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An Assessment of Performance Drivers in Knowledge-Intensive Entrepreneurial Firms: The Roles of Knowledge Management and Policy Support

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1. INTRODUCTION

Entrepreneurial ventures with high growth potential in the most diverse sectors and contexts have been the focus of attention of academics and professionals (Liu et al., 2022; Vedula & Kim, 2019). Knowledge-intensive entrepreneurial firms (KIE) represent a core part of this group of companies (Czarnitzki & Delanote, 2013). KIE can be defined as new innovation-driven firms that use a significant intensity of knowledge in their business activities, creating, disseminating, and using this knowledge with new products and technologies (Malerba & McKelvey, 2020). This type of company drives economic growth and creates value in the regional ecosystem by playing a pivotal role in building innovative capabilities that spillover to other agents (Acs et al., 2017; Gronning, 2014; Liu et al., 2022).

Interest in the success of such companies has triggered a policy focus oriented towards the 'quality' (rather than quantity) of entrepreneurial ventures to be supported by dedicated initiatives (Acs et al., 2017; Vedula & Kim, 2019). Thus, several governmental programs have emerged with the goal of promoting high-quality entrepreneurship, capable of improving market dynamism (Colombelli et al., 2020; Kantis et al., 2020). However, due to the scarcity of public resources to support entrepreneurship, selecting companies to invest in is critical, as the selection process often falls short in identifying the most promising ventures, thus leading to lackluster outcomes from such policy initiatives (Brown & Mason, 2014; Fischer et al., 2022; Shane, 2009). That is why a better comprehension of performance drivers in KIE firms can serve the purpose of informing entrepreneurs and policymakers alike.

In the current competitive environment characterized by innovation, quality, and rapid and continuous development, the high performance of companies is linked to well-structured knowledge management (Ferreira et al., 2020), especially for KIE (Marques Júnior et al., 2020). In this context, technical knowledge presents itself as an essential variable, as it forms the basis for the development of technologies and innovations (Bock et al., 2018; Paoloni et al., 2020; Temouri et al., 2020). Technical Knowledge comprises the knowledge accumulated by the entrepreneur and his employees. It is essential not only for high performance but also for the very survival of these nascent ventures – exposed to substantial risks *vis-à-vis* their innovation-driven nature (Adams et al., 2016; Gimenez-Fernandez et al., 2020). Another critical variable for the high performance of KIE is Strategic Knowledge Management, which is a systematic process of managing and activating organizational knowledge in favor of the company's objectives (Abubakar et al., 2019). Employees acquire and consolidate the necessary knowledge, promoting strategic thinking skills and creating competitive advantages for the company (Laihonen & Mäntylä, 2018; Venkitachalam & Willmott, 2017). Thus, the strategic management of knowledge is linked to structuring organizational systems to organize and promote technical knowledge (Mukhtarova et al., 2019).

The complexity involved in knowledge management processes for innovative companies makes it difficult to understand the phenomenon, and the literature has not yet made significant progress in this domain (Audretsch et al., 2020). Thus, conspicuous gaps remain concerning our comprehension on how successful KIE ventures operate and what are their main drivers of superior performance (Brown & Mason, 2014; Fischer et al., 2022). In this context, our research question can be stated as follows: What are the influences of technical knowledge and strategic knowledge management on the performance of knowledge-intensive entrepreneurial companies? Our objective is to provide a comprehensive perspective on the determinants and configurations that lead to high KIE performance based on knowledge management indicators from the firm level. Additionally, we verified differences between

selected and non-selected KIE in small companies' public innovation research initiatives. Such a complementary perspective sheds light on the role played by policy initiatives in supporting these ventures.

The present study has as its research object companies that submitted projects to the Innovative Research in Small Businesses (PIPE) program, which is a support program for micro, small and medium KIE in the State of São Paulo, Brazil. This initiative is analogous to the SBIR Program in the United States, nurturing innovation-driven undertakings in nascent ventures. The existing literature on the dynamics of knowledge management in KIE is mainly focused on developed markets, and research in a developing country context remains scarce (Mukhtarova et al., 2019). We expect our approach to help filling this gap, particularly considering that entrepreneurship policy requires evidence-based guidance for its socioeconomic specificities, instead of simply emulating examples from highly dissimilar entrepreneurial ecosystems (Kantis et al., 2020; Mátyás et al., 2019).

