

Internationalization of technology-based firms: proposal and validation of a model for the Brazilian context

Internacionalización de empresas basadas en tecnología: propuesta y validación de un modelo para el contexto brasileño

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ABSTRACT

The internationalization of technology-based firms creates jobs, enhances competitiveness, and promotes market diversification. This study aims to propose and validate a theoretical model that addresses the key factors influencing the internationalization of Brazilian technology-based companies, specifically strategy, knowledge, resources, capabilities, and commitment, as well as the degree of internationalization achieved by these companies. The methodology identifies the main determinants of internationalization to develop a theoretical model representing the relationships between these factors and the degree of internationalization. The model was empirically validated through a survey with Brazilian firms affiliated with

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the Technological Innovation Park of São José dos Campos, located in the state of São Paulo, using multivariate analysis of primary data. The results indicate that the factors resources, capabilities and commitment, and knowledge, were decisive for successful internationalization. However, the factor strategy did not show a significant influence within the model, suggesting the need for future research into the role of this factor in the internationalization process. This research contributes by proposing a unique theoretical model for the internationalization of technology-based firms.

Keywords: Internationalization – Services – Technology – Technology-based firms.

RESUMEN

La internacionalización de empresas basadas en tecnología genera empleo, mejora la competitividad y fomenta la diversificación de mercados. Este estudio tiene como objetivo proponer y validar un modelo teórico que aborde los factores clave que influyen en la internacionalización de empresas brasileñas de base tecnológica, específicamente la estrategia, el conocimiento, los recursos, las capacidades y el compromiso, así como el grado de internacionalización alcanzado por dichas empresas. La metodología empleada identifica los principales determinantes de la internacionalización con el fin de desarrollar un modelo teórico que represente las relaciones entre estos factores y el grado de internacionalización. El modelo fue validado empíricamente mediante una encuesta aplicada a empresas brasileñas vinculadas al Parque de Innovación Tecnológica de São José dos Campos, ubicado en el estado de São Paulo, utilizando análisis multivariado de datos primarios. Los resultados indican que los factores recursos, capacidades y compromiso, junto con el conocimiento, fueron determinantes para una internacionalización exitosa. Sin embargo, el factor estrategia no mostró una influencia significativa dentro del modelo, lo que sugiere la necesidad de investigaciones futuras sobre el papel de este factor en el proceso de internacionalización. Esta investigación contribuye al campo al proponer un modelo teórico original para la internacionalización de empresas de base tecnológica.

Palabras clave: Internacionalización – Servicios – Tecnología – Empresas de base tecnológica.

INTRODUCTION

Technology-based firms are defined, according to the Organisation for Economic Co-operation and Development (OECD), as technology-intensive industries operating across various sectors, whether in manufacturing or not, based on their technological intensity (Hatzichronoglou, 1997). These firms can be ranked according to their spending on research and development (R&D) relative to their revenue (Bolzani et al., 2021; Colombo & Grilli, 2005).

According to the study *Panorama of the Technology-Based Industry*, published by the Brazilian organization SEBRAE (2024), there are more than 46,000 firms with this profile in the country. Microenterprises represent 60% of the total (27,600 firms), followed by small enterprises at 26% (12,000 firms), and individual microentrepreneurs at 14% (6,400 firms). Regarding regional distribution, the state of São Paulo accounts for 30% of the total, corresponding to 13,800 technology-based firms operating in the region.

These companies are commonly found in innovation environments such as science and technology parks, which aim to promote a culture of innovation, enhance competitiveness, and increase business capability. This is achieved through knowledge and technology transfer to foster regional wealth creation (Audy & Piqué, 2016).

Technology parks offer services such as training, business incubation, and acceleration programs, fundraising for R&D projects, and networking opportunities. One of their contributions is supporting the international expansion of companies, helping them extend their reach beyond their country of origin. This international involvement often results from strategic decisions that include identifying products and services suitable for foreign markets (Johanson & Vahlne, 1990; Maçães & Dias, 2001). Thus, internationalization becomes a critical process for enhancing competitiveness.

