



Analysis of Entrepreneurial Behaviour in Incubated Technology-Based Companies

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Abstract

Background: The analysis of entrepreneurial behaviour in incubated technology-based companies can help managers to understand their characteristics and how these aspects can be maximized to increase the performance of the companies.

Objectives: This study proposes to measure the entrepreneurial behaviour of managers of technology-based companies in incubators in southern Brazil facing different stages of the business life cycle.

Methods/Approach: The Analytic Hierarchy Process is used to measure the entrepreneurial behaviour index of technology-based companies' managers throughout the stage of the business life cycle.

Results: In the early stages, entrepreneurs have ample self-confidence and are willing to make quick decisions. In the intermediate stages, the entrepreneur shows greater persistence and effort in the tasks. In the later stages, the entrepreneur acquires a greater sense of group activity and punctuality in completing tasks.

Conclusions: This study analyses how managers demonstrate their entrepreneurial behaviour as the stages the company experiences. The results can help managers better understand their performance and actions reflected through their behaviours.

Keywords: entrepreneurial behaviour; technology-based companies; business life cycle

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Introduction

The entrepreneurial characteristics present in managers of companies are essential for the development of innovation and business performance (Ahmed et al., 2018). Peng et al. (2018) state that entrepreneurial behaviour impacts the economic growth of society and connects with innovation and technology. In this context, technology-based companies stand out for their use of innovation and technology, depending on these factors for internal decision-making and external business development (Kaplan & Vakili, 2015).

The capital-intensive investments in incubators' infrastructure seek to facilitate the emergence of technology-based companies by aiding access to markets and developing ideas (Bliemel et al., 2019). Besides, the potential to develop human and social capital can influence the incubated environments of technology-based companies (Wynn & Jones, 2019). Thus, the entrepreneurs' intellectual capital and behavioural characteristics are crucial during their business's several moments. Pujol-Cols and Dabos (2020) state that emotionally stable individuals focus on their success and the most favourable aspects of their jobs rather than their failures.

Studying entrepreneurial behaviour has been an essential topic in entrepreneurship (Zhang et al., 2015). Kim and Chung (2017) highlight that the research about entrepreneurial behaviour focuses on individuals' more active roles during innovation implementation. This concept considers that individuals' requisite knowledge, skills, and experience effectively engage in entrepreneurship.

In technology-based companies, analyzing characteristics of entrepreneurial behaviour is relevant to increasing business performance and competitiveness throughout its life cycle. Gupta et al. (2019) provide evidence supporting the notion that companies led by managers adept at capturing entrepreneurial aspects of decision-making practices and managerial trends demonstrate superior performance. McClelland (1987) notes that entrepreneurs are differentiated individuals with characteristics distributed in three actions: realization, planning, or power.

According to Rodrigo et al. (2018), the primary motivations driving entrepreneurial activities include pursuing independence, career advancement, economic necessity, expertise in the field, market opportunities, increased leisure time, and self-realization. Claver-Cortés et al. (2015) identify the most critical human capital for companies and which indicators can assist in their measurement. These articles point to the growth of academic interest in entrepreneurial behaviour and concerns about how it should face the different stages of the business cycle. However, few studies associate entrepreneurial behaviour with performance measurement in technology-based companies.

Eijdenberg et al. (2019) highlight that existing research has predominantly examined institutions through social, political, economic, geographical, and ethnic lenses, thereby underscoring a dearth of studies focusing on entrepreneurial behavior and resilience in demanding institutional contexts. There is a gap in identifying how managers of technology-based companies behave as the business develops. So, this study aims to measure the entrepreneurial behaviour of managers of incubated technology-based companies facing the different stages of the business life cycle.

This study contributes to theory through a method to measure the entrepreneurial behaviour level of 31 managers of 7 incubated technology-based companies in southern Brazil. Moreover, this study understands human behaviour while managers participate in complex systems such as incubated technology-based companies and analyses performance characteristics to guarantee the success of the businesses. This study also shows that entrepreneurs' behaviour and emotions directly influence

business success and points out that organizational performance must be measured from several perspectives, including in the behavioural field.

Theoretical background

One of the main factors that measure the level of competitiveness and performance is human capital, specifically the levels of entrepreneurs' leadership, innovative spirit, and team cohesion (Xiao & Zhao, 2017). These aspects represent some of the essential characteristics for the development of an entrepreneur. As stated by Isichei et al. (2020), it is essential to understand and strengthen entrepreneurs' internal characteristics and capabilities to ensure significant gains for companies.

Kirkley (2016) states that entrepreneurial behavior encompasses values and needs that foster intrinsic motivation and self-determination. Studies examining entrepreneurs and their impact on national economic development reveal that individuals exhibiting entrepreneurial behavior tend to display increased confidence and courage in taking risks, leading them to make decisions that yield valuable experiences (Bockorny & Youssef-Morgan, 2019).

Theoretically, personal entrepreneurial characteristics are defined by the United Nations Conference on Trade and Development (UNCTAD) as a set of ten attributes identified by McClelland (1987). UNCTAD is an institution belonging to the UN (United Nations), representing one of the leading organizations developing projects for inclusive and sustainable development. Thus, entrepreneurial behaviour has well-defined characteristics supported by a global institution. Despite this, the opportunities and obstacles encountered throughout a company's development can define how managers develop their entrepreneurial behaviour (Adizes et al., 2017).

