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A BUSINESS PERFORMANCE MEASUREMENT SYSTEM FOR INCUBATED STARTUPS

UM SISTEMA DE MEDIÇÃO DE DESEMPENHO PARA STARTUPS INCUBADAS

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ABSTRACT

Purpose – The development of a model to measure and assess the performance of start-ups in a standard incubation process, based on 99 critical success factors identified as the most relevant for the context.
Design/methodology/approach – A total of three sequential steps were developed to reach the objectives proposed (Problem overview; modeling; and usage). The model was tested on four development stage incubation processes start-ups and three maturity stage incubation processes start-ups, located at the Technological Incubator of Santa Maria (ITSM).
Findings – After the modeling phase, compromising results were found for only one developed stage start-up evaluated. Meanwhile, for the maturity stage, all three evaluated start-ups are competitive. To support the strategic decision-making process, the scores obtained were stratified to diagnose which perspective may compromise the performance of each start-up.
Originality/value – This research proved to be adaptable to the decision context, thus being amenable to be used in different scenarios. The model presented in this work is composed of a systematic tool suitable to support the continuous improvement and learning processes for incubated start-ups, in specific to measure and assess the performance of start-ups.
Keywords: Startups, Performance measurement, Technological incubators, Competitiveness.

RESUMO

Proposta – O desenvolvimento de um modelo para medir e avaliar o desempenho de startups em um processo padrão de incubação, baseado em 99 fatores críticos de sucesso identificados como os mais relevantes para o contexto.

Metodologia – Um total de três etapas sequenciais foram desenvolvidas para atingir os objetivos propostos (visão geral do problema; modelagem e uso). O modelo foi testado em quatro startups em estágio de desenvolvimento e três startups em estágio de maturidade, localizados na Incubadora Tecnológica de Santa Maria (ITSM).

Resultados – Após a fase de modelagem, os resultados comprometedores foram encontrados para apenas uma startup em estágio de desenvolvimento. Enquanto isso, para o estágio de maturidade, todas as três startups avaliadas são competitivas. Para apoiar o processo decisório estratégico, os escores obtidos foram estratificados para diagnosticar quais perspectivas podem comprometer o desempenho de cada startup.

Originalidade – Esta pesquisa mostrou-se adaptável ao contexto de decisão, sendo, portanto, passível de ser utilizada em diferentes cenários. O modelo apresentado neste trabalho é composto por uma ferramenta sistemática adequada para apoiar a melhoria contínua e os processos de aprendizagem para startups incubadas, em específico para medir e avaliar o desempenho de startups.

Palavras-chave: Startups, Mensuração de desempenho, Incubadoras tecnológicas, Competitividade.

1 INTRODUCTION

The ability to generate knowledge and transform it into wealth and social development is directly related to actions proposed by government, universities, and business companies (Etzkowitz, 2003; Lundberg, 2013; Jimenez-Zarco et al., 2013; Ye *et al.*, 2013). Since the 1950s, the incubators have grown in influence, number, and variety (Mian, Lamine & Fayolle, 2016). Therefore, incubators have been part of a Brazilian national innovation system, created to promote the interaction between researchers and institutions (universities, public and private organizations), guided towards technology transfer, knowledge generation, and protection (Chandra & Fealey, 2009; Salvador & Rolfo, 2011; Soetanto & Jack, 2013). Table 1 presents the incubation status and important characteristics of the five incubation stages.

Table 1: Five incubation stages.

Incubation stage	Main characteristic	Incubation status
Initiation (Seed)	The conception of the idea, market research, and business plan development	Pre-incubation
Development	Financial resources (investments), Prototypes testing, development of social networks, brand design, and relationships with potential customers/suppliers	Incubation
Growth (Expansion)	Products' commercialization, checking the balance between costs-venues, and the expansion of physical and organizational infrastructure	Incubation
Maturity (Establishment)	The developed product is already consolidated in the market	Graduation
Aging	Products' technological limit. Reevaluation of market niche, technology, and processes	Post-graduation

Source: Authors.

