latent variable with a high factor loading value. Accordingly, the factor loading value must be greater than 0.40. It should be noted that a factor loading value smaller than 0.40 is considered weak and should be removed from the set of indicators. This process is performed manually by removing indicators with factor loadings less than 0.40. After calculating the factor loadings of the questionnaire items and removing those with factor loadings less than 0.40, the values presented in Figure 4-6 and Table 4-11 were obtained. Furthermore, after recalculating the factor loadings and removing items with loadings less than 0.50, the final factor loading values presented in Figure 1 were confirmed.

Table 1. Factor Loadings of Research Variable Items

Construct	Item Code	Item Description	Factor Loading	R^2
Market Needs Recognition	q1	Our company regularly monitors current and future market needs.	0.765	—
	q2	Decisions related to technology development are made based on market demand analysis.	0.719	—
	q3	Market information plays a decisive role in guiding technology projects.	0.552	—
	q4	Before initiating any technology project, target customer needs are carefully examined.	0.635	—
	q5	Our company has the ability to quickly identify changes in customer needs.	0.708	—
Technological Innovation	q6	Our company continuously applies new technologies in its products.	0.774	—
	q7	The company's products are more technologically innovative than competitors.	0.717	—
	q8	Employees are encouraged to propose new technological solutions.	0.685	—
	q9	The company invests in the development of advanced technologies.	0.774	—
	q10	The company's R&D capability enables continuous innovation.	0.771	—
Market Foresight	q11	Our company predicts long-term market trends and incorporates them into decision-making.	0.792	—
	q12	Our technology planning is based on future market vision.	0.828	—
	q13	Future technological changes are considered in company strategy formulation.	0.842	—
	q14	The company can identify future market opportunities.	0.769	—
	q15	Company managers adopt a long-term perspective in market analysis.	0.826	—
Customer Experience and Demands	q16	Our company regularly collects and analyzes customer feedback.	0.777	—
	q17	Customer requests play an important role in improving company products.	0.787	—
	q18	Interaction with customers leads to identification of new technological opportunities.	0.651	—
	q19	Our company has a defined process for responding to new customer demands.	0.687	—
	q20	Customer experiences serve as a basis for product design improvements.	0.740	—
Technological Capability	q21	Our company utilizes advanced and competitive technologies.	0.789	—
	q22	The technological maturity level of the company is above the industry average.	0.780	—
	q23	The company has the capability to rapidly upgrade its technologies.	0.821	—
	q24	The company's technological infrastructure enables development of complex products.	0.834	—
	q25	The company's technological capability creates a significant competitive advantage.	0.763	—

Technology Commercialization	q26	Our company can convert developed technologies into marketable products.	0.789	0.625
	q27	Decisions related to technology market entry are made systematically.	0.775	0.625
	q28	Processes for transferring technology from development to production are clearly defined.	0.826	0.625
	q29	The company has successfully commercialized its technologies.	0.773	0.625
	q30	Developed technologies have resulted in new product introductions.	0.797	0.625
Profitability	q31	Technology commercialization has increased company profits.	0.858	0.521
	q32	Technological products contribute significantly to company revenue.	0.875	0.521
	q33	New technologies have increased company profit margins.	0.892	0.521
	q34	Technological innovation has reduced production costs.	0.655	0.521
	q35	Technological products have enhanced price competitiveness.	0.750	0.521
Market Development	q36	Technology commercialization has increased company market share.	0.830	0.522
	q37	Technological products have attracted new customers.	0.831	0.522
	q38	The company has entered new domestic or international markets.	0.758	0.522
	q39	New technologies have expanded sales channels.	0.813	0.522
	q40	Market development is directly influenced by technology commercialization.	0.804	0.522
Customer Satisfaction	q41	Customers are satisfied with technological product quality.	0.732	0.351
	q42	New technologies have improved customer experience.	0.865	0.351
	q43	Customer complaints regarding technological products have decreased.	0.666	0.351
	q44	Customers recommend company products to others.	0.778	0.351
	q45	Technology development has increased perceived customer value.	0.756	0.351
Competitive Advantage	q46	Company technologies have created significant competitive advantage.	0.802	0.467
	q47	Technology development speed exceeds competitors.	0.771	0.467
	q48	Company technological products are difficult to imitate.	0.707	0.467
	q49	Unique technologies have strengthened market superiority.	0.891	0.467
	q50	Technological innovations have strengthened competitive position.	0.851	0.467
Sustainable Production	q51	Technologies have increased production productivity.	0.833	0.418
	q52	New technologies have enhanced production stability.	0.855	0.418
	q53	Company can sustain long-term production of technological products.	0.821	0.418
	q54	Developed technologies have reduced resource waste.	0.874	0.418
	q55	Technology use has reduced production interruption risks.	0.800	0.418
Market Leadership	q56	Our company is a pioneer in introducing new technologies.	0.887	0.396
	q57	Company is recognized as an innovation leader.	0.896	0.396
	q58	Competitors follow company technological innovations.	0.821	0.396
	q59	Company introduces new technologies rapidly.	0.880	0.396
	q60	Technological leadership defines company brand identity.	0.850	0.396
Marketing and Sales	q61	The company has a clear strategy for marketing technological products.	0.766	0.431
	q62	The company's promotional activities have increased awareness of new technologies.	0.817	0.431
	q63	The sales team can effectively explain the technology-based features of products.	0.827	0.431
	q64	The company uses digital tools for technology marketing.	0.778	0.431
	q65	Effective marketing plays a key role in commercialization success.	0.706	0.431
Branding	q66	The company's brand successfully communicates the value of developed technologies.	0.887	0.431
	q67	Brand credibility increases customer trust in purchasing technological products.	0.852	0.431