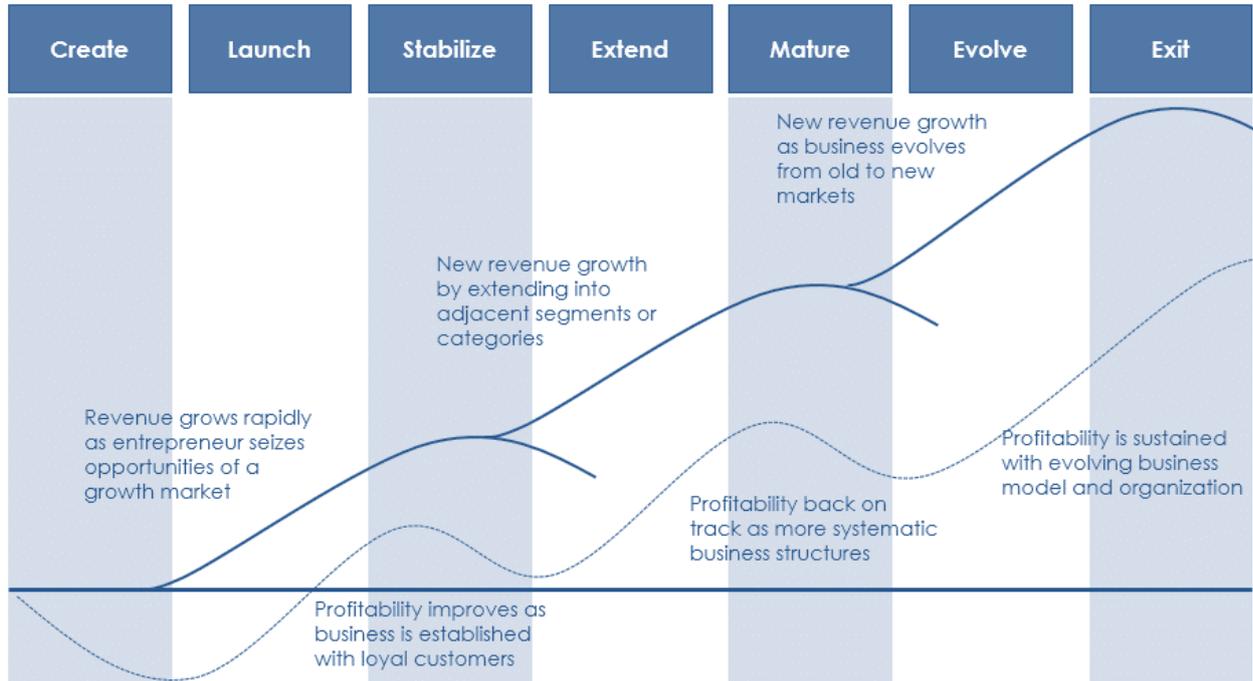
According to Michelin et al. (2021), managers' behaviour can be influenced by the phase the company goes through, interfering with the company's results and performance. The different situations present during the stages experienced by companies justify the importance of business life cycle analysis.

Since the business life cycle interferes with the manager's behaviour, it was considered an essential variable for data compilation. de Oliveira Reis et al. (2018) highlight that most research evaluates the business life cycle according to the time companies remain active in the market. Given the different approaches expressed in the literature, Fisk's (2008) method was chosen because it comprises a dynamic market view and is used in companies' practical contexts.

Figure 1 shows a possible scenario for a company involving all stages. Though each stage results from its age, size, and performance, its structure and sophistication can also be characterized. Each company's evolution level is different, depending on the type of business. There are other priorities and challenges, propositions, and the managers' level of investment at each stage.

Recognizing the influence of the business life cycle on the behaviour of company managers (Adizes et al., 2017; Michelin et al., 2021), the particularities of certain companies can also determine the behaviour of managers. Incubated technology-based companies cultivate a culture of decision-making based on innovative and technological processes (Kaplan & Vakili, 2015). These companies need managers with entrepreneurial behaviour to work with the different challenges found in their niche. Creativity, opportunity identification, initiative, perseverance, and teamwork are characteristics needed for technology-based companies to thrive (Lopes & Sassi, 2019).

Figure 1
Business life cycle proposed by Fisk (2008)



Source: Fisk (2008)

The challenges technology-based companies encounter at different stages of the business life cycle influence the behaviour of managers. Characteristics in McClelland's (1987) proposal of entrepreneurial behaviour may define how managers maintain the habits that determine the companies' performance.

Methods

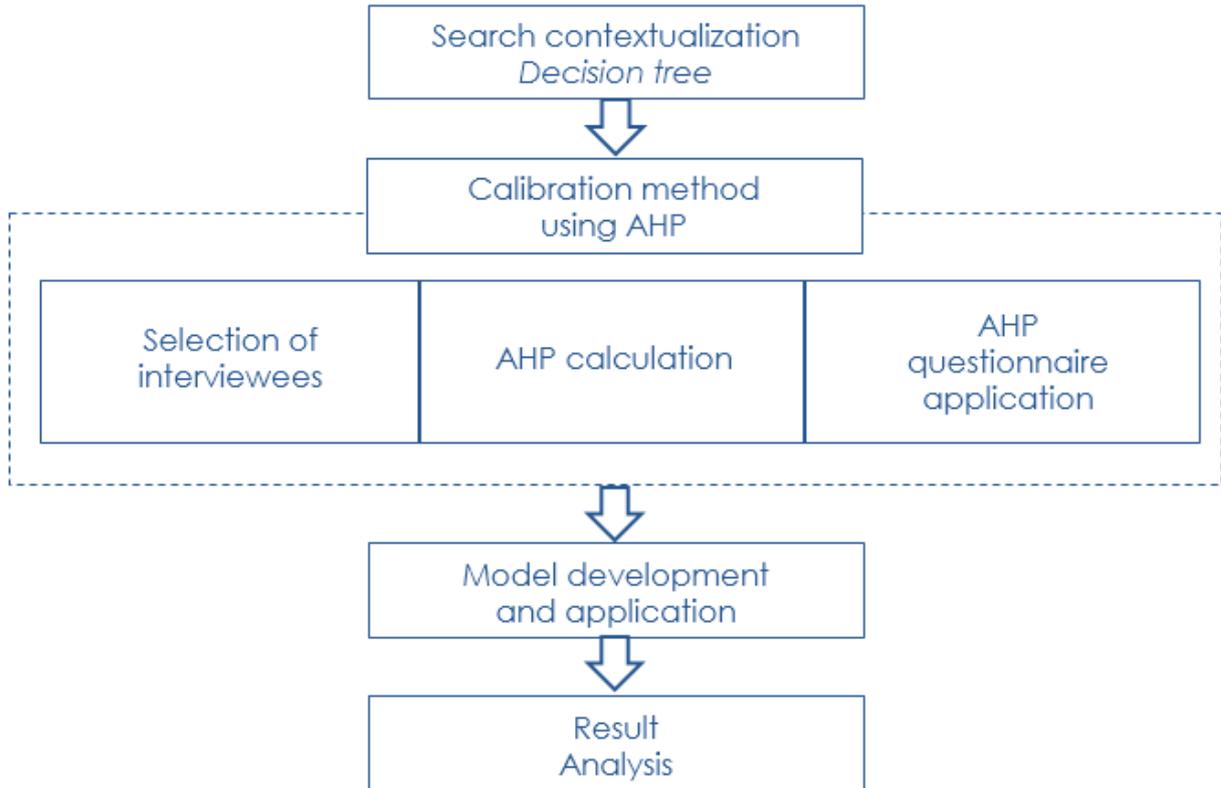
Studies using different quantitative methods have been observed in the academic literature on entrepreneurial behaviour in managers of companies. Badri and Hachicha (2019) conducted a study investigating the influence of entrepreneurship education on students' inclination to start their businesses. Ataei et al. (2020) evaluated the impact of young people's entrepreneurial skills in creating new businesses through the Fuzzy Analytic Hierarchy Process method.