When referring to startups, many incubators suffer from a lack of mechanisms to support business management. Thus, incubators are limited to provide physical infrastructure and support services, which is not fundamental to support startup innovation and business processes (Al-Mubaraki & Busler, 2010; Soetanto & Jack, 2013). Startups have several critical moments, especially in the very early incubation stages, where the strategic resources cannot always available to produce (Somsuk *et al*., 2012; Knockaert, 2013), and many startups managers do not know if they have the right value proposition and the right process to deliver value proposition (Sheehan & Bruni-Bossio, 2015).

As a traditional organization structure, incubators governance needs to be explored concerning the relationships between startups management board, clients, and key stakeholders (Mian, Lamine, & Fayolle, 2016), implementing mechanisms for business management to provide visibility to startups evolution, to support productivity strength and to increase the competitiveness, to reduce risks during the incubation process. Thus, the knowledge about the Critical Success Factors (CSFs) that contributes to the startup empowerment and sustainability is fundamental, aiming to create new strategies focused on the economic development process (Patton *et al*., 2009).

Given these aspects, the research problem is to measure and monitor the startup performance, considering the CSFs of the incubation business context and its incubation stage. Therefore, the main objective of this research is to propose a model for startups performance evaluation within a standard incubation process through a performance measurement system. In a modern organizational vision, developing performance measurement systems is a key factor in supporting management, enable the decision to support a systematic process at the right time of the organization's operations. The decision support system helps to reduce performance shortfall, which has a significant and negative impact on the startup structure since underperformance leads to resources conservation (Osiyevskyy & Dewald, 2015).

Therefore, some points define the importance of this paper. The complexity of startups context (Onetti *et al*., 2012; Knockaert *et al*., 2013), the sensible need to implement management tools capable of improving the startup business performance, avoiding the managerial deficiencies described by Hackett and Dilts (2004), Al-Mubaraki and Busler (2010), and Soetanto and Jack (2013). This systematic tool is an instrument to support startups for operational excellence, allowing the measure of essential aspects, quantifying the startup CSFs performance. This study contributes to the scientific community, presenting an original proposal aiming to measure the startup development, based on CSF listed as fundamental for the incubation business context.

The paper is organized as follows. Section 2 presents the methods adopted to develop this research. Section 3 presents the results and discussion. Finally, Section 4 presents some final remarks and future research ideas about the problem.

2 METHODS

For the methodological procedures, a total of three sequential steps were developed to reach the objectives proposed, as shown in Figure 1: Problem overview; modeling; and usage. Firstly, a problem overview was conducted to compile the main literature review and concepts about incubators, startups, and business performance evaluation.