	q68	The company has plans to strengthen its technological brand.	0.858	0.431
	q69	The company's brand is recognized for product innovation.	0.853	0.431
	q70	Branding plays an important role in attracting new customers.	0.643	0.431
Networking	q71	Our company maintains continuous relationships with other technology firms.	0.808	0.135
	q72	Collaboration within industrial and technological networks has supported product development.	0.765	0.135
	q73	The company actively participates in technology exhibitions and events.	0.680	0.135
	q74	Networking helps identify new business opportunities.	0.837	0.135
	q75	Collaboration with innovation ecosystem institutions has improved company performance.	0.724	0.135
University Collaboration	q76	The company collaborates with universities to develop technology.	0.876	0.075
	q77	Academic research contributes to solving technological challenges of the company.	0.904	0.075
	q78	Interaction with universities improves technological product quality.	0.913	0.075
	q79	The company participates in joint research projects.	0.824	0.075
	q80	The company utilizes faculty and student expertise in technology development.	0.853	0.075
Product Standardization	q81	Company products are designed according to national and international standards.	0.804	0.280
	q82	Compliance with standards enhances product competitiveness.	0.854	0.280
	q83	The company has programs to develop technology-related standards.	0.864	0.280
	q84	Standardization increases customer trust.	0.876	0.280
	q85	Obtaining standard certifications is essential in commercialization.	0.690	0.280
Export Strategy Formulation	q86	The company has a clear plan to enter international markets.	0.817	0.269
	q87	Export standards are considered in product design.	0.879	0.269
	q88	The company uses support tools to expand international markets.	0.637	0.269
	q89	Company technologies have strong international competitiveness.	0.745	0.269
	q90	Exporting technological products is part of long-term company goals.	0.787	0.269
Use of Emerging Technologies	q91	The company uses emerging technologies to improve products.	0.732	0.293
	q92	Process digitalization is actively pursued within the company.	0.817	0.293
	q93	Technologies such as AI, IoT, or blockchain are used in company products.	0.743	0.293
	q94	The company provides training for adopting new technologies.	0.861	0.293
	q95	Emerging technologies enhance company competitiveness.	0.899	0.293

Feasibility Study	q96	Detailed feasibility studies are conducted before technology development.	0.737	0.294
	q97	Market feasibility plays a key role in production decisions.	0.850	0.294
	q98	The company analyzes costs and benefits before technology development.	0.841	0.294
	q99	Technical and economic feasibility studies are conducted before commercialization.	0.867	0.294
	q100	Accurate feasibility studies reduce the risk of new product failure.	0.865	0.294

Based on the results presented in Table 1, the factor loading values of all items were greater than 0.40, and no items were removed from the model. After calculating the Composite Reliability (CR) values related to the research variables, the table of composite reliability values was completed as presented in Table 2.