Accordingly, our research offers theoretical and practical contributions by providing an original perspective on the relationships between knowledge management and the performance of KIE in a developing country. We combined symmetric and asymmetric techniques using a multi-method approach, giving greater robustness to the results. Results confirmed the positive influence of technical knowledge and strategic knowledge management on KIE performance. Additionally, we confirmed the positive moderating effect of technical knowledge on the relationship between strategic knowledge management and KIE performance. We also have identified some relevant insights on the group differences in the relationships between selected and non-selected companies in the PIPE program. We have also identified six different configurations of knowledge management indicators that lead to high levels of performance, highlighting the importance of qualified labor, entrepreneur education, strategic R&D planning, and public initiatives to support innovation. These features offer relevant contributions on the heterogeneous trajectories established by KIE ventures in order to reach superior outcomes.

After this introductory section, the article is structured as follows: Section 2 explores key concepts and elements associated with KIE performance, strategic knowledge management, and technical knowledge. Section 3 presents the methodological approach. Section 4 outlines the empirical results. Section 5 brings our discussions and derives key implications from our assessment. Section 6 concludes with final remarks, limitations and avenues for future research.

2. THEORETICAL BACKGROUND

2.1. Knowledge Components of KIE I: Technical Knowledge

Companies' body of technical knowledge is an essential aspect of innovation, as this knowledge is incorporated into the routines and capabilities of firms, enabling the development of new technologies, products, and services and, consequently, organizational growth (Bock et al., 2018; Paoloni et al., 2020; Tang & Murphy, 2012; Temouri et al., 2020). In the case of KIE, the accumulation of technical knowledge is key both to achieving superior performance levels and for the survival of businesses due to the innovative orientation of firms, an aspect that entails significant levels of risk and uncertainty (Adams et al., 2016; Agarwal & Shah, 2014; Andersson & Lööf, 2012).

The technical basis of KIE is associated with some central elements. The first one is the formation of the founding entrepreneur, responsible for the innovative business. In this case, the higher the level of human capital and knowledge, the greater the chances of maintaining innovation as the basis of routines and ideas (Boccardelli & Magnusson, 2006; Marques Júnior et al., 2020; Protogerou et al., 2017). The founder's background of training and market knowledge allows for the use and development of critical technology for products, services,

and operations (Agarwal & Shah, 2014). In turn, another critical element refers to a skilled workforce, i.e., the qualifications of the entrepreneurial team. These aspects have been associated with an increase in companies' competitiveness (Fischer et al., 2022; Gimenez-Fernandez et al., 2020). In knowledge-intensive companies, studies highlighted human capital in several segments as having pivotal importance for performance (Campbell et al., 2012; Carnahan et al., 2012; Phillips, 2002).

A third element that composes the core of technical knowledge refers to the origins of the entrepreneurial endeavor. In this case, academic spin-offs are likely to present stronger research capabilities and more intense embeddedness in knowledge transfer networks (Breschii et al., 2019; Oliveira et al., 2019). In this regard, companies founded by scientists are innovating in the university context, thus translating scientific outcomes into marketable technologies (Aldridge & Audretsch, 2011; Feldman et al., 2005; Lockett et al., 2005). This can be particularly critical in the case of a country that demonstrates a striking concentration of technological competencies in academic institutions (Fischer, Schaeffer, et al., 2019). Yet, Fischer et al. (2019, 2022) highlight that while these associations of technical knowledge with the performance of KIE are relatively validated for the context of developed markets, insights on their dynamics within less mature business environments remain largely uncharted. Following this background, our first research hypothesis is proposed:

H1. Technical knowledge positively influences KIE performance.

2.2. Knowledge Components of KIE II: Strategic Knowledge Management

For the organization to transform technical knowledge into an organizational asset that generates superior value and performance, it is necessary to relate this knowledge to the business strategy (Heisig et al., 2016). For this knowledge conversion to take place, the development of the innovation strategy must consider the business model adopted by the company and its integration with 'hard' capabilities (Cahen et al., 2016; Hahn et al., 2019; Katila et al., 2012; Soetanto & Jack, 2016; Symeonidou & Nicolaou, 2018). In this manner, it becomes possible to consider knowledge-based capabilities as sources of market competitiveness (Cabrilo & Dahms, 2018; Grant, 1996; Inkinen, 2015, 2016). For this, the innovative behavior of the entrepreneur and employees must be incorporated into the company's structure, reinforcing the organizational culture of innovation and increasing the interaction between the company's technical, managerial, and operational knowledge (Mukhtarova et al., 2019; Siepel et al., 2017; Teece, 2007).