Multiple-criteria decision analysis (MCDA) contributes precisely to help make this process less complicated by having tools that elucidate the cause-and-effect relationships on the decision-maker's preferences, increasing knowledge about the problem (Love et al., 2015). Zhü (2014) says that the Analytic Hierarchy Process (AHP) method is an adequate tool for measuring intangibles side by side with the tangibles and a widely used multicriteria tool in the decision-making of defining priorities.

Through this analysis, none of the methods already published in the literature aims to measure managers' entrepreneurial behaviour of technology-based companies. Also, it is noted that the MCDA methods can assist in measuring entrepreneurial behaviour to better understand the manager's perception at each stage of the business life cycle. Thus, the proposed method uses the Analytic Hierarchy Process and Key Performance Indicators (KPI) concepts to measure the entrepreneurial behaviour of managers of technology-based companies.

The development of the method consists of four main steps. They include the decision tree construction, the modelling calibration, the building and application of the model, and the result analysis. Figure 2 shows the research flowchart.

Figure 2
Research flowchart



Source: Authors' work

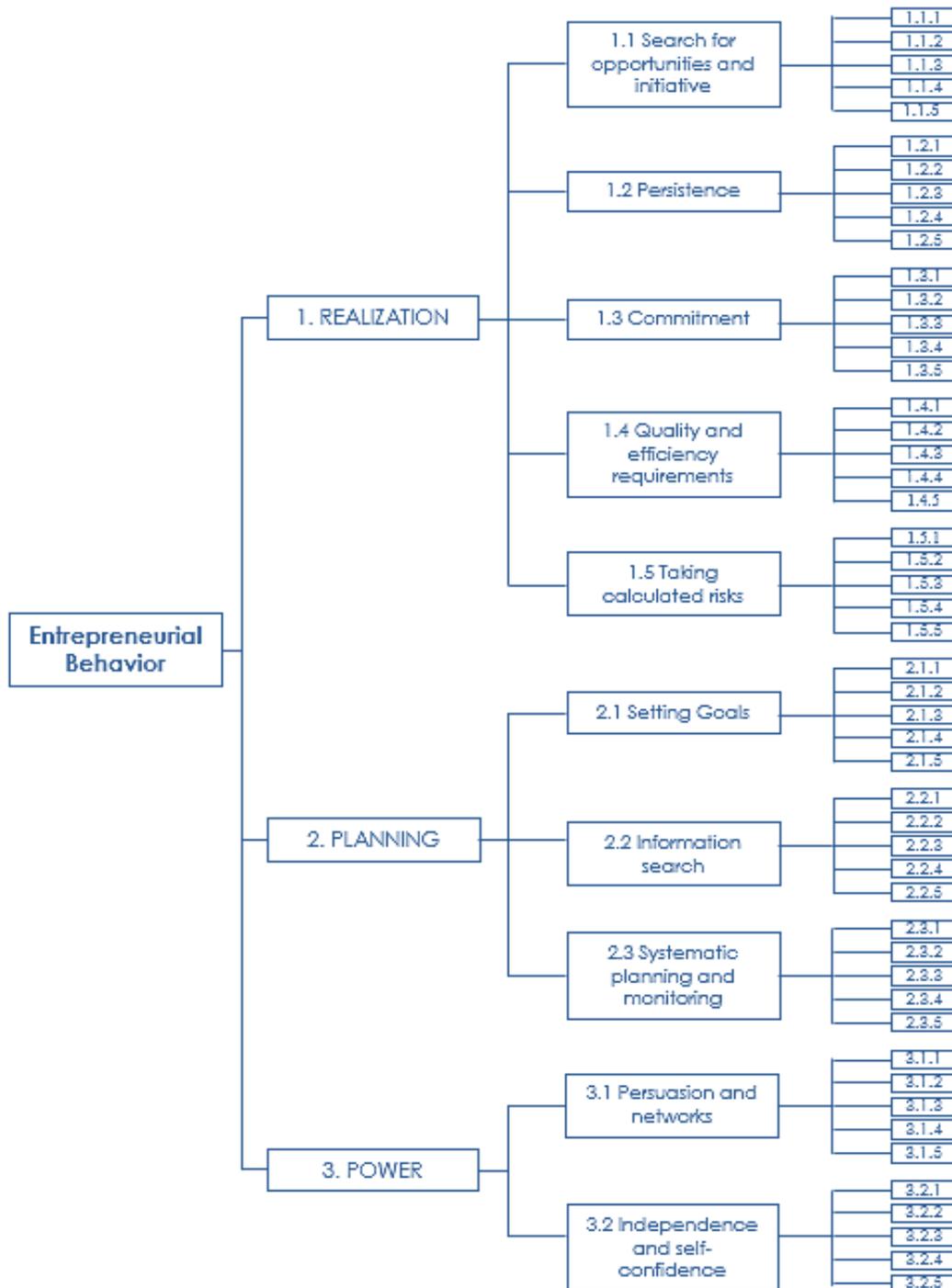
Decision tree

The proposed decision tree was elaborated from the Characteristics of Entrepreneurial Behaviour (CEB) by McClelland (1987) and adapted from the United Nations Conference on Trade and Development Division on Investment and Enterprise (2021).

Three dimensions are related to McClelland's and are defined as Fundamental Points of View (FPV): Realization, Planning and Power. They are deployed in 10 characteristics that reflect the Critical Success Factors (CSF), which are extended to 50 KPIs related to entrepreneurial behaviour.

Figure 3 shows the decision tree representing the hierarchical structure for evaluating the manager's entrepreneurial behaviour in a technology-based company, culminating in the decision tree study.

Figure 3
Decision tree



Source: Authors' work

Calibration of KPIs

The stage of the company's business life cycle influences the result of its manager's entrepreneurial behaviour. Thus, KPIs' must be calibrated, so weights were defined for each of them using the AHP methodology to reflect the company's stage (Saaty, 1980). In the next step, each KPI will have a multiplier factor to make the manager's entrepreneurial behaviour appropriate to their reality.