Encouraging the strategic internationalization of technology-based firms reinforces the role of innovation ecosystems as drivers of economic development. Accessing international markets through structured processes and measurable outcomes strengthens the innovations developed within these ecosystems.

For technology-based firms, finding ways to support their business models, especially by promoting lean internationalization (Neubert, 2017) improves outcomes and positively influences their growth, creating jobs and generating income for society.

Therefore, this study aims to identify, through a review of the literature, the

key factors that contribute to the internationalization of technology-based firms. A theoretical model was proposed and validated to explore the relationships between these factors and the degree of internationalization among such companies in the Brazilian context, which was based on multivariate analysis of primary data.

Although several studies have examined the internationalization of technology-based firms, few have addressed the main determining factors within a single model using a quantitative approach specifically focused on Brazilian companies. Therefore, this study makes a meaningful contribution to literature on the subject.

2. LITERATURE REVIEW

The literature typically seeks to analyze the path of internationalization based on a firm's profile, challenges, competencies, priorities, and potential outcomes (Andersson & Evangelista, 2006). Many studies aim to understand Brazil's scientific production on the topic of business internationalization by surveying journals and graduate-level publications, examining the particularities of this body of work (Gomes, Oliveira, & Vieira, 2011; Ribeiro, 2022; Santos Junior, Stocker, & Abib, 2021).

Historically, theories from International Relations, Foreign Trade, and Internationalization studies have evolved alongside new business models in the international market, supporting theoretical development and offering tools that enable firms to navigate the internationalization process successfully.

The Uppsala model, developed in the 1970s, views a company's entry

into the international market as stemming from its established production chain (Johanson & Vahlne, 2009; Knight & Liesch, 2016). This model emphasizes the need for support from local networks to generate business opportunities and to gain access to knowledge about international markets (Neubert, 2017).

Born-global firms, on the other hand, begin their internationalization early in their life cycle (Rasmussen & Tanev, 2015). These firms typically target international markets with rapid entry, low costs, and minimal risks, adopting export strategies through either direct sales or local intermediaries (Neubert, 2017; Tanev, 2012). Their managers exhibit an international outlook and orientation, adopt differentiation strategies, and use information technology tools to segment customers and communicate globally with partners.

International new ventures, meanwhile, are characterized by intangible assets based on knowledge that they aim to commercialize (Lehrer & Almor, 2021). In addition to exporting or engaging in accidental internationalization, these firms may pursue internationalization through technology licensing or by attracting international investment (Morano et al., 2023).

Lean global startups create niche markets with innovative technologies using new business models that include internationalization from the outset. These startups focus on eliminating waste in non-value-creating activities (Blank, 2013; Neubert, 2017; Rasmussen & Tanev, 2015), forming hypotheses for entering international markets through prototypes and minimum viable products, which they validate through a lean internationalization process (Neubert, 2018).

From the reviewed literature, several common factors emerge as influential in the internationalization process: strategy (Andersson & Evangelista, 2006; Coudonaris, 2018; Lehrer & Almor, 2021; Mações & Dias, 2001; Neubert, 2017; Taylor et al., 2021; Weerawardena et al., 2007), knowledge (Andersson & Evangelista, 2006; Coudonaris, 2018; Johanson & Vahlne, 2009; Lehrer & Almor, 2021; Neubert, 2017; Schwens & Kabst, 2011; Taylor et al., 2021), resources (Andersson & Evangelista, 2006; Coudonaris, 2018;

Elo et al., 2018; Loane et al., 2007; Neubert, 2017; Rasmussen & Tanev, 2015), and capabilities and commitment (Ciravegna et al., 2014; Coudonaris, 2018; Gao et al., 2021; Johanson & Vahlne, 2009; Lehrer & Almor, 2021; Neubert, 2018; Rasmussen & Petersen, 2017; Schwens & Kabst, 2011; Taylor et al., 2021).