Thus, strategic knowledge management can be defined as the dynamics of interaction between technical and managerial knowledge. It refers to strategic decisions and deployments that facilitate the creation, sharing, and transfer of the company's knowledge base (Zack, 1999). In this regard, strategic knowledge management becomes a driver of sustainable competitive advantage (Cabrilo & Dahms, 2018; Heisig et al., 2016).

This planning for effectively managing knowledge and integrating it into the organizational model involves the application of managerial information systems. Management systems integrate knowledge assets into businesses models (Cabrilo & Dahms, 2018). However, information technology support for organizational practices alone does not lead to better performance. Rather, it is necessary to establish a correct association with managerial procedures and technical knowledge (Andreeva & Kianto, 2012; Kamhawi, 2012). For instance, a company can leverage performance with information technology support in conjunction with senior management support for knowledge processes (e.g., acquisition, application, conversion, and protection) (Lee et al., 2012). Hence, strategic knowledge management alone may not be sufficient to drive KIE performance. In this respect, the lack of technical capabilities may render

such strategic approach to organizational knowledge fruitless. Therefore, we present the second and third research hypotheses:

H2. Strategic knowledge management positively influences KIE performance.

H3. Technical knowledge moderates the relationship between strategic knowledge management and KIE performance.

2.3. The importance of public initiatives to support KIE

The governmental interest in fomenting KIE emerges as a function of the several positive impacts in terms of economic development that these companies entail (Colombelli et al., 2020; Kantis et al., 2020). Both the social and private gains arising from the operation of these ventures can be deemed as significant drivers of market dynamism (Lerner, 2002). However, with few exceptions, funding options for KIE ventures are extremely limited, with financial markets filled with information asymmetries (Lerner, 2002). Such conditions have provided the background for public subsidies towards nascent ventures.

Nonetheless, there is an inherent complexity in the process of selecting companies with the most significant potential, even with the participation of experienced policymakers (Brown & Mason, 2014; Chatterji et al., 2014; Shane, 2009), since the degree of uncertainty inherent in this prediction of the potential of new ideas and technologies is very high (Audretsch & Link, 2012). In this context, evaluating the available information on indicators of the knowledge management process (for example, strategic management of knowledge and technical knowledge) and the performance of these companies and comparing the results of companies that received or did not receive public incentives can help in processes of future selection, as well as approximating the impacts of policy on the business development of KIE ventures. Thus, we present our fourth research hypothesis and its respective sub-hypotheses.

H4. KIE firms that received public support present differences in the relationships between different knowledge scopes and their levels of organizational performance.

H4a. There is a difference in the relationship between technical knowledge and KIE performance between supported and non-supported firms.

H4b. There is a difference in the relationship between strategic knowledge management and KIE performance between supported and non-supported firms.

3. METHODOLOGICAL APPROACH

The research combined symmetrical and asymmetrical techniques using a multimethod approach. The symmetric technique was the Partial Least Squares Structural Equation Modeling (PLS-SEM), used to validate the theoretical hypotheses with a predictive perspective, analyze complex models with latent constructs, and multigroup analyses (Hair et al., 2022). In addition, the asymmetric approach used was the fuzzy-set Qualitative Comparative Analysis (fsQCA) by Ragin (1987), which is a technique that provides more nuanced insights on the complex configurations and causal relationships involving the variables of interest (Rasoolimanesh et al., 2021). We used SmartPLS 3.0 (Ringle et al., 2015) and fsQCA 3.1b software to calculate and validate statistical tests.

The conceptual model of the research is shown in Figure 1 and represents the research objective dealing with the analysis of the relationship involving technical knowledge, strategic knowledge management and the performance of KIE ventures.