The questionnaire was applied to managers of 31 technology-based companies. The questions encouraged respondents to compare each CSF's KPIs in a paired way to meet the criteria for starting the calculation using the AHP methodology. Respondents needed to score KPIs on a scale of importance so that 1 represents equal importance, 3 represents marginally strong importance, 5 represents strong importance, 7 represents very strong importance, and 9 represents extremely strong importance. Besides, managers could select intermediate importance values (2, 4, 6, and 8) (Saaty, 1980). Figure 4 shows how the questions were presented to managers.

Figure 4
Questions of CSF 1.1

CSF 1.1 Search for opportunities and initiative																		
1.1.1. I strive to accomplish the things that must be done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.2. I do the things that must be done without others having to ask me
1.1.1. I strive to accomplish the things that must be done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.3. I like challenges and new opportunities
1.1.1. I strive to accomplish the things that must be done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.4. I prefer to perform tasks that I master perfectly and in which I feel secure
1.1.1. I strive to accomplish the things that must be done	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.5. I venture to do things new and different from those I have done in the past
1.1.2. I do the things that must be done without others having to ask me	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.3. I like challenges and new opportunities
1.1.2. I do the things that must be done without others having to ask me	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.4. I prefer to perform tasks that I master perfectly and in which I feel secure
1.1.2. I do the things that must be done without others having to ask me	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.5. I venture to do things new and different from those I have done in the past
1.1.3. I like challenges and new opportunities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.4. I prefer to perform tasks that I master perfectly and in which I feel secure
1.1.3. I like challenges and new opportunities	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.5. I venture to do things new and different from those I have done in the past
1.1.4. I prefer to perform tasks that I master perfectly and in which I feel secure	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	1.1.5. I venture to do things new and different from those I have done in the past

Source: Authors' work

The questionnaires' results were entered into a spreadsheet in the Excel™ software, modelled to perform AHP calculations. The AHP method decomposes problems into a hierarchy of qualitative and quantitative criteria, facilitates the analysis, and compares alternative solutions to selected criteria. In this case, the first level comprises the problem to be solved or the decision's goal. The second level corresponds to the criteria that influence the decision (de Oliveira & Martins, 2015).

The steps used to calculate the KPI indexes followed Zanardo et al. (2018)'s methodology. The consistency ratio index (CR) was used to verify the decision-maker's data when deciding the criteria' priority. If CR is equal to or lower than 10%, then the data is consistent (Saaty, 1980), and the questionnaire must be applied again with the manager. In this study, all the consistency ratio indexes were lower than 10%, indicating that the data is consistent.

After data collection was conducted in the 31 companies, and the calculations performed were consistent, the KPIs' weights were calculated. Each manager selected at which stage of Fisk's (2008) business life cycle the company was at that moment. In each stage of the cycle, the importance of each KPI can be different, so this analysis is essential to understand the company's characteristics. So, the average of each KPI for each stage of the business life cycle was calculated. These values were used as a multiplier factor in the next step to calculate the managers' entrepreneurial behaviour.

Calculation of the indicators of entrepreneurial behaviour

The second survey questionnaire was applied based on McClelland's (1987) entrepreneurial characteristics in this stage. This data collection instrument refers to a structured questionnaire that approaches the indicators from Annex A and consists of a series of questions answered by the respondent without interference from the researcher (Triviños, 2008). This questionnaire is used in the projects developed by the United Nations Conference on Trade and Development Division on Investment and Enterprise in more than 27 countries. This study used McClelland's (1987) questionnaire to measure entrepreneurial behaviour since this is the most comprehensive and applicable model.

The survey had multiple-choice questions for each indicator. It enabled the creation of a ranking of importance among the indicators. Consequently, evaluating and comparing the participating managers' performance was possible since the instrument allowed standardized data collection. The performance was assessed from each indicator and also globally. The entrepreneurial characteristics and behaviours were identified in each stage of the business life cycle. Equation 1 shows how entrepreneurial behaviour was calculated for each technology-based company.

$$c = \sum_{i=1}^3 \left[\sum_{m=1}^M \left(\sum_{j=1}^5 v_j \cdot p_{1j} \right) \cdot p_{2i} \right] \cdot p_{3i} \quad (1)$$

where:

- c = the company's entrepreneurial behaviour;
- v = value obtained for KPI j in the second data collection;
- j = KPI number for a given CSF;
- m = CSF number of a given FPV;
- i = FPV number;
- p1 = weight of each KPI [obtained through the AHP calculation (first questionnaire)];
- p2 = weight of each CSF (standard for each FPV – Table 1);
- p3 = weight of each FPV (standard – Table 1)

The value attributed to each KPI by managers in the second questionnaire was multiplied by the KPI weight previously calculated in the calibration step. It represented the stage of the business life cycle in which the company is. The sum of each CSF's KPI product was multiplied by the weight assigned to the corresponding CSF, equivalent to the number of CSFs each FPV has. Finally, the sum of the products of CSFs was multiplied by the weight of each FPV, which was defined proportionally to the number of CSFs that comprise them. This calculation generated the manager's

entrepreneurial behaviour. Table 1 shows the weights assigned to the CSFs and FPVs used during the calculation.

Table 1

Weight of CSF and FPV

FPV	Weight attributed to FPV	Weight attributed to each CSF
Realization	50%	20%
Planning	30%	33%
Power	20%	50%

Source: Authors' work

Results

Stage of the business cycle of companies

This section presents the analysis of the results obtained by applying the methodology of evaluating the manager's entrepreneurial behaviour, facing the different business life cycle stages. Managers of technology-based companies were considered the unit of analysis, and the respondents' selection was made intentionally.

All of the incubators are located in higher education institutions since companies linked to educational institutions provide interaction among research groups, expand the network of contacts, and enable the exchange of knowledge. Thus, the sample consists of managers of 31 companies in seven incubators from five cities in Southern Brazil.

The first question to the managers was: What stage of the business life cycle is your company currently experiencing? In this way, the concepts of each stage of the business life cycle of the Fisk (2008) model were presented. The managers indicated which stage the company was experiencing. Table 2 shows the result of the application of the question.