Table 2. Reliability and Validity Indicators

Construct	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	Convergent Validity (AVE)
Market Foresight	0.871	0.873	0.906	0.659
Product Standardization	0.880	0.913	0.911	0.673
Use of Emerging Technologies	0.872	0.889	0.906	0.661
Feasibility Study	0.890	0.908	0.919	0.695
Competitive Advantage	0.864	0.871	0.903	0.651
Marketing and Sales	0.838	0.844	0.885	0.608
Branding	0.880	0.909	0.912	0.678
Technology Commercialization	0.851	0.853	0.894	0.627
Customer Experience and Demands	0.787	0.798	0.851	0.534
Export Strategy Formulation	0.835	0.859	0.883	0.604
Technological Capability	0.857	0.858	0.897	0.636
Market Development	0.867	0.872	0.904	0.652
Sustainable Production	0.894	0.904	0.921	0.701
Customer Satisfaction	0.817	0.828	0.873	0.581
Profitability	0.868	0.892	0.905	0.658
Networking	0.823	0.844	0.875	0.585
Market Needs Recognition	0.715	0.735	0.809	0.503
Technological Innovation	0.799	0.802	0.862	0.555
University Collaboration	0.923	0.930	0.942	0.765
Market Leadership	0.918	0.921	0.938	0.752

R^2 is a criterion used to connect the measurement model and the structural model in structural equation modeling and indicates the effect of an exogenous variable on an endogenous variable. It should be noted that the R^2 value is calculated only for endogenous constructs in the model, and its value is zero for exogenous constructs. This coefficient ranges from 0 to 1, and higher values indicate better explanatory power. Chin (1988) evaluated values close to 0.67 as substantial, values around 0.33 as moderate, and values near 0.19 as weak.

Table 3. Coefficient of Determination (R^2) Values

Endogenous Construct	R^2	Adjusted R^2
Product Standardization	0.280	0.276
Use of Emerging Technologies	0.293	0.289
Feasibility Study	0.294	0.290
Competitive Advantage	0.467	0.464
Marketing and Sales	0.431	0.428
Branding	0.431	0.428
Technology Commercialization	0.625	0.614

Export Strategy Formulation	0.269	0.265
Market Development	0.522	0.520
Sustainable Production	0.418	0.415
Customer Satisfaction	0.351	0.348
Profitability	0.521	0.518
Networking	0.135	0.130
University Collaboration	0.075	0.070
Market Leadership	0.396	0.392
Average R^2	0.367	—

The R^2 values obtained in Table 4 indicate a satisfactory fit of the structural model.

The most fundamental criterion for evaluating the relationships between constructs in the structural model is the significance of the t-statistic. If the t-value exceeds 1.96, it indicates that the relationship between constructs is statistically significant and confirms the research hypotheses at a 95% confidence level.

Table 4. t-Statistic Results for the Conceptual Model

Path	Path Coefficient	Standard Deviation (STDEV)	t-Statistic	p-Value	Result
Market Foresight → Technology Commercialization	0.273	0.086	3.166	0.002	Accepted
Technology Commercialization → Product Standardization	0.529	0.054	9.837	0.000	Accepted
Technology Commercialization → Use of Emerging Technologies	0.541	0.054	10.069	0.000	Accepted
Technology Commercialization → Feasibility Study	0.542	0.051	10.628	0.000	Accepted
Technology Commercialization → Competitive Advantage	0.683	0.049	13.846	0.000	Accepted
Technology Commercialization → Marketing and Sales	0.657	0.043	15.124	0.000	Accepted
Technology Commercialization → Branding	0.656	0.044	14.818	0.000	Accepted
Technology Commercialization → Export Strategy Formulation	0.519	0.060	8.583	0.000	Accepted
Technology Commercialization → Market Development	0.723	0.040	18.069	0.000	Accepted
Technology Commercialization → Sustainable Production	0.647	0.047	13.882	0.000	Accepted
Technology Commercialization → Customer Satisfaction	0.593	0.047	12.551	0.000	Accepted
Technology Commercialization → Profitability	0.722	0.040	18.026	0.000	Accepted
Technology Commercialization → Networking	0.368	0.066	5.542	0.000	Accepted
Technology Commercialization → University Collaboration	0.274	0.068	4.009	0.000	Accepted
Technology Commercialization → Market Leadership	0.629	0.053	11.801	0.000	Accepted
Customer Experience and Demands → Technology Commercialization	0.142	0.063	2.267	0.023	Accepted
Technological Capability → Technology Commercialization	0.447	0.064	6.958	0.000	Accepted
Market Needs Recognition → Technology Commercialization	0.103	0.075	1.376	0.169	Rejected
Technological Innovation → Technology Commercialization	0.016	0.070	0.230	0.818	Rejected