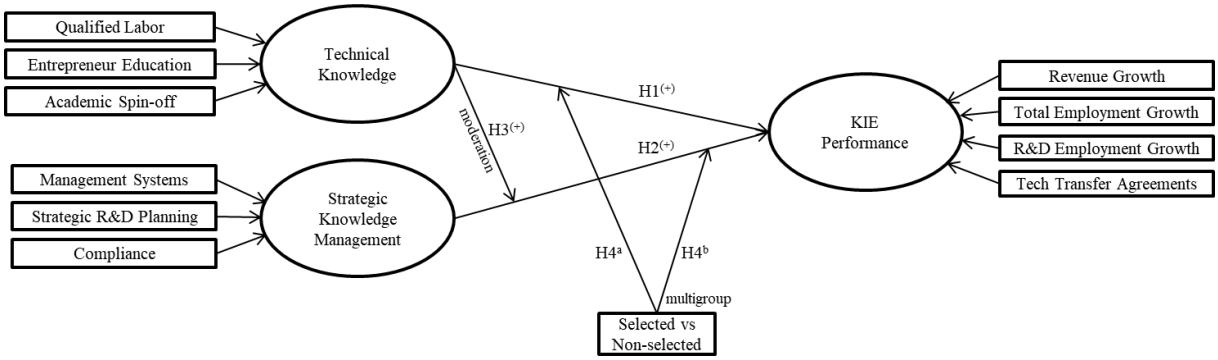

Figure 1. Conceptual model

The sample consisted of 223 KIE firms that submitted projects to the PIPE Program, an initiative targeted at supporting innovative initiatives in small ventures in the State of São Paulo, Brazil. PIPE is managed by the São Paulo Research Foundation (Fapesp), and it was designed to mirror the experience of the SBIR Program in the United States. Data collection was carried out in 2017 and 2018 through a questionnaire prepared and validated by the coordinators of Fapesp's innovation programs. Respondents were entrepreneurs who submitted projects between 2001 and 2015. The final samples comprised 142 selected and 81 non-selected firms.

The sample size was calculated before and analyzed after the survey. The minimum size was calculated using the G * Power 3.1 software (Faul et al., 2009), recommended for using PLS-SEM (Hair et al., 2022). The minimum sample size calculated is 68 observations. Since the sample consisted of 223 companies, it is suitable for estimation by PLS-SEM. Post hoc analyzes indicate that R^2 greater than 4.19% can be considered significant.

The questionnaire collected information two years before project submission and three years after submission. The constructs and indicators are presented in Table I.

Table I.
Analytical Variables

Indicator	Description
KIE Performance	
KP1	Compound annual growth rate of firms' revenues[1]
KP2	Compound annual growth rate of firms' total employment[1]
KP3	Compound annual growth rate of firms' employment in R&D[1]
KP4	Count of technology transfer agreements signed by firms[1]
Technical Knowledge	
TK1	Composite growth rate in employee education[1]
TK2	Entrepreneur's education level
TK3	Companies that identify themselves as academic spin-offs
Strategic Knowledge Management	
SKM1	The way the company adopts a project management system (likert scale from 1 to 4)
SKM2	Firms that include R&D and innovation explicitly in their strategic planning or business plans
SKM3	Firms that adopt formal compliance rules in their operations

Note 1: Considering a three-year window.
Note 2: KP1: revenue growth; KP2: total employment growth; KP3: R&D employment growth; KP4: tech transfer agreements; SKM1: management systems; SKM2: strategic R&D planning; SKM3: compliance; TK1: qualified labor; TK2: entrepreneur education; TK3: academic spin-off.
Note 3: We adjusted the financial indicators to the 2019 Brazilian Reais.

The KIE performance construct (dependent variable) was formed by indicators that

address the company's dynamics in terms of revenue growth, job growth, intensification of R&D employment, and technology transfer agreements. These variables provide a multidimensional perspective for addressing the performance of entrepreneurial firms, allowing a more in-depth comprehension of firm-level outcomes and evolutionary trajectories (Autio & Rannikko, 2016; Santarelli & Tran, 2013; Siegel & Wessner, 2012).

The technical knowledge construct is formed by qualified labor, entrepreneurial education, and academic spin-off. These indicators present a type of knowledge that is the essence of ideas and represents the new and innovation of the company, being essential for the performance and survival of the business (Adams et al., 2016; Agarwal & Shah, 2014b; Fischer et al., 2022). In turn, the strategic knowledge management construct considers the variables of management systems, strategic R&D planning, and compliance adoption. These indicators encompass the knowledge management structure that serves as the basis for the company's technical capabilities, which is fundamental to achieving high performance (Cabrilo & Dahms, 2018; Desouza & Awazu, 2006).