Strategy involves identifying products and services to be offered internationally, selecting target markets and entry modes, and establishing a presence abroad (Mações & Dias, 2001). It also includes using various tools to track and monitor international objectives (e.g., an internationalization plan). For lean global startups, the ability to validate solutions quickly and at low cost in foreign markets is a key strategic element. Knowledge refers to the information a firm collects about its target markets, including cultural nuances, negotiation practices, and internationalization procedures (Andersson & Evangelista, 2006; Coudonaris, 2018; Taylor et al., 2021). Resources encompass the human, financial, and technological assets available to the firm for supporting its international expansion (Loane et al., 2007; Neubert, 2017; Rasmussen & Tanev, 2015). Capabilities and commitment are related to the firm's ability to create market opportunities, attract new customers, and build partnerships through local networks, as well as the consistent execution of international strategies

(Ciravegna et al., 2014; Johanson & Vahlne, 2009; Lehrer & Almor, 2021).

Finally, all these factors are associated with the degree of internationalization, which reflects the outcomes of the internationalization process. These outcomes may include export sales, partnerships with local distributors, technology licensing, and the attraction of foreign direct investment, among others. Therefore, the four main factors identified as influencing the internationalization of technology-based firms are: (i) Strategy, (ii) Knowledge, (iii) Resources, and (iv) Capabilities and Commitment.

Based on these, the following research hypotheses are proposed:

H1: Strategy positively influences the firm's Degree of Internationalization;

H2: Knowledge positively influences the firm's Degree of Internationalization;

H3: Resources positively influence the firm's Degree of Internationalization;

H4: Capabilities and Commitment positively influence the firm's Degree of Internationalization.

3. METHODOLOGY

A quantitative study was conducted to collect primary data on the factors influencing the internationalization of Brazilian technology-based firms (Sampieri et al., 2013). Based on the literature review presented in the previous section, it was possible to define the key determinants, which were operationalized into constructs used to validate the proposed theoretical model. These constructs represent the four main factors that influence the internationalization of technology-based firms: strategy, knowledge, resources, and capabilities and commitment, as well as the firm's degree of internationalization.

For each construct, corresponding statements were developed for the research questionnaire, as presented in Table 1. The questionnaire was used due to the unavailability of other sources to supplement the information, and studies with startups often rely solely on self-reported data in the literature. The survey instrument, composed of ad hoc statements subjected to face validation, employed a seven-point Likert-type scale (1 = strongly disagree to 7 = strongly agree) to measure respondents' level of agreement (Silva et al., 2014; Meireles, 2020; Oliveira Junior et al., 2016). The questionnaire was administered to technology-based firms associated with the Technological

Innovation Park of São José dos Campos, located in the state of São Paulo. These firms operate in sectors such as aerospace, defense, information technology, artificial intelligence, and biotechnology, and collaborate with universities, research centers, and government

agencies to foster innovation. They are also involved in internationalization projects or processes. The research project was submitted to and approved by the Research Ethics Committee.

Table 1. List of constructs and statements

Construct	Statement
Internationalization Strategy (IS)	IS1 - The internationalization process is present in the strategic planning of the firm I work for and/or in its business plan. IS2 - The firm I work for is aware of its competitive advantages in the international market it accesses or seeks access. IS3 - The firm I work for has an internationalization plan. IS4 - The firm I work for, to access and grow in the international market, chose to follow a Brazilian client that operates outside the country. IS5 - The firm I work for defined how, when, and which international market to access based on the existence of potential clients outside the country.
Knowledge (KN)	KN1 - The firm I work for is familiar with international markets in its industry. KN2 - The firm I work for knows the culture of the international markets in which it operates. KN3 - The firm I work for is familiar with the main internationalization processes. KN4 - The firm I work for knows the main Brazilian and international laws and rules for internationalization. KN5 - The firm I work for is aware of its potential competitors and international clients, as well as the rules for international contracts, taxation, and other related matters.