Table 2

Number of technology-based companies in each stage of the business life cycle

Stage of the business life cycle	Number of technology-based companies
Create	8
Launch	5
Stabilise	9
Extend	3
Mature	1
Evolve	5
Exit	0

Source: Authors' work

Model construction and application

The KPIs analysis allowed the evaluation of each factor's impact on the managers' entrepreneurial behaviour. Table 3 shows the three KPIs with the highest predominance for each stage of the business life cycle and their average percentage impact.

Table 3
KPIs with the highest predominance by the stage of the business life cycle

Stage of the business life cycle	KPI	Average predominance
Create	3.2.1. I am confident that I can succeed in any activity that proposes me to perform.	32.90%
	1.2.2. I insist several times on getting other people to do what I want.	31.83%
	1.1.1. I strive to accomplish the things that must be done.	30.00%
Launch	2.2.3. I make decisions without wasting time looking for information.	31.95%
	1.2.2. I insist several times on getting other people to do what I want.	31.17%
	1.3.1. I finish my work/activity on time.	28.59%
Stabilise	1.1.1. I strive to accomplish the things that must be done.	28.40%
	1.2.2. I insist several times on getting other people to do what I want.	28.08%
	2.1.4. I count on a clear plan of life.	28.03%
Extend	1.4.5. I find the fastest way to finish work at home and at work/college.	37.56%
	2.3.1. I plan a large project by dividing it into simpler tasks.	33.41%
	1.4.4. I'm never really satisfied with how things are done; I always think there is a better way to do them.	33.30%
Mature	2.3.1. I plan a large project by dividing it into simpler tasks.	47.20%
	1.4.5. I find the fastest way to finish work at home and at work/college.	46.41%
	1.3.3. If necessary, I do not mind doing the work of others to meet a deadline.	46.41%
Evolve	1.3.1. I finish my work/activity on time.	37.35%
	1.2.2. I insist several times on getting other people to do what I want.	34.80%
	2.1.3. The more specific my expectations are concerning what I want to achieve, the greater my chances of success.	31.19%

Source: Authors' work

Through this analysis, it was possible to perceive that the indicator that most impact the managers' entrepreneurial behaviour in the Creation stage is confidence in obtaining success in any activity. Managers need a strong belief in the value of what they are trying to accomplish to overcome the initial rejection of their innovations. Thus, when people have confidence in their ability to perform specific tasks, they are more likely to take the initiative, face challenging situations, and have more significant risks, leading to higher returns (Neto et al., 2018; Piperopoulos & Dimov, 2015).

The most striking indicator of managers' entrepreneurial behaviour for companies in the Launch stage is making decisions without wasting time searching for information. Nandram et al. (2018) relate the managers' rapid decision-making to the "context of intuition". This result is supported by Robert Mitchell et al. (2005), who attest that entrepreneurs often use intuition to explain their actions. The use of intuition is directly

related to identifying opportunities. On the other hand, the result found in this study, which reflects the behaviours of incubated entrepreneurs and, therefore, connected to more significant opportunities, contrasts in parts with Ardichvili et al. (2003) afirmam que os empresários individuais consideravam a identificação de oportunidades significativamente mais crucial do que os empresários ligados em rede. Além disso, os empresários individuais consideravam-se mais criativos e estavam mais dispostos a dedicar tempo específico a actividades criativas.

In the Stabilize stage, the indicator that most impacts managers' entrepreneurial behaviour is the effort applied in carrying out the activities. This factor relates to entrepreneurial intent and indicates to what extent an individual is motivated to engage in entrepreneurial behaviour and invest in business management activities (Neneh, 2019). Shirokova et al. (2016) argue that the more time and effort devoted to accomplishing a task, the more likely it will be to achieve and succeed. Fried and Tauer (2015) say that business success can be measured through the owner hours' variable, which measures the entrepreneur's commitment and effort to run the company.

Finding the fastest way to finish work at home and work/college is the predominant indicator of entrepreneurial behaviour and significantly impacts the companies' Expand stage. In general, most small business managers tend to address competing work and life demands ad hoc manner, lacking a structured or planned approach to managing these responsibilities. Home-based technology has subliminally extended the day's work for these entrepreneurs as they engage in more work-at-home. This situation reflects that entrepreneurs in fast-growing companies seek increasingly more immediate results, taking work to do at home.

Planning a project through its unfolding in more straightforward tasks is the primary indicator of entrepreneurial behaviour in the Mature stage. Martens et al. (2018) support this assertion by emphasizing that managers of companies face mounting complexities, necessitating the adoption of highly competitive strategies and project execution through escalated activities to effectively respond to rapidly changing market dynamics. Implementing project-based activities within the organizational environment is commonly accompanied by strategies that foster evolution and comprehend their impact on business performance and success. Thus, as project activities are successful, organizational results can be favoured, contributing to technology-based companies' performance, efficiency, innovation, and development (Yang et al., 2014).

In the Evolve stage, the indicator of entrepreneurial behaviour with the most significant impact was finishing work/activity on time. Punctuality is one of the primary non-cognitive skills that positively impact the success of technology-based companies (Alva, 2019). Also, Bluedorn and Martin (2008) concluded that the fewer activities are carried out, the more likely it is to be punctual in delivering the activities to be fulfilled by the entrepreneurs. On the other hand, the higher number of jobs developed simultaneously tends to cause the managers to perform the activities demanded in a shorter time than if the activities were done in isolation.

Entrepreneurial behaviour by the stage of the business life cycle

Analyzing leading indicators of performance and critical success factors allowed us to find the overall index of each manager's entrepreneurial behaviour, which corresponds to the critical success factor's proportionality from the fundamental point of view. Table 4 shows the entrepreneurial behaviour of each company's managers studied and the average rate per stage of the business life cycle.