4. RESULTS

4.1. PLS-SEM Approach

For the PLS-SEM analysis, the criteria for formative constructs were considered to assess the constructs, as the three constructs of the research are formative – technical knowledge, strategic knowledge management, and KIE performance. Thus, convergent validity, multicollinearity, and significance were assessed (Hair et al., 2022). Redundancy analysis determined the convergent validity by correlating the variables with a global measure of the indicator. For the three constructs, the values of the path coefficients were greater than 0.85, being greater than the minimum of 0.80 (Hair et al., 2022). Collinearity was assessed by the Variance Inflation Factor (VIF) and all values were below five, being within the established value. Significance was analyzed using the bootstrapping technique, and the analysis of the external weights and external loads statistic indicates that all variables are significant and should be kept in the model. Additionally, the collinearity of the structural model was evaluated. For this, we assessed the VIF values for each subpart of the model, and all are below five, being within the established limit Hair et al. (2022). Relationships were analyzed using the bootstrapping technique as well. The analysis of the two relationships showed Student's t values above 1.96 (significance level = 5%), indicating significant values. Thus, hypotheses 1, 2, and 3 were confirmed. Table II presents the coefficients of the structural model between the constructs.

Table II.
Coefficients of the Structural Model

Relationship	Sample Mean	Standard Deviation	T Statistics	P-values
TK -> KIE Performance	0.760	0.040	14.784	0.000
SKM -> KIE Performance	0.105	0.046	2.490	0.010
TK * SKM -> KIE Performance (moderating effect)	0.160	0.087	2.111	0.035

Note: KIE: knowledge-intensive entrepreneurial firms; TK: technical knowledge; SKM: strategic knowledge management

To assess the coefficient of determination (R^2), we adopted the perspective that R^2 values equal to 2% signal small effects, 13% refer to medium effects, and above 25% comprehends large effects (Cohen, 1988; Faul et al., 2009). The KIE performance construct presented an R^2 equal to 70.7, i.e., a large explanatory effect based on the chosen determinants.

To test our fourth hypothesis (H4), i.e., if there are differences in relationships between

KIE firms that participated or not in PIPE, the multigroup analysis (Table III) was used (Hair et al., 2022).

Table III.
Multigroup analysis

Indicator	Path Coefficients-diff (Selected vs Non-selected)	P-value
TK -> KIE Performance	-0.151	0.046
SKM -> KIE Performance	0.209	0.031

Note: KIE: knowledge-intensive firms; TK: technical knowledge; SKM: strategic knowledge management

The results of the research hypothesis tests are presented in Table IV, and the resulting research model is shown in Figure 2.

Table IV.
Synthesis of the study's hypotheses test

Hypothesis	Description	Result
H1	Technical Knowledge positively influences KIE Performance	Confirmed
H2	Strategic Knowledge Management positively influences KIE Performance	Confirmed
H3	Technical knowledge moderates the relationship between strategic knowledge management and KIE performance.	Confirmed
H4	KIE firms that received public support present differences in the relationships between different knowledge scopes and their levels of organizational performance	Confirmed
H4a	There is a difference in the relationship between technical knowledge and KIE performance between supported and non-supported firms	Confirmed
H4a	There is a difference in the relationship between strategic knowledge management and KIE performance between supported and non-supported firms	Confirmed

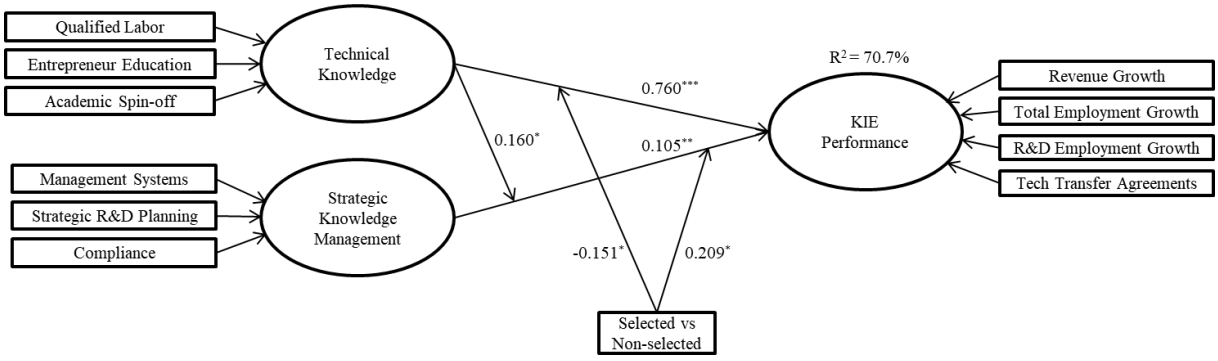

Figure 2. Resulting research model
Note. *** = significant at 0.1%; ** = significant at 0.5%; * = significant at 1%; NS = not significant