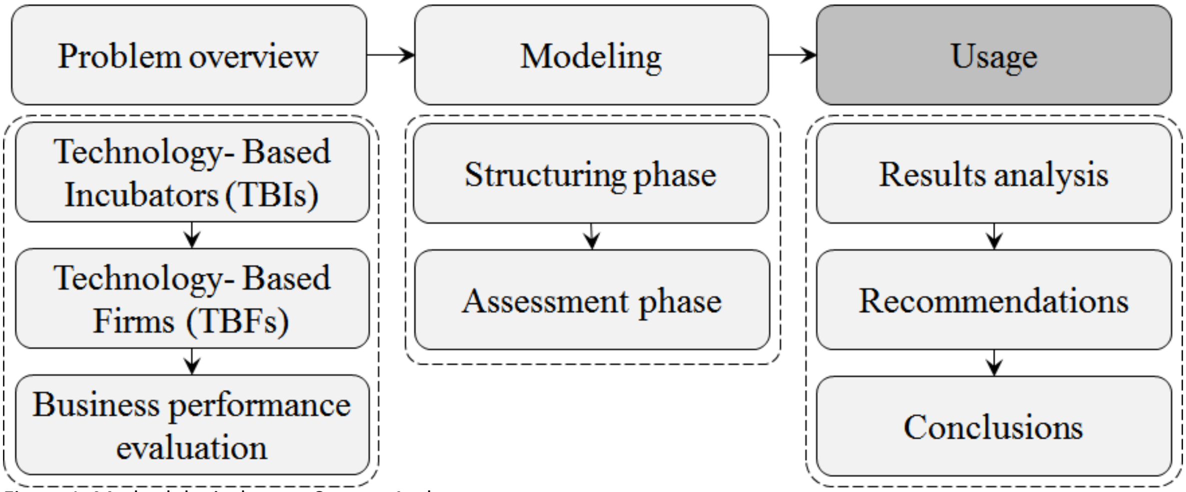


Figure 1: Methodological steps. Source: Authors.

For the modeling development step, the concepts proposed by De Oliveira Lacerda *et al.* (2011), Doumpos and Grigoroudis (2013), and Ensslin *et al.* (2013) about Multiple-Criteria Decision Analysis (MCDA) were considered. The decision-making flow proposed by Guitouni and Martel (1998) was used to found intrinsic characteristics and guidelines of the incubation business context, to enable the generation of consistent information.

Figure 2 shows the modeling development step, considering the structuring and assessment phases to obtain the performance evaluation model.

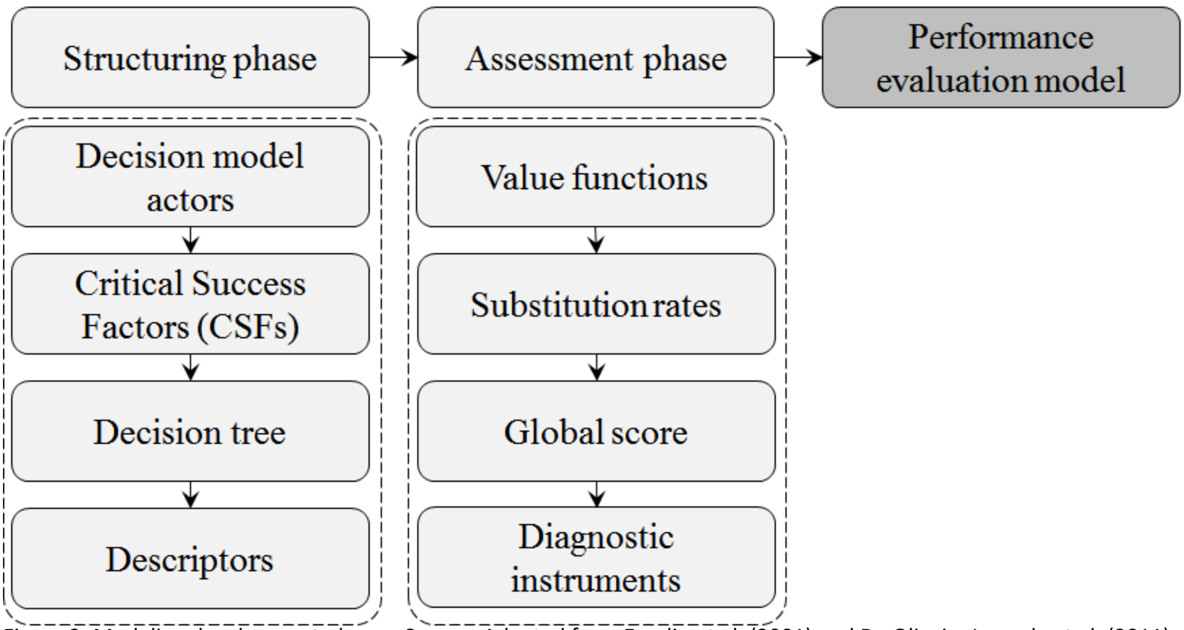


Figure 2: Modeling development phases. Source: Adapted from Ensslin et al. (2001) and De Oliveira Lacerda et al. (2011).