Resources (RE)	<p>RE1 - The firm I work for has an experienced professional and/or team dedicated to international sales and partnerships.</p> <p>RE2 - The firm I work for has a team dedicated to internationalization activities with knowledge of languages other than Portuguese.</p> <p>RE3 - The firm I work for has an annual budget dedicated to internationalization activities.</p> <p>RE4 - The firm I work for uses technological tools (such as social media, for example) to communicate with customers and potential international partners.</p> <p>RE5 - The firm I work for invests in the resources necessary to internationalize.</p>
Capabilities and Commitment (CC)	<p>CC1 - The firm I work for has communication and marketing materials (such as catalogs, websites, and pitch decks) in languages other than Portuguese.</p> <p>CC2 - The firm I work for frequently participates in international events (such as fairs, business rounds, and trade missions).</p> <p>CC3 - The firm I work for regularly interacts with customers, suppliers, and potential partners in the international market.</p> <p>CC4 - The firm I work for has relationships with export promotion agencies, embassies, and chambers of commerce, which can connect it to international markets.</p> <p>CC5 - The firm I work for conducts prospective activities through communication on multiple channels (internet, trade fairs, for example) to attract potential customers.</p>
Degree of Internationalization (DI)	<p>DI1 - The firm I work for has revenues from direct or indirect international sales through international partners (distributors, representatives, multinationals, etc.).</p> <p>DI2 - Based on international experiences, the firm I work for has customers in other countries.</p> <p>DI3 - Based on international experiences, the firm I work for has adapted or created products and services aimed at gaining new international customers.</p> <p>DI4 - The firm I work for obtains or has obtained international results through exports, licensing, and/or collaboration with partners in the international market (franchises, distributors, for example).</p> <p>DI5 - The firm I work for has achieved international results through the establishment of offices in other countries, partnerships in R&D, foreign direct investment, and/or joint ventures.</p>

Source: Elaborated by the authors.

The questionnaire also included additional information about the respondents and their firms: (1) the respondents' role within the company; (2) length of experience in the role (in years); (3) history of previous international experience (in years); (4) industry sector (with selectable options); and (5) firm size (based on employee count ranges).

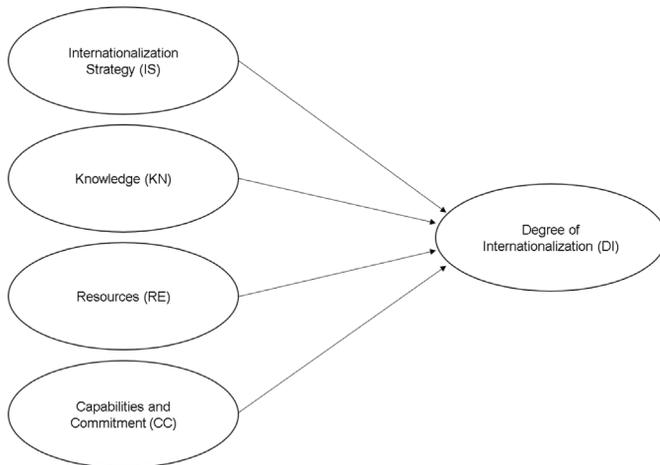
At least one statement from each construct was reversed to the negative meaning in the online presentation to minimize the common method bias related to how respondents completed the questionnaire (Podsakoff et al., 2003). The statements in the questionnaire were previously submitted to experts, researchers with

doctoral degrees in the field of internationalization of technology-based companies, for validation.

To test the four proposed hypotheses, a theoretical model (Figure 1) was developed, incorporating the constructs and their relationships. This model was validated using structural equation modeling (Hair et al., 2009; Hair et al., 2019; Rivera et al., 2018).

The independent variables are strategy, knowledge, resources, and capabilities and commitment related to internationalization. The dependent variable is the firm's degree of internationalization.

Figure 1. Proposed theoretical model



Source: Elaborated by the authors.

The questionnaire was sent to 148 technology-based firms (respondents) affiliated with the Technological Innovation Park, selected for convenience. The sample size was determined based on a five-to-one ratio of respondents to the number of questionnaire items (Table 1), as recommended by Hair et al. (2009).