Table 4

Managers' entrepreneurial behaviour by the stage of the business life cycle

Stage of the business life cycle	The average index of managers' entrepreneurial behaviour	Index of managers' entrepreneurial behaviour	Technology-based companies
Create	80.70%	84.12%	Auster
		83.93%	Conífera
		81.30%	Diferencial
		79.72%	Fisalis
		70.90%	Fox
		74.52%	MachPal
		89.52%	Tecknogelatto
		81.57%	TecSynthesis
Launch	79.45%	82.99%	Chemweg
		83.33%	Expin
		80.42%	Mais Gestão
		74.81%	Mercateria
		75.70%	Qiron Robotics
Stabilise	79.33%	76.51%	Café
		88.97%	Conplan
		79.75%	Cowmed
		79.01%	Dillon
		80.84%	GCB Drone
		82.36%	Pizetta
		82.48%	Soha On Taxi
		68.27%	Taskka
Extend	80.52%	75.76%	XL7
		85.29%	Polvo Louco
		76.85%	Sonnen
Mature	91.29%	79.41%	WeeVee
		91.29%	Seven
Evolve	82.44%	88.53%	Agener
		78.08%	Enovative
		81.91%	FP2
		77.81%	Perseus
		85.87%	SRA

Source: Authors' work

This analysis showed that the average entrepreneurial behaviour rates are higher in the business life cycle's final stages. It should be noted that only one company was identified as belonging to the mature stage, explaining the highest index. Conversely, Riviezzo et al. (2019) contend that managers of companies with a longer operating history are more inclined to exhibit deeply ingrained entrepreneurial behaviour. Furthermore, as the company evolves into a well-organized and disciplined business, the founding team must establish the groundwork for a rapidly expanding enterprise, building credibility and acquiring vital resources for growth (Picken, 2017b). It requires managers to adjust their leadership style and management behaviour and have experience and competence to deal with strategic direction and market positioning (Picken, 2017a).

The Create stage also exhibited a notable level of entrepreneurial behavior, as it involves significant engagement in business creation, product launch, and pursuit of expansion opportunities during the initial stages. In the early stages of the cycle, managers must build networks with actors to develop and communicate with

academia and businesses to accelerate research and technology transfer (Pettersen & Tobiassen, 2012). Entrepreneurs must proactively manage their company's social capital in business creation to foster knowledge acquisition and establish a competitive advantage. They should also encourage the exchange of knowledge between the company and its customers to form a basis for alliances that can lead to even more excellent opportunities for wealth generation (Pettersen & Tobiassen, 2012). Also, the entrepreneurs' research and business planning activities, through generating new ideas for products or services, continue to be essential for the company's performance throughout the business life cycle (Baron et al., 2016).

The intermediate stages of the cycle presented the lowest entrepreneurial behaviour rates among the business life cycle stages. These steps are marked when a company gains strength in the market and represent a bridge between the vaguely structured informality of a technology-based company and the formal and disciplined form required for rapid scaling. So, there is a substantial increase in managers' challenges since new resources must be developed, and partnerships must be established to make the business sustainable (Picken, 2017b). That is why managers need to create effective planning in the early stages of their business life cycle. They must identify potential milestones and obstacles and align their functional objectives with their companies' organizational goals so that the materialization of results and their entrepreneurial behaviour indices are more significant in the business life cycle's intermediate stages (Păunescu & Badea, 2014).

Conclusion

Summary of research

Entrepreneurial behavioural characteristics are fundamental for developing technology-based companies, influencing the business's success. In the initial stage of incubated companies' operation, measuring these characteristics helps managers verify how they can evolve and their impact. Thus, the study proposed and tested a model to measure and evaluate managers' entrepreneurial behaviour in technology-based companies. This model was successfully tested in 31 companies, obtaining data from all its managers. Study findings demonstrate that all entrepreneurs present McClelland's (1987) features. The behavioural perspective can guide managers' decision-making and help them achieve higher performance indices, making their companies more competitive.

The questionnaires applied to the managers of technology-based companies verified their entrepreneurial behaviours in their actions, the constant search for competitiveness, permanence in the market, intention to leave a legacy, and improved development and economic growth. Thus, technology-based companies that enjoy the structure, networking, and mentoring from business incubators and avail themselves of universities' specific knowledge may have a competitive advantage during the business's initial stages.

The managers highlight the search for opportunity and initiative, persistence, commitment, goal setting, information search and persuasion, contact networks, independence, and autonomy. Besides, managers cited other entrepreneurial behaviour features not named by the researchers, such as discernment, pragmatism, resilience, empathy, communication skills, and observation.

Implications for theory and practice

The results of this study improve the understanding of the entrepreneur in the organizational context. It happens because its characteristics can be affected by

environmental changes and the different stages experienced in its business. The study makes a new contribution by proposing an original method to measure the entrepreneurial behaviour of managers of technology-based companies throughout the business life cycle. Hence, this study generates opportunities for entrepreneurs and their companies and advances for the scientific community, reinforcing that the union between universities, companies, and society can contribute efficiently to economic development.

This study provides some recommendations that give the managers of technology-based companies better understand their performance and their actions reflected through their behaviour. This comprehension can develop skills, address gaps, seek improvements, reduce uncertainties, favour the business's success, and contribute to technology-based companies' growth and economic development. Thus, the model developed in this paper offers a rich set of data and different types of results that can be explored, analyzed, and adapted to measure other intangible assets' performance.

Besides, a study involving performance measurement and intangible assets helps technology-based companies to position themselves competitively. Tripathi et al. (2019) emphasise that human capital is essential in the technology-based company ecosystem analysis. Studies have shown that entrepreneurs' emotions and behaviours significantly influence business development and success (Wang et al., 2019). So, performance can be measured from many perspectives, including in the behavioural sphere.

Limitations and suggestions for future research

Although this study provides significant contributions, the results must be analyzed within some factors that limited its development. One of the limitations concerns the non-existence of companies classified in the Exit stage within the business life cycle of the analyzed sample. Also, the study did not represent many business incubators in southern Brazil. Moreover, it is noteworthy that although the study was developed in Southern Brazil, the conclusions can be extended to other emerging economies with similar characteristics.

The knowledge and results obtained during this research's development can generate a new study, which involves applying the proposed model to analyze entrepreneurial behaviour in other sectors. It is possible to adjust the model to measure other intangible assets and deepen the diffusion of other undefined characteristics since their definitions address the abilities and ways of acting that contribute to the entrepreneurial individual's development.