The decision model actors' description follows the assumptions designated by Da Rosa (2012), where the actors are divided into three groups: Decision-makers; facilitators; and acted. The decision-makers (startups managers) are responsible for making decisions on the startups' business management process. The facilitators (in our research the researchers) support the decision-makers to apply the tools developed. Finally, the acted suffer the consequences of the startups' business context, without participating directly in the decision-making process.

Research in the literature review was proposed to understand the particularities and most precise strategies adopted to manage incubators and startups, to find explanatory variables of the incubation business context process to establish CSFs. To evaluate the startups' growth, a total of 99 CSFs were developed, based on researches proposed by Somsuk *et al.* (2012), Soetanto and Jack (2013), Knockaert *et al.* (2013), and Siluk *et al.* (2017).

To organize the CSFs in a hierarchical structure, the Resource-Based View (RBV) theory was used to develop the decision tree (Scarano et al., 2014; Neuenfeldt Júnior et al., 2014; Alves et al., 2015; Costa et al., 2015; Neuenfeldt Júnior et al., 2015; Nora et al., 2016; Júnior et al., 2018). This process was conducted by expert researchers on incubators, demonstrating the hierarchical relationship between the CSFs and the five FPV proposed. The requirements for a startup success are factors and strategic assets, where human resources, technology, financial, organizational, and social were designated in five Fundamental Points of View (FPV): Human resources (FPV_1); Technological resources (FPV_2); Financial resources (FPV_3); Organizational resources (FPV_4); and Social resources (FPV_5). The FPVs are at the top of the decision tree structure. Next, 18 CSFs were allocated at the second level, 48 CSFs at the third level, 30 CSFs at the fourth level, and 4 CSFs at the fifth level.

To map startup performance, the descriptors are proposed to measure the performance levels for CSFs. The first definition was assigning the "Good" and "Neutral" concepts, respectively, in two performance levels available for each CSFs. A list comprising all performance levels corresponding to the operational excellence (located above the "Good" level) was structured, and another one that reflects a situation considered compromising (located below the "Neutral" level). Descriptors between "Neutral" and "Good" levels define startups with an acceptable competitive capacity.

The assessment phase is performed in three parts: Vale function; substitution rates; global scores; and diagnostic instruments.

To measure in quantitative scales the equivalent impact of CSFs in the global performance evaluation, value functions Z_i were proposed for the 99 CSF_i. "Neutral" performance level descriptors received a score $Z_i = 0$, while "Good" performance level descriptors received a score $Z_i = 100$. Scores below zero represent a compromising performance. On the other hand, scores above 100 represent that the startup obtained an excellent performance higher than expected for the criteria. Aiming to exemplify both the descriptors and value functions, Table 2 presents the content describing the number of patents (CSF_{19}) registered by a specific startup. The FPVs measures were developed using the same structure developed for CSFs.

Table 2: CSF_{19}: Patents.

CSF_{19}	Patents		
Concept	The startup has registered patents in the year... The startup has not registered any patent.		
Performance level	**Description**	**Descriptors**	**Value functions**
N1	More than 5 patents registered		150
N2	Between 2 and 4 patents registered	Good	100
N3	One patent registered	Neutral	0
N4	No patents registered		-100

Source: Authors.

To measure the Patents (CSF_{19}) criterion, four performance levels were stipulated, two being designated as descriptors: N3 as "Neutral" level and N2 as "Good" level. The value function is negative ($Z_i = -100$) when performance is below the expectation, verified for startups with no patents. In contrast, a result above the expected is verified when the startup was able to register more than 5 patents, considered as above competitive performance, with a value function (Z_i = 150).

The *substitution rates* (W_i) represent the importance degree assigned by decision-makers for CSF_i. The bottom-up format was the logic chosen, where the fourth level CSFs are initially quantified by the decision-maker, considering as a qualitative reference the CSFs directly located at the third level in the decision tree. Located in the first level of the decision tree, the substitution rates of the FPVs are the last to be quantified.