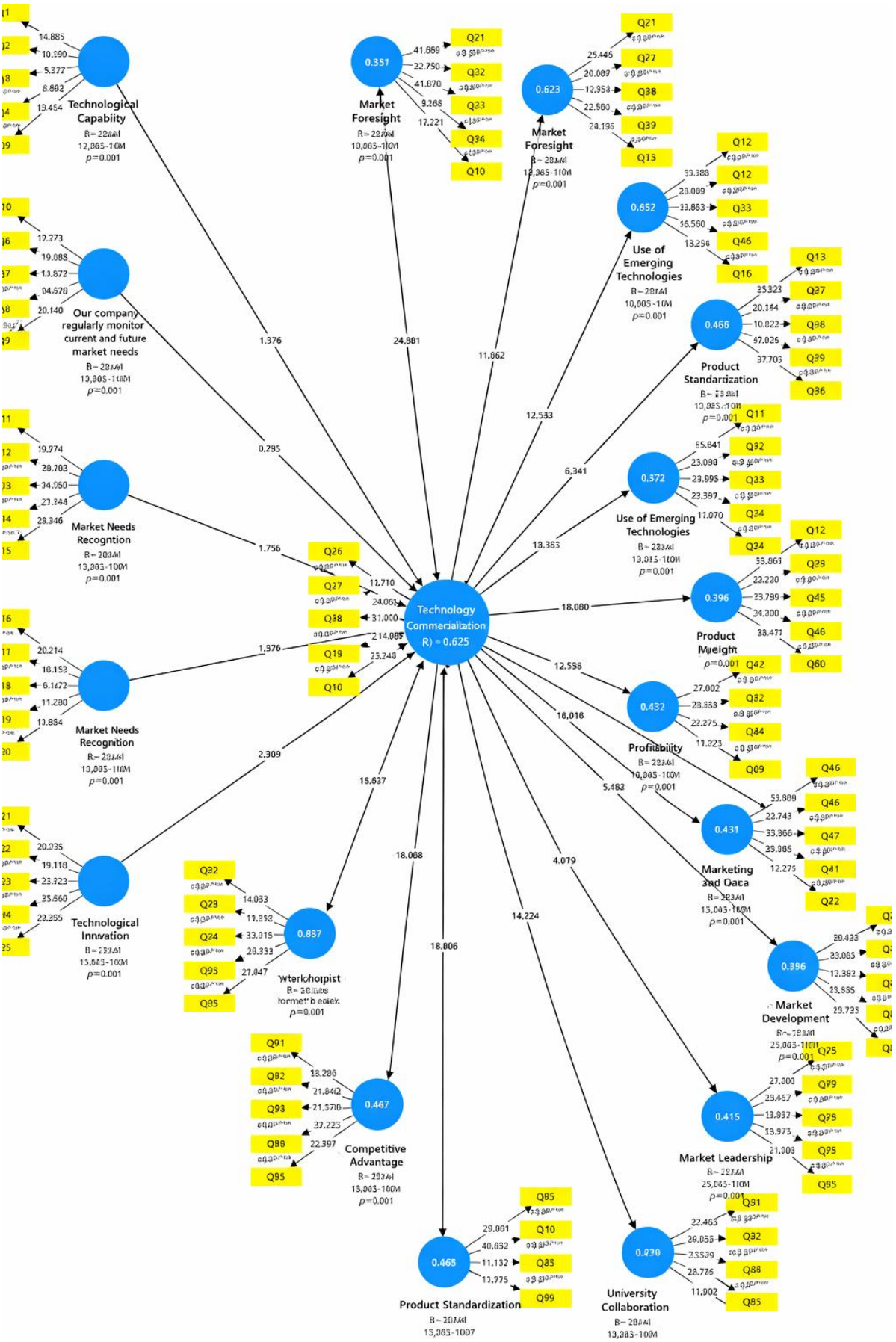

Figure 1. Significance Coefficients of the Structural Model

Discussion and Conclusion

The findings of this study provide empirical evidence regarding the key determinants of technology commercialization and their subsequent effects on organizational outcomes and strategic capabilities in technology-based and knowledge-based firms. The structural model results indicated that technological capability, market foresight, and customer experience and demands exert significant positive effects on technology commercialization, whereas market needs recognition and technological innovation did not demonstrate statistically significant effects. Furthermore, technology commercialization was found to significantly influence a wide range of organizational outcomes, including profitability, market development, customer satisfaction, sustainable production, competitive advantage, and market leadership, as well as strategic activities such as marketing and sales, branding, networking, university collaboration, product standardization, export strategy formulation, feasibility assessment, and the use of emerging technologies. These results highlight the central role of technology commercialization as a mediating and enabling mechanism that translates technological and market capabilities into tangible organizational performance and strategic positioning advantages.

One of the most important findings of this study is the significant positive effect of technological capability on technology commercialization. This finding confirms that organizations possessing advanced technological infrastructure, strong research and development capabilities, and the ability to adapt and upgrade technologies are more successful in transforming technological innovations into marketable products and services. This result is consistent with previous research emphasizing that technological capability is a fundamental driver of commercialization success because it enhances innovation performance, improves product quality, and enables firms to respond effectively to technological and market changes (9). Technological capability also strengthens organizational flexibility and supports the implementation of advanced technological solutions, which are essential for effective commercialization in dynamic technological environments (10). Moreover, strong technological capability enhances firms' ability to develop proprietary technologies, protect intellectual property, and maintain competitive advantage, thereby facilitating successful commercialization outcomes (3). These findings reinforce the argument that technological capability represents a foundational resource for commercialization success, particularly in knowledge-based companies operating in technology-intensive industries.

Another important finding of the study is the significant effect of market foresight on technology commercialization. This result suggests that organizations capable of anticipating future market trends, technological developments, and customer preferences are more effective in aligning their technological innovations with market opportunities. Market foresight enables organizations to reduce uncertainty, improve strategic decision-making, and enhance the effectiveness of commercialization strategies. This finding aligns with prior studies indicating that successful commercialization requires strategic alignment between technological innovation and anticipated market demand, as well as the ability to identify emerging opportunities and adapt commercialization strategies accordingly (1, 4). Organizations with strong market foresight capabilities can proactively develop technologies that address future market needs, thereby increasing the likelihood of successful commercialization and sustained competitive advantage. In addition, market foresight contributes to better resource allocation and strategic planning, allowing firms to invest in technologies with the highest commercialization potential (8).