References

1. Adizes, I., Cudanov, M., & Rodic, D. (2017). Timing of proactive organizational consulting: difference between organizational perception and behaviour. *Amfiteatru Economic*, 19(44), 232.
2. Ahmed, U., Shah, S. A., Qureshi, M. A., Shah, M. H., & Khuwaja, F. M. (2018). Nurturing innovation performance through corporate entrepreneurship: The moderation of employee engagement. *Studies in Business and Economics*, 13(2), 20-30. <https://doi.org/10.2478/sbe-2018-0017>
3. Alva, E. P. (2019). What is a good worker? Non-cognitive skills and trade microenterprises' success. *International Journal of Organizational Analysis*, 27(4), 986-1003. <https://doi.org/10.1108/IJOA-06-2018-1449>
4. Ardichvili, A., Cardozo, R., & Ray, S. (2003). A theory of entrepreneurial opportunity identification and development. *Journal of Business venturing*, 18(1), 105-123. [https://doi.org/10.1016/S0883-9026\(01\)00068-4](https://doi.org/10.1016/S0883-9026(01)00068-4)

5. Ataei, P., Karimi, H., Ghadermarzi, H., & Norouzi, A. (2020). A conceptual model of entrepreneurial competencies and their impacts on rural youth's intention to launch SMEs. *Journal of Rural Studies*, 75, 185-195. <https://doi.org/10.1016/j.jrurstud.2020.01.023>
6. Badri, R., & Hachicha, N. (2019). Entrepreneurship education and its impact on students' intention to start up: A sample case study of students from two Tunisian universities. *The International Journal of Management Education*, 17(2), 182-190. <https://doi.org/10.1016/j.ijme.2019.02.004>
7. Baron, R. A., Mueller, B. A., & Wolfe, M. T. (2016). Self-efficacy and entrepreneurs' adoption of unattainable goals: The restraining effects of self-control. *Journal of business venturing*, 31(1), 55-71. <https://doi.org/10.1016/j.jbusvent.2015.08.002>
8. Bliemel, M., Flores, R., De Klerk, S., & Miles, M. P. (2019). Accelerators as start-up infrastructure for entrepreneurial clusters. *Entrepreneurship & Regional Development*, 31(1-2), 133-149. <https://doi.org/10.1080/08985626.2018.1537152>
9. Bluedorn, A. C., & Martin, G. (2008). The time frames of entrepreneurs. *Journal of Business Venturing*, 23(1), 1-20. <https://doi.org/10.1016/j.jbusvent.2006.05.005>
10. Bockorny, K., & Youssef-Morgan, C. M. (2019). Entrepreneurs' courage, psychological capital, and life satisfaction. *Frontiers in psychology*, 789. <https://doi.org/10.3389/fpsyg.2019.00789>
11. Claver-Cortés, E., Zaragoza-Sáez, P. C., Molina-Manchón, H., & Úbeda-García, M. (2015). Intellectual capital in family firms: human capital identification and measurement. *Journal of Intellectual Capital*, 16(1), 199-223. <https://doi.org/10.1108/JIC-04-2014-0046>
12. de Oliveira Reis, C. F., Silva, W. A. C., de Oliveira Santos, A., & Amaral, H. F. (2018). Proposta de instrumento para análise dos fatores de sucesso do ciclo de vida da organização e do processo empreendedor: uma análise da percepção dos empresários da Mesorregião do Norte de Minas Gerais. *Revista Gestão & Tecnologia*, 18(3), 97-118.
13. de Oliveira, V. H. M., & Martins, C. H. (2015). *Ahp: ferramenta multicritério para tomada de decisão-shopping centers*. Appris Editora e Livraria Eireli-ME.
14. Eijdenberg, E. L., Thompson, N. A., Verduijn, K., & Essers, C. (2019). Entrepreneurial activities in a developing country: an institutional theory perspective. *International Journal of Entrepreneurial Behavior & Research*, 25(3), 414-432. <https://doi.org/10.1108/IJEER-12-2016-0418>
15. Fisk, P. (2008). *Business genius: A more inspired approach to business growth*. John Wiley & Sons.
16. Fried, H. O., & Tauer, L. W. (2015). An entrepreneur performance index. *Journal of Productivity Analysis*, 44, 69-77. <https://doi.org/10.1007/s11123-015-0436-0>
17. Gupta, S., Chen, H., Hazen, B. T., Kaur, S., & Gonzalez, E. D. S. (2019). Circular economy and big data analytics: A stakeholder perspective. *Technological Forecasting and Social Change*, 144, 466-474. <https://doi.org/10.1016/j.techfore.2018.06.030>
18. Isichei, E. E., Emmanuel Agbaeze, K., & Odiba, M. O. (2020). Entrepreneurial orientation and performance in SMEs: The mediating role of structural infrastructure capability. *International Journal of Emerging Markets*, 15(6), 1219-1241. <https://doi.org/10.1108/IJOEM-08-2019-0671>
19. Kaplan, S., & Vakili, K. (2015). The double-edged sword of recombination in breakthrough innovation. *Strategic Management Journal*, 36(10), 1435-1457. <https://doi.org/10.1002/smj.2294>
20. Kim, J. S., & Chung, G. H. (2017). Implementing innovations within organizations: A systematic review and research agenda. *Innovation*, 19(3), 372-399. <https://doi.org/10.1080/14479338.2017.1335943>
21. Kirkley, W. W. (2016). Entrepreneurial behaviour: the role of values. *International Journal of Entrepreneurial Behavior & Research*, 22(3), 290-328. <https://doi.org/10.1108/IJEER-02-2015-0042>
22. Lopes, W. S., & Sassi, R. J. (2019). Development of technology-based firms of the Vale do Paraíba Paulista region: survey with incubators managers and incubated companies. *Gestão & Produção*, 26. <https://doi.org/10.1590/0104-530X1302-19>
23. Love, P. E., Liu, J., Matthews, J., Sing, C. P., & Smith, J. (2015). Future proofing PPPs: Life-cycle performance measurement and building information modelling. *Automation in Construction*, 56, 26-35. <https://doi.org/10.1016/j.autcon.2015.04.008>