The substitution rates can vary between 0% and 100% proportionally to three conditions: a) the CSFs relevance in a pairwise comparison with CSFs directly related to CSF (or FPV) located at a higher level of the decision tree; b) the total number of CSFs (or FPVs) located at the same level of the decision tree; and c) the lower the location of the CSF in the decision tree, the less important it is to the problem. Based on the relative position of CSF_i in the decision tree, the substitution rates are normalized using the swing weights method (Doumpos & Grigoroudis, 2013).

An additive aggregation function was adopted to calculate startups' global score V(β), where β is the index to represent the startups. V(β) is calculated by the sum of the normalized substitution rates W_i of all CSFs and the value function score $Z_i(\beta)$, as shown in equation (1):

$$V(\beta) = \sum_{i=1}^{99} w_i Z_i(\beta) \quad (1)$$

To obtain the necessary data for the performance measurement system proposed objective of this research, two diagnostic instruments were developed, based on the descriptors, vale functions, and substitution rates.

The first instrument (called "Instrument 1") intends to collect the importance degree assigned to each CSF from decision-makers, generating the information needed to calculate substitution rates. For "Instrument 1", a document containing the 99 CSFs was prepared, followed by a scale ranging from zero, indicating the CSF absence of importance, to 10, when CSF is important. Different weights were obtained for both development and maturity stages.

The second instrument (called "Instrument 2") is responsible for identifying performance levels achieved by each startup during the assessment modeling process. The "Instrument 2" has multiple-choice questions, where the respondents must describe the startups' performance level (e.g. N1, N2, N3, ...), according to the startup situation for each CSF.

The performance evaluation model is the final product obtained to analyze the current situation of each startup. This evaluation was built distributing in the hierarchy of a decision tree the 99 CSFs, using the metrics and rating scales provided by descriptors and value functions, CSF substitution rates, and the overall evaluation function. The information used as input for modeling and perform the startups' evaluation was collected by the two diagnostic instruments presented ("Instrument 1" and "Instrument 2").

To test and provide a practical usage for the modeling proposed, the Technological Incubator of Santa Maria (ITSM), located at the Federal University of Santa Maria (UFSM), was chosen as an incubator for the performance measurement, based on the geographical proximity with the researchers and ITSM managers experience, fundamental to support the incubated startups in the innovation and business process. During the process, a semi-structured interview with ITSM and startups managers was conducted, to ensure the quality and accuracy of the information collected.

3 RESULTS AND DISCUSSION

This section aims to incorporate the information about the modeling to perform the evaluation analysis of seven development and maturity stage ITSM startups. Firstly, a brief characterization of the startups selected to test the modeling is proposed. Next, the substitutions rates were measured, using the "Instrument 1" separately for development and maturity stage startups. After identifying the performance level with the "Instrument 2", the global evaluation model achieved by each startup was calculated. With the results obtained, some recommendations and improvement goals aiming to improve the performance of non-competitive startups ($V(\beta) < \alpha$) were described.

The modeling usage was proposed in seven startups located in the ITSM, four in the development stage (β = A, β = B, β = C, β = C, and β = D) and three in the maturity stage (β = E, β = F, and β = G). Table 3 shows the incubation stage and the business sector of each startup selected.

Table 3: Characteristics of startups measured.

Startup	Incubation stage	Segment
Startup A	Development	Acoustic engineering
Startup B	Development	Information system
Startup C	Development	Information system
Startup D	Development	Information system
Startup E	Maturity	Agronomy
Startup F	Maturity	Information system
Startup G	Maturity	Information system

Source: Authors.

To identify the CSF importance degree, the "Instrument 1" was submitted individually for each startup's decision-maker. The substitution rates obtained considering the general result found in both development stage and maturity stage startups are presented for Human resources FPV_1 (Table 4), Technological resources FPV_2 (Table 5), Financial resources FPV_3 (Table 6), Organizational resources FPV_4 (Table 7), and Social resources FPV_5 (Table 8). All substitution rates data were compiled using V.I.S.A. standard edition decision-making software.

Table 4: Human resources (FPV_1) CSFs and substitution rates.