Respondents were required to be over 18 years of age and to hold a leadership, managerial, or collaborative role within a technology-based firm, preferably with involvement in the company's internationalization project or process. Participation was voluntary and anonymous.

In addition to validating the theoretical model presented in Figure 1, which examines cause-and-effect relationships related to the internationalization of technology-based firms, the survey also included a demographic analysis of the sample (e.g., company size, respondent role), presented using descriptive statistics (Hair et al., 2009).

A composite confirmatory analysis (Hair et al., 2020) was first conducted to assess the reliability and validity of the scales used to measure the constructs included in the model shown in Figure 1.

Among the indicators used to evaluate data adequacy for composite confirmatory analysis, average

variance extracted (AVE) and construct reliability (CR) stand out. AVE assesses the convergent validity of a set of items representing a construct, while CR measures the internal consistency of the observed variables corresponding to a construct (Hair et al., 2019). AVE values of 0.5 or higher and CR values of 0.7 or higher indicate acceptable convergent validity and internal consistency for the measurement scales (Hair et al., 2019). Discriminant validity was also tested to ensure that the items in the questionnaire accurately measured their intended constructs and not others. This was assessed using both cross-loading and the Fornell-Larcker criterion.

Following the composite confirmatory analysis, structural equation modeling was employed to evaluate whether the paths proposed in the theoretical model (Figure 1) demonstrated cause-and-effect relationships among the variables (Hair et al., 2019). This analysis was based on path coefficients (β) (Hair et al., 2019), their statistical significance, and the strength of the causal relationships. The model's explanatory power was evaluated using the coefficient of determination (R^2), where higher R^2 values indicate a greater proportion of the variance in the degree of internationalization explained by the model's antecedent constructs.

4. ANALYSIS AND DISCUSSION OF RESULTS

The sample is described in Table 2, which presents the respondents' positions within their firms; Table 3, which details their years of experience in those roles; and Table 4, which reports on their years of international experience. Table 5 displays the size of the companies in the sample, while Table 6 shows the industry sector in which they operate.

As shown in Table 2, most respondents hold high-level positions

within their organizations, primarily as Managers, Directors, or CEOs. In the "Other" category, respondents reported roles such as Senior Advisor, Commercial Agent, Head of Global Strategic Partnerships, COO, Consulting Partner, Supervisor, and Founder. These results confirm that the questionnaire successfully reached its intended audience, i.e., individuals responsible for or directly involved in the firm's internationalization processes.

Table 2. Respondents' Position in the Company

Position	Frequency	Percentage (%)
Assistant	2	1
Analyst	3	2
Coordinator	2	1
Manager	23	16
Director	41	28
CEO	62	42
Other	14	10
Total	147	100

Source: Elaborated by the authors.

The fact that 39% of respondents have been in their current role for over 15 years, as shown in Table 3, reinforces the involvement of an experienced target audience.

Table 3. Years of Experience in the Position

Ranges	Frequency	Percentage
Less than 1 year	7	5
Between 1 and 3 years	26	18
Between 4 and 6 years	21	14
Between 7 and 9 years	10	7
Between 10 and 12 years	11	7
Between 13 and 15 years	15	10
Over 15 years	57	39
Total	147	100

Source: Elaborated by the authors.

Table 4 presents the years of the respondents' previous international experience. Approximately 30% of the respondents reported having no international experience. However, 70% of the group indicated that they had some experience, which may have contributed to the creation or development of the firm's internationalization activities.

Table 4. Years of Previous International Experience

Ranges	Frequency	Percentage
No experience	44	30
Less than 1 year	12	8

Between 1 and 3 years	19	13
Between 4 and 6 years	20	14
Over 7 years	52	35
Total	147	100

Source: Elaborated by the authors.

Table 5 shows a considerable number of respondents representing micro and small companies, which corroborates the profile of the business ecosystem in a technology park.