The results also demonstrated that customer experience and demands significantly influence technology commercialization. This finding highlights the critical role of customer engagement and feedback in guiding technology development and commercialization decisions. Customer-driven commercialization strategies enable firms to develop products that align with customer expectations, improve product acceptance, and enhance market success. This finding is consistent with research emphasizing that customer involvement and market orientation are essential components of successful commercialization because they ensure that technological innovations meet real market needs and generate customer value (5, 11). Customer feedback provides valuable insights that can improve product design, enhance usability, and increase the commercial viability of technological innovations. Furthermore, customer-driven innovation strengthens customer relationships and enhances brand loyalty, thereby supporting long-term commercialization success and market competitiveness (12).

In contrast, the results indicated that market needs recognition and technological innovation did not have statistically significant direct effects on technology commercialization. This finding suggests that simply recognizing market needs or developing technological innovations may not be sufficient to ensure successful commercialization without complementary organizational capabilities and strategic alignment. This result can be interpreted in light of previous research indicating that commercialization success depends not only on technological innovation but also on the organization's ability to integrate technological innovation with strategic planning, market positioning, and commercialization execution processes (7). Technological innovation alone does not guarantee commercialization success if organizations lack the necessary infrastructure, strategic orientation, and commercialization capabilities required to bring innovations to market. Similarly, recognizing market needs may not lead to commercialization success unless organizations possess the technological and organizational capacity to develop and commercialize solutions that address those needs effectively (6). These findings highlight the importance of adopting a comprehensive and integrated approach to commercialization that combines technological capability, strategic foresight, and customer engagement.

Another key finding of the study is the significant impact of technology commercialization on organizational outcomes, particularly profitability and market development. This result confirms that successful commercialization directly contributes to financial performance by generating new revenue streams, increasing market share, and enhancing organizational competitiveness. This finding is consistent with prior studies demonstrating that technology commercialization plays a crucial role in improving firm performance by transforming technological innovations into economically valuable products and services (2, 16). Commercialization enables firms to capture value from technological innovations, improve financial sustainability, and achieve long-term growth. Moreover, commercialization enhances firms' ability to enter new markets, expand customer bases, and strengthen competitive positioning, thereby supporting organizational development and market expansion (13).