CSF_i	Description	Substitution rates w_i (%)	
		Development stage	Maturity stage
	FPV_1 : **Human resources**	**16.2**	**13.3**
CSF_1	**1.1 Skills development**	**17.2**	**22.5**
CSF_2	1.1.1 Participation in courses	100.0	50.0
CSF_3	1.1.2 Perception of development	0.0	50.0
CSF_4	**1.2 Professional experience**	**12.1**	**7.9**
CSF_5	**1.3 Educational background**	**13.8**	**9.0**
CSF_6	**1.4 Entrepreneurial orientation**	**51.7**	**29.2**
CSF_7	1.4.1 Leadership	33.0	34.6
CSF_8	1.4.2 Competitors	33.0	30.8
CSF_9	1.4.3 Management	33.0	34.6
CSF_{10}	**1.5 Planning**	**5.2**	**31.5**
CSF_{11}	1.5.1 Team	100.0	32.1
CSF_{12}	1.5.2 Career Plan	0.0	32.1
CSF_{13}	1.5.3 Training level	0.0	35.7

Source: Authors.

For the development stage, Technological Resources (FPV_2) with 32.4% present the highest importance degree comparing all five FPVs, incorporating the product's adaptation and insertion in the market and their management. Among Technological Resources (FPV_2) CSFs, the highest representation is the startup' Management of innovation (W_{33} = 60.3%), mainly through its planning activities that involve innovation, as well as adapting to its strategies.

Regarding Technological resources (FPV_2), with 26.4%, the diagnostic presents a greater emphasis on Innovation management (W_{33} = 31.6%), followed by the advantage presented by the startup's main Products (services) advantage (W_{24} = 24.9%). The lowest substitution rates are linked to the adequacy of the startup's main products (services or processes) in the market in which the startup is inserted, named as Merchantability (W_{30} = 9.0%).

Table 5: Technological resources (FPV_2) CSF and substitution rates.

CSF_i	Description	Substitution rates w_i (%)	
		Development stage	**Maturity stage**
	FPV_2 : **Technological resources**	**32.4**	**26.4**
CSF_{14}	**2.1 Product mix**	**13.8**	**10.2**
CSF_{15}	2.1.1 Number of products developed	50.0	55.6
CSF_{16}	2.1.2 Number of products in development	50.0	44.4
CSF_{17}	**2.2 Research**	**0.0**	**9.0**
CSF_{18}	2.2.1 Total invested in R&D in the year	0.0	56.3
CSF_{19}	2.2.2 Number of patents	0.0	43.7
CSF_{20}	**2.3 Degree of innovation**	**25.9**	**15.3**
CSF_{21}	2.3.1 Degree of technical innovation	33.0	29.6
CSF_{22}	2.3.2 Degree of innovation competence	33.0	37.0
CSF_{23}	2.3.3 Startup' degree of innovation	33.0	33.3
CSF_{24}	**2.4 Product advantage**	**0.0**	**24.9**
CSF_{25}	2.4.1 Advantage over competitors	0.0	18.2
CSF_{26}	2.4.2 Quality advantage	0.0	18.2
CSF_{27}	2.4.3 Advantage of the benefits	0.0	18.2
CSF_{28}	2.4.4 Advantage of using	0.0	22.7
CSF_{29}	2.4.5 Advantage of efficiency	0.0	22.7
CSF_{30}	**2.5 Merchantability**	**0.0**	**9.0**
CSF_{31}	2.5.1 Learning	0.0	43.7
CSF_{32}	2.5.2 Technology knowledge	0.0	56.3
CSF_{33}	**2.6 Innovation management**	**60.3**	**31.6**
CSF_{34}	2.6.1 Innovation culture	14.3	14.3
CSF_{35}	2.6.2 Planning	28.6	30.4
CSF_{36}	2.6.2.1 Processes	50.0	52.9
CSF_{37}	2.6.2.2 Measurement	50.0	47.1
CSF_{38}	2.6.3 Innovation incentives	14.3	14.3
CSF_{39}	2.6.4 Training for innovation	14