Table 5. Firm Size

Size	Frequency	Percentage
MEI (1)	5	4
Micro (2)	44	30
Small (3)	56	38
Medium (4)	24	16
Large (5)	18	12
Total	147	100

Note. 1 = Individual microentrepreneur; 2 = Commerce/Services: up to 9 employees - Industry: up to 19 employees; 3 = Commerce/Services: 10 to 49 employees - Industry: 20 to 99 employees; 4 = Commerce/Services: 50 to 99 employees - Industry: 100 to 499 employees; 5 = Commerce/Services: 100 or more employees - Industry: 500 or more employees. Source: Elaborated by the authors.

Table 6 indicates the firms' main sector/industry and highlights the Aerospace and Defense sector and the Information and Communication Technology sector. In the "Other" option, the Education and Financial sectors were mentioned, despite not having been previously mapped before the questionnaire was applied,

indicating a potential interest in internationalization among the firms.

Table 6. Industry Sector

Sector	Frequency	Percentage
Aerospace and Defense	64	23
Information and Communication Technology	65	24
Agribusiness	22	8
Automotive	21	8
Logistics	16	6
Health	13	5
Biotechnology	8	3
Renewable Energy	16	6
Oil and Gas	15	5
Creative Economy	2	1
Fashion	1	0
Outros	29	11
Total	272(1)	100%

Note. 1 = This item allowed multiple responses

Source: Elaborated by the authors.

Harman's one-factor test was performed to verify whether a single latent factor would be responsible for all the indicators used (Podsakoff et al., 2003) to assess the sensitivity of

the analyses performed to common method bias (Chin et al., 2012; Fuller et al., 2016; Kock, 2015; Podsakoff et al., 2003). The test shows whether the variance generated by the common

method, derived from systematic error in data collection, represents a considerable risk to the analytical procedures developed. The results showed no risk of common method variance since the single factor was able to extract a value less than 50% of the total variance explained.

An analysis was performed before executing the model to ensure the reliability and validity of the data collection instruments, using confirmatory composite analysis (CCA) (Hair et al., 2020).

Therefore, it was possible to ensure that the factor loadings were adequate and there was a minimum degree of correspondence between the questionnaire statements (measurable variable) and the construct (latent variable) that such statements were intended to measure.

According to Hair et al. (2019), Table 7 shows that all variables meet the acceptance criteria ($CR \geq 0.7$; $AVE \geq 0.5$). Therefore, it can be considered that the variables meet the guidelines proposed in the literature.

Table 7. Composite Reliability and Convergent Validity

Constructs	Composite Reliability (CR)	Average Variance Extracted (AVE)
Capability and Commitment	0.866	0.866
Knowledge	0.924	0.924
Strategy	0.890	0.890
Degree of Internationalization	0.892	0.892
Resources	0.919	0.919

Source: Elaborated by the authors.

To determine whether each variable is associated with a single factor or if it loads significantly onto multiple constructs, the discriminant validity of the scales was assessed. Factor loadings above 0.708 were obtained,

as recommended, indicating that each construct explains more than 50% of the variance of its respective measurable variable, thereby providing acceptable item reliability (Hair et al., 2019).

During the analysis, the statements IS2, IS4, RE3, CC4, and DI1 (see Table 1) did not meet the minimum acceptable factor loading threshold of 0.708. As they did not contribute to the model's validity, they were removed from the final sample used in the structural equation modeling (Hair et al., 2019).

All remaining items showed higher factor loadings for their respective constructs than for other constructs,

as indicated in bold in Table 8, thereby satisfying discriminant validity using the cross-loading method (Ringle et al., 2014). Additionally, except for one item (KN5), all measurable variables had loadings above 0.708, as recommended by the literature (Hair et al., 2019). Despite KN5 falling slightly below this threshold, it was retained in the model based on satisfactory results in subsequent analyses (composite reliability and convergent validity).