4.2. A configurational perspective: the fsQCA assessment

For the fsQCA analysis, the scores of the latent variables extracted from the PLS-SEM were used for the performance variable (outcome) and the indicators of the strategic knowledge management and technical knowledge constructs. All indicators were standardized and calibrated between 0 (no-set membership) and 1 (full-set membership), with 0.5 being the crossover point. Then, the truth table was created, with all possible configurations, considering the performance variable as an outcome and the indicators management systems, strategic R&D

planning, compliance, qualified labor, entrepreneur education, and academic spin-off as drivers. Table V presents the truth table for the configurations.

Table V.
Truth table for the configurations to predict KIE performance

TK1	TK2	TK3	SKM1	SKM2	SKM3	PIPE	Number of observations	PERF	Consistency
1	1	0	1	1	1	0	4	1	0.994
1	0	0	1	0	0	0	4	1	0.992
1	1	0	0	1	1	0	7	1	0.988
1	0	0	0	1	0	0	5	1	0.984
1	1	0	0	1	1	1	13	1	0.984
1	1	0	0	1	0	0	5	1	0.984
1	1	1	0	1	0	1	11	1	0.981
1	1	0	1	1	0	1	6	1	0.972
1	1	0	0	0	0	0	4	1	0.970
1	1	0	0	0	0	1	8	1	0.950
1	1	0	0	1	0	1	28	1	0.938
0	1	0	0	1	0	1	9	1	0.898
0	1	0	0	1	0	0	5	1	0.890
0	1	0	0	0	0	1	5	1	0.870

Note: TK1: qualified labor; TK2: entrepreneur education; TK3: academic spin-off; SKM1: management systems; SKM2: strategic R&D planning; SKM3: compliance; PIPE: selected PIPE program companies; PERF: KIE performance.

The configurations that presented acceptable consistency (>0.8) and coverage (>0.2) were considered sufficient configurations. Table VI shows seven sufficient configurations for high levels of KIE performance. In the analysis of necessary conditions (Table VII), qualified labor reached consistency and coverage values above 0.9, indicating that qualified labor is a necessary condition for high levels of KIE performance.

Table VI.
Sufficient configurations of KIE performance

Configurations	Raw coverage	Unique coverage	Consistency
Configurations for high level of KIE Performance			
PERF = *f (TK1, TK2,TK3, SKM1, SKM2, SKM3, PIPE)*			
TK2*~TK3*~SKM1*SKM2*~SMK3	0.276	0.010	0.815
TK2*~TK3*~SKM1*~SMK3*PIPE	0.293	0.067	0.793
TK1*TK2*~TK3*~SKM1*SKM2	0.406	0.135	0.953
TK1*~TK3*~SKM1*SKM2*~SMK3*~PIPE	0.129	0.020	0.974
TK1*TK2*~SKM1*SKM2*~SMK3*PIPE	0.268	0.046	0.941
TK1*TK2*~TK3*SKM2*~SMK3*PIPE	0.278	0.056	0.929
solution coverage: 0.599			
solution consistency: 0.844			

Note: TK1: qualified labor; TK2: entrepreneur education; TK3: academic spin-off; SKM1: management systems; SKM2: strategic R&D planning; SKM3: compliance; PIPE: selected PIPE program companies; PERF: KIE performance.

Table VII.

Necessary configurations of KIE performance

	Outcome		Outcome Negation	
Condition	**Consistency**	**Coverage**	**Consistency**	**Coverage**
TK1	0.955	0.928	0.306	0.589
TK2	0.856	0.610	0.483	0.684
TK3	0.185	0.630	0.022	0.150
SKM1	0.807	0.740	0.361	0.656
SKM2	0.780	0.539	0.474	0.650
SMK3	0.406	0.570	0.169	0.471
PIPE	0.654	0.524	0.405	0.644
~TK1	0.787	0.824	0.350	0.728
~TK2	0.437	0.753	0.150	0.514
~TK3	0.875	0.518	0.593	0.696
~SKM1	0.678	0.760	0.292	0.649
~SKM2	0.279	0.521	0.141	0.522
~SMK3	0.654	0.514	0.446	0.696
~PIPE	0.406	0.551	0.210	0.567

Note: TK1: qualified labor; TK2: entrepreneur education; TK3: academic spin-off; SKM1: management systems; SKM2: strategic R&D planning; SKM3: compliance; PIPE: selected PIPE program companies; PERF: KIE performance; ~: the absence or negation of the condition.