The study also found that technology commercialization significantly influences customer satisfaction, competitive advantage, sustainable production, and market leadership. These findings demonstrate that commercialization contributes to both operational and strategic performance by enabling firms to develop innovative products, improve production efficiency, and differentiate themselves from competitors. Commercialization enhances customer satisfaction by providing technologically advanced products that meet customer expectations and improve customer experiences. This finding aligns with research emphasizing that commercialization strengthens competitive advantage by enabling firms to develop unique products, improve product quality, and maintain technological leadership in competitive markets (15). Furthermore, commercialization contributes to

sustainable production by enabling firms to implement advanced technologies that improve efficiency, reduce costs, and enhance operational sustainability. These findings support the argument that technology commercialization is a critical driver of organizational competitiveness and long-term sustainability.

In addition to performance outcomes, the results showed that technology commercialization significantly influences strategic and organizational capabilities, including marketing and sales, branding, networking, university collaboration, product standardization, export strategy formulation, feasibility assessment, and the use of emerging technologies. These findings suggest that commercialization plays a transformative role in shaping organizational strategies and capabilities by enabling firms to integrate technological innovation with marketing, branding, and strategic development activities. This finding is consistent with research highlighting the importance of strategic alignment and organizational capabilities in achieving successful commercialization outcomes (14). University collaboration and networking facilitate knowledge transfer, enhance technological innovation, and improve commercialization effectiveness by providing access to scientific expertise and market networks (13). Moreover, commercialization encourages firms to adopt emerging technologies, improve product standardization, and develop export strategies, thereby enhancing their global competitiveness and market expansion potential (7). These findings highlight the strategic importance of commercialization as a catalyst for organizational transformation and innovation-driven growth.

Despite its contributions, this study has several limitations that should be considered when interpreting the findings. First, the study was conducted within a specific geographical context and focused on knowledge-based companies located in a science and technology park, which may limit the generalizability of the findings to other industries, regions, or organizational contexts. Second, the study employed a cross-sectional research design, which limits the ability to examine the dynamic and longitudinal nature of technology commercialization processes over time. Third, the use of self-reported questionnaire data may introduce potential biases, including respondent bias and subjective interpretation of commercialization performance and organizational capabilities. Fourth, although the study examined multiple factors influencing commercialization, other relevant factors such as organizational culture, financial resources, institutional support, and regulatory environments were not explicitly included in the model. Finally, the structural equation modeling approach, while robust, may not fully capture the complexity and dynamic interactions among commercialization determinants, particularly in rapidly evolving technological environments.

Future research should expand the scope of investigation by examining technology commercialization across different industries, sectors, and geographical regions to enhance the generalizability of the findings. Longitudinal studies are recommended to examine how commercialization processes evolve over time and how technological, organizational, and market factors influence commercialization success at different stages of the innovation lifecycle. Future research should also incorporate additional variables, such as organizational culture, leadership styles, financial resources, institutional support, and regulatory frameworks, to develop more comprehensive models of technology commercialization. Comparative studies between successful and unsuccessful commercialization cases could provide valuable insights into the critical success factors and barriers affecting commercialization outcomes. In addition, future research should explore the role of emerging technologies, digital transformation, and artificial intelligence in shaping technology commercialization processes and outcomes.

From a practical perspective, managers and policymakers should prioritize the development of technological capabilities as a fundamental prerequisite for successful commercialization. Organizations should invest in research

and development, technological infrastructure, and workforce skills to enhance their technological readiness and commercialization potential. Firms should also strengthen their market foresight capabilities by continuously monitoring market trends, analyzing customer needs, and aligning technological development with future market opportunities. Customer engagement should be integrated into the commercialization process to ensure that technological innovations meet market demands and achieve successful adoption. Furthermore, organizations should develop comprehensive commercialization strategies that integrate technological development with marketing, branding, networking, and strategic planning activities. Policymakers and innovation ecosystem stakeholders should provide institutional support, infrastructure, and collaboration opportunities to facilitate technology commercialization and support the growth and competitiveness of knowledge-based companies.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

All ethical principles were adheried in conducting and writing this article.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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