Table 8. Discriminant validity of the scales – Cross-loading

Acronym	Capability and Commitment	Knowledge	Strategy	Internacionalization	Resources
CC1	0.831	0.695	0.66	0.655	0.698
CC2	0.817	0.576	0.534	0.627	0.657
CC3	0.832	0.620	0.628	0.647	0.743
KN1	0.657	0.871	0.737	0.674	0.719
KN2	0.669	0.885	0.658	0.739	0.715
KN3	0.722	0.918	0.684	0.714	0.745
KN4	0.704	0.859	0.65	0.695	0.704
KN5	0.419	0.656	0.458	0.473	0.518
IS1	0.534	0.600	0.842	0.534	0.593
IS3	0.646	0.619	0.872	0.617	0.673

IS5	0.69	0.727	0.849	0.659	0.754
DI2	0.689	0.637	0.548	0.876	0.694
DI3	0.664	0.76	0.721	0.828	0.77
DI4	0.629	0.605	0.525	0.829	0.618
DI5	0.564	0.574	0.517	0.748	0.591
RE1	0.736	0.716	0.688	0.749	0.910
RE2	0.772	0.706	0.731	0.750	0.883
RE4	0.627	0.665	0.600	0.595	0.782
RE5	0.766	0.713	0.704	0.714	0.859

Source: Elaborated by the authors.

Table 9 shows an additional way to verify the discriminant validity of the scales using the Fornell-Larcker criterion. This approach compares the square root of the average variance extracted (AVE) with the Pearson correlation between the scales representing the constructs. If the correlation is lower than the square root of the AVE, there is discriminant validity (Fornell & Larcker, 1981).

Table 9. Discriminant validity of the scales – Fornell-Larcker method

Constructs	1.	2.	3.	4.	5.
1. Capability and Commitment	0.827				
2. Knowledge	0.763	0.843			
3. Strategy	0.736	0.763	0.855		
4. Degree of Internacionalization	0.778	0.791	0.711	0.822	
5. Resources	0.846	0.813	0.794	0.820	0.860

Note: the square root of the AVE of each construct is found on the diagonal, while the other values are the correlations between the constructs. Source: Elaborated by the authors.

Table 9 shows that there is no discriminant validity between the constructs Resources and Capability and Commitment, as the correlation between them was 0.846 (exceeding the threshold of 0.827 required for discriminant validity). However, since the analysis of indicators is conducted jointly, all variables were retained in the model. The marginal gain from removing the Resources construct was deemed negligible (a difference of only 0.019). Furthermore, organizational models in the early stages of growth (scale-up) often have similar concepts across different constructs; technology-based companies may have similar practices and perceptions due to ecosystem influence; and theoretically distinct items may be mistakenly interpreted by the respondent as similar. Moreover, the analysis of cross-loadings, another indicator of discriminant validity, showed satisfactory results, as did the AVE and CR values.

The results of the structural model, including the estimated path coefficients, standard deviations, and p-values (significance levels) for each path, are presented in Table 10. These results indicate that the constructs Capability and Commitment, Knowledge, and Resources exert a positive and significant influence on Degree of Internationalization. The same was not observed for the Strategy construct.

According to Hair et al. (2019), the path coefficient (β) indicates the strength of standardized relationships between constructs. Values closer to -1 or 1 show stronger relationships. With $\beta = 0.030$ and $p = 0.736$ (>0.05), it was confirmed that the construct Strategy does not have a statistically significant influence on Degree of Internationalization.

This result, based on a sample of 148 firms associated with the Technological Innovation Park, highlights a key issue in the international competitiveness of this group, given that the literature stresses the importance of strategy in the internationalization process.

In this context, strategy is understood as a planned approach to entering a target market, aligned with the organization's mission and overarching goals (Camargos & Dias, 2003; Maçães & Dias, 2001). When viewed as a plan, several paths are available (Maçães & Dias, 2001), especially when internationalization is integrated into the company's strategic objectives. These paths may include identifying suitable products for international markets, selecting target regions, and choosing the most appropriate modes of entry, ranging from exporting (Coudonaris, 2018), following key clients and licensing technology (Taylor et al., 2021) to making foreign direct investments (Lehrer & Almor, 2021).