Table VIII presents these causal paths, identifying the core and contributing causal conditions and the cities that present such configurations.

Table VIII.
Configurational paths for KIE performance

Condition	**Path1**	**Path2**	**Path 3**	**Path4**	**Path5**	**Path6**	**Path7**
TK1	●	●		●	●	◯	●
TK2	•	•	•				•
TK3	○		○	○	○	○	○
SKM1		○	○	○	•	○	•
SKM2	•	•		•	•	•	○
SKM3			○	○	•	•	○

Note 1: TK1: qualified labor; TK2: entrepreneur education; TK3: academic spin-off; SKM1: management systems; SKM2: strategic R&D planning; SKM3: compliance; PIPE: selected PIPE program companies; PERF: KIE performance.

Note 2: ● = core causal contributing condition (present); ◯ = core causal contributing condition (absent); • = contributing causal conditions (present); ○ = contributing causal conditions (absent).

5. DISCUSSION

We approach the case of KIE firms located in the State of São Paulo, Brazil, applying a conceptual model validated through symmetric and asymmetric methods, thus providing a comprehensive perspective on the determinants and configurations that lead to high KIE performance from a multidimensional perspective and based on the effects of strategic knowledge management and technical knowledge indicators.

Regarding the PLS-SEM results, our assessment is aligned with previous research. The results of the technical knowledge construct indicate that this is the construct with the most significant impact on KIE performance. The intangible assets that provide the basis for these organizations to develop new technologies allow the company to grow (Bock et al., 2018; Paoloni et al., 2020; Temouri et al., 2020). The strategic knowledge management construct results confirmed the positive influence on KIE performance. This positive influence

emphasizes the central relevance of establishing management systems that integrate and incorporate knowledge assets into companies' value propositions to obtain positive outcomes (Ferreira et al., 2020; Laihonen & Mäntylä, 2018; Marques Júnior et al., 2020; Venkitachalam & Willmott, 2017).

Results also confirmed the moderating effect of technical knowledge on the relationship between strategic knowledge management and KIE performance. This result is in line with the definition of strategic knowledge management, which is the interaction between technical knowledge and the organizational structure (Zack, 1999). Positive moderation indicates that the greater the technical knowledge, the greater the influence of strategic management capabilities on firm-level performance. Thus, it is essential to establish a correct association between knowledge and the technological components of the business in order for it to achieve high levels of competitiveness (Andreeva & Kianto, 2012; Kamhawi, 2012).

A multigroup analysis indicated that in companies selected for the PIPE Program, an initiative targeted at nurturing innovative new ventures, the influence of strategic knowledge management on performance is more significant than in non-selected companies. However, in the relationship between technical knowledge and KIE performance, the results indicated that the influence is lower for companies selected by PIPE than for non-selected. These results indicate that selection for public support for KIE seems to place greater emphasis on strategic knowledge management indicators than on technical knowledge by itself. Although this may be associated with a policy of greater focus on market orientation of projects, with a greater emphasis on strategic issues than just technical capabilities. In contrast, the model results showed that the influence of technical knowledge on KIE performance is more intense and important. These results reinforce the difficulty involved in selecting projects to support entrepreneurship with public resources, which, due to the complexity involved, often do not select the most promising businesses (Brown & Mason, 2014; Fischer et al., 2022; Shane, 2009).

The fsQCA results complement the PLS-SEM analysis, with more detailed information on the complex relationships of knowledge management indicators that influence KIE performance, considering different (but equifinal) configurations. Comparing the various configurations of technical knowledge and strategic knowledge management allows for a deeper analysis of the different patterns of companies that lead to positive performance results. The first significant result is that the only necessary condition for high-performance levels is qualified labor. Findings identified six different configurations that lead to high levels of KIE performance, which are considered sufficient configurations (Tables VI and VIII). Although the PLS-SEM results point to the positive influence of technical knowledge and strategic knowledge management on KIE performance, the fsQCA results indicate that not all the indicators of the constructs are essential to obtain superior outcomes. In addition to qualified labor, which is a necessary condition, strategic R&D planning appeared as a critical factor in the six sufficient configurations. Entrepreneur education also appeared as a relevant factor in five of the six configurations. Public investment (companies selected by PIPE) also appeared as an essential factor in the configurations, being present in half of the configurations sufficient for high-performance levels. Such aspects highlight both some essential criteria to be incorporated in selection procedures of public initiatives aiming at supporting KIE ventures, but also the positive impacts associated to the PIPE Program.