24. Martens, C. D. P., Machado, F. J., Martens, M. L., & de Freitas, H. M. R. (2018). Linking entrepreneurial orientation to project success. *International Journal of Project Management*, 36(2), 255-266. <https://doi.org/10.1016/j.ijproman.2017.10.005>
25. McClelland, D. C. (1987). Characteristics of Successful Entrepreneurs. *Journal of Creative Behavior*, 21, 219-233. <https://doi.org/10.1002/j.2162-6057.1987.tb00479.x>
26. Michelin, C. F., Minello, I. F., Siluk, J. C. M., Santos, J. R., Gerhardt, V.J and Stieler, E.G (2021). Mensuração do comportamento empreendedor como norteador de competitividade em startups na fase inicial do negócio. *Revista Espacios*, 42(2), 167-184. <https://doi.org/10.48082/espacios-a21v42n02p14>
27. Mitchell, J. R., Friga, P. N., & Mitchell, R. K. (2005). Untangling the intuition mess: Intuition as a construct in entrepreneurship research. *Entrepreneurship theory and practice*, 29(6), 653-679. <https://doi.org/10.1111/j.1540-6520.2005.00102.x>
28. Nandram, S. S., Mourmont, G., Norlyk Smith, E., Heaton, D. P., & Bindlish, P. K. (2018). Understanding entrepreneurial decision-making by objectivizing subtle cues. *Journal of management, spirituality & religion*, 15(5), 398-423. <https://doi.org/10.1080/14766086.2018.1503088>
29. Neneh, B. N. (2019). From entrepreneurial alertness to entrepreneurial behavior: The role of trait competitiveness and proactive personality. *Personality and Individual Differences*, 138, 273-279. <https://doi.org/10.1016/j.paid.2018.10.020>
30. Neto, R. D. C. A., Rodrigues, V. P., Stewart, D., Xiao, A., & Snyder, J. (2018). The influence of self-efficacy on entrepreneurial behavior among K-12 teachers. *Teaching and Teacher Education*, 72, 44-53. <https://doi.org/10.1016/j.tate.2018.02.012>
31. Păunescu, C., & Badea, M. R. (2014). Examining the social capital content and structure in the pre-start-up planning. *Procedia Economics and Finance*, 15, 560-568. [https://doi.org/10.1016/s2212-5671\(14\)00510-3](https://doi.org/10.1016/s2212-5671(14)00510-3)
32. Peng, M. W., Sun, W., Vlas, C., Minichilli, A., & Corbetta, G. (2018). An institution-based view of large family firms: A recap and overview. *Entrepreneurship Theory and Practice*, 42(2), 187-205. <https://doi.org/10.1177/1042258717749234>
33. Pettersen, I. B., & Tobiassen, A. E. (2012). Are born globals really born globals? The case of academic spin-offs with long development periods. *Journal of International Entrepreneurship*, 10, 117-141. <https://doi.org/10.1007/s10843-012-0086-5>
34. Picken, J. C. (2017a). From founder to CEO: An entrepreneur's roadmap. *Business Horizons*, 60(1), 7-14. <https://doi.org/10.1016/j.bushor.2016.09.004>
35. Picken, J. C. (2017b). From startup to scalable enterprise: Laying the foundation. *Business Horizons*, 60(5), 587-595. <https://doi.org/10.1016/j.bushor.2017.05.002>
36. Piperopoulos, P., & Dimov, D. (2015). Burst bubbles or build steam? Entrepreneurship education, entrepreneurial self-efficacy, and entrepreneurial intentions. *Journal of small business management*, 53(4), 970-985. <https://doi.org/10.1111/jsbm.12116>
37. Pujol-Cols, L., & Dabos, G. E. (2020). Dispositional and situational factors at work: A validation of scales and examination of effects on job satisfaction. *Academia Revista Latinoamericana de Administración*, 33(1), 49-70. <https://doi.org/10.1108/ARLA-12-2017-0355>
38. Riviezzo, A., Santos, S. C., Liñán, F., Napolitano, M. R., & Fusco, F. (2019). European universities seeking entrepreneurial paths: the moderating effect of contextual variables on the entrepreneurial orientation-performance relationship. *Technological Forecasting and Social Change*, 141, 232-248. <https://doi.org/10.1016/j.techfore.2018.10.011>
39. Rodrigo, L. M., Román, G., & Ricci, E. (2018). Immigrant entrepreneurs in Antofagasta, Chile: The contribution of South-South entrepreneurs. *Academia Revista Latinoamericana de Administración*, 31(3), 450-470. <https://doi.org/10.1108/ARLA-11-2016-0301>
40. Saaty, T. L. (1980). The analytic hierarchy process, New York: Mcgrew hill. *International, Translated to Russian, Portuguese and Chinese, Revised edition, Paperback (1996, 2000), Pittsburgh: RWS Publications*, 9, 19-22.
41. Shirokova, G., Osiyevskyy, O., & Bogatyreva, K. (2016). Exploring the intention-behavior link in student entrepreneurship: Moderating effects of individual and environmental characteristics. *European Management Journal*, 34(4), 386-399. <https://doi.org/10.1016/j.emj.2015.12.007>

42. Tripathi, N., Oivo, M., Liukkunen, K., & Markkula, J. (2019). Startup ecosystem effect on minimum viable product development in software startups. *Information and Software Technology, 114*, 77-91. <https://doi.org/10.1016/j.infsof.2019.06.008>
43. Triviños, A. N. S. (2008). Introdução à pesquisa em ciências sociais: a pesquisa qualitativa em Educação. São Paulo: Atlas, 2010. UFRGS. *Cadastro de crianças, adolescentes e adultos em situação de rua e estudo do mundo da população adulta em situação de rua de Porto Alegre/RS. Porto Alegre.*
44. Wang, Y., Tsai, C. H., Lin, D. D., Enkhbuyant, O., & Cai, J. (2019). Effects of human, relational, and psychological capitals on new venture performance. *Frontiers in Psychology, 10*, 1071. <https://doi.org/10.3389/fpsyg.2019.01071>
45. Wynn, M., & Jones, P. (2019). Context and entrepreneurship in knowledge transfer partnerships with small business enterprises. *The International Journal of Entrepreneurship and Innovation, 20*(1), 8-20. <https://doi.org/10.1177/1465750318771319>
46. Xiao, J., & Zhao, Y. (2017, July). Key intellectual capital factors of competitiveness for startups: evidence from China. In *Proceedings of the 14th International Conference on Intellectual Capital, Knowledge Management & Organisational Learning* (pp. 301-309).
47. Yang, L. R., Huang, C. F., & Hsu, T. J. (2014). Knowledge leadership to improve project and organizational performance. *International Journal of Project Management, 32*(1), 40-53. <https://doi.org/10.1016/j.ijproman.2013.01.01>
48. Zanardo, R. P., Siluk, J. C. M., de Souza Savian, F., & Schneider, P. S. (2018). Energy audit model based on a performance evaluation system. *Energy, 154*, 544-552. <https://doi.org/10.1016/j.energy.2018.04.179>
49. Zhang, P., Wang, D. D., & Owen, C. L. (2015). A study of entrepreneurial intention of university students. *Entrepreneurship Research Journal, 5*(1), 61-82. <https://doi.org/10.1515/erj-2014-0004>
50. Zhü, K. (2014). Fuzzy analytic hierarchy process: Fallacy of the popular methods. *European Journal of Operational Research, 236*(1), 209-217. <https://doi.org/10.1016/j.ejor.2013.10.034>

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