Considering that 70% of the respondents were senior leaders (42% were CEOs and 28% were Directors) and thus directly responsible for corporate strategy (Schwens & Kabst, 2011), the lack of significance given to Strategy in the internationalization of the studied firms may indicate that strategies are not being properly developed. Alternatively, it may suggest that internationalization is not being prioritized in corporate strategies, which could result in outcomes below the firms' potential. Another possible explanation for this finding could be that the strategies developed

by the companies may not be well communicated to the entire team involved in the internationalization processes, causing this discrepancy between what the literature indicates and what was observed among the companies surveyed.

The constructs Knowledge ($\beta = 0.308$, S.D. = 0.081, $p < 0.001$) and Resources ($\beta = 0.372$, S.D. = 0.118, $p = 0.002$) showed the strongest positive and significant influences on Degree of Internationalization, followed by Capability and Commitment ($\beta = 0.207$, S.D. = 0.097, $p = 0.033$).

Table 10. Path Coefficient

Constructs	Path Coefficient	SD	p-Value
Capability and Commitment	0.207	0.097	0.033
Knowledge	0.308	0.081	<0.001
Strategy	0.030	0.079	0.736
Resources	0.372	0.118	0.002

Source: Elaborated by the authors.

Lastly, the coefficients of determination R^2 (0.730) and adjusted R^2 (0.722) confirm the model's strong explanatory power. In other words, 73% of the variance in internationalization outcomes can be explained by the constructs Capability and Commitment, Knowledge, and Resources.

The remaining 27% is likely attributable to other factors not explored in this study.

5. CONCLUSION

The main objective of this study was to identify, based on the literature, the key factors that contribute to the internationalization of technology-based firms. This was accomplished by proposing and validating, through multivariate data analysis, a theoretical model that outlines the relationships between these factors and the degree of internationalization of these firms.

To achieve this objective, a quantitative approach was adopted, involving the administration of a survey questionnaire to technology-based firms associated with the Technological Innovation Park of São José dos Campos, São Paulo. The data collected were analyzed using structural equation modeling to validate the proposed theoretical model. The model was successfully validated, quantitatively confirming that the identified constructs are significant determinants of the internationalization of these firms.

The academic contributions of this study enhance the understanding of the internationalization process of technology-based firms, particularly in the Brazilian context. By addressing the main influencing factors in an integrated and quantitative manner, the study validates the proposed variables within a single theoretical model and offers insights into the relevance

and impact of these factors on internationalization. Its application to a Brazilian sample adds further value to the existing literature.

During this research, some limitations and directions for future investigation were identified. For instance, the statements developed to capture the constructs of Resources and Capabilities and Commitment may have been conceptually similar and deserve attention in future works. Furthermore, future studies could explore other factors that impact firms' internationalization, which were not examined in this study.

Another limitation concerns the influence of cultural and local factors, which are critical for achieving success in international markets and require further exploration. The predominance of companies in the aerospace technology sector may limit the generalizability of the results. However, to mitigate this, the questionnaire was developed with items that would allow for the collection of broader information, encompassing other contexts.

Lastly, the lack of significance of the Strategy factor in predicting successful internationalization based on the responses from firms affiliated with the Technological Innovation Park opens new avenues for research

and practical action. This result is particularly notable, given that the reviewed literature consistently identifies Strategy as a critical success factor in internationalization. This opens opportunities for new research that seeks to identify possible causes for what was found: communication problems, lack of strategy development, ecosystem influence, among others.

History of the article

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Declaration of authorship roles

Mariana Gomes: Conceptualization - Data curation - Investigation - Methodology - Project administration - Resources - Supervision - Validation - Visualization - Writing – original draft.

Alcides Barrichello: Formal analysis - Methodology - Project administration - Supervision - Validation - Visualization - Writing – review & editing.

Emerson Gomes dos Santos: Methodology - Project administration - Supervision - Validation.

Rogério Scabim Morano: Conceptualization - Methodology - Project administration - Supervision - Validation - Visualization - Writing – review & editing.

Declaration of conflict of interest

The authors declare that there are no conflicts of interest that could have influenced the performance of this research or the preparation and publication of this article.

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