Based on the results, we can draw four main contributions. *First*, we outline the importance of knowledge management indicators for the performance of KIE in a developing country context. Research on these dynamics have traditionally been focused on the context of developing markets (Fischer et al., 2022; Mukhtarova et al., 2019), and our findings contribute with empirical evidence from a group of Brazilian KIE, which is critical for the proper development of entrepreneurial policy in order to adequately address the idiosyncrasies of its

entrepreneurial players (Kantis et al., 2020; Mátyás et al., 2019). The level of uncertainty and failure rate of KIE are high due to novelty liabilities (Audretsch et al., 2020; Audretsch & Link, 2012; Hyytinen et al., 2015), and understanding the extent to which knowledge management indicators affect firm-level results helps filling this gap. Again, this is especially relevant in a socioeconomic context that comprises immature entrepreneurial ecosystems and where innovation-driven entrepreneurship is still an incipient phenomenon (Fischer, Moraes, et al., 2019).

Second, technical knowledge is the most critical factor for the high performance of KIE ventures. Our findings indicate that the influence of technical knowledge on performance is significantly more critical than that of strategic knowledge management. While strategic knowledge management also exerts valuable contributions to firm-level competitiveness, its effects are contingent upon the existence of strong technical capabilities. In this regard, our research pinpointed that the most important indicators comprehend qualified labor and the entrepreneurs' educational levels, thus highlighting the centrality of human capital in creating organizational competitiveness in entrepreneurial ventures.

Third, public investments are essential to the success of KIE. This result contradicts the view that only private investors achieve positive performance in choosing promising small ventures, highlighting that KIE support needs heterogeneous development initiatives (Eberhart et al., 2017). This public support can be deemed as more relevant in economic contexts that lack fluid and efficient capital markets for startups, such as those of developing countries (Fischer et al., 2022).

Fourth, the selection of KIE in public innovation research initiatives needs to be improved. The results indicate that selected companies are generally more focused on strategic knowledge management, while non-selected companies present a stronger association between technical knowledge and firm-level performance. Uncertainties surround the dynamics of KIE, and concrete implications for policymakers and managers are very difficult to present (Fischer et al., 2022). However, there are strong indications that companies with qualified human capital and well-qualified founding entrepreneurs have better economic prospects. In this respect, the lack of articulation between business capabilities and the technical side of firms has already been highlighted as a point to be improved in KIE promotion policies (Lerner, 2002). Accordingly, complementary initiatives that help shaping managerial competencies in knowledge-intensive entrepreneurial firms can leverage the impacts of such programs.

6. CONCLUDING REMARKS

The growing interest in companies with high growth potential to drive economic growth and value creation in entrepreneurial ecosystems has drawn increasing attention to the performance of KIE ventures (Acs et al., 2017; Liu et al., 2022; Malerba & McKelvey, 2020). Our research fills a gap in understanding how KIE operate and their main performance drivers (Brown & Mason, 2014; Fischer et al., 2022) by presenting essential insights into the influences and configurations of strategic knowledge management and technical knowledge and the importance of public initiatives to support innovation.

Our analysis provided new evidence for a sample of knowledge-intensive Brazilian firms with a multi-method approach, combining symmetric and asymmetric techniques, thus offering a comprehensive perspective of the analyzed relationships. Findings reinforce the notion of complexity in structuring adequate knowledge management dynamics for KIE. However, one can highlight the importance of some key indicators for the high performance of KIE, such as qualified labor, entrepreneur education, strategic R&D planning, and public initiatives to support innovation.

Our results are not without limitations. First, we use only two latent knowledge management variables with six indicators, which offer a limited perspective on the complex

interactions between knowledge management and the performance of KIE. Second, only companies that applied (selected and non-selected) to the PIPE Program were analyzed, which causes sampling bias. Third, despite considering companies participating in fourteen years of the program, our assessment is transversal, not allowing us to capture how these constructs are related from an evolutionary perspective. In this context, some suggestions for future research are presented: carrying out similar research among other contexts and regions of developing countries; using qualitative methodologies to deepen the understanding of knowledge management practices and processes in KIE, which can affect the results; develop longitudinal research that allows for how the relationships between knowledge management and performance change over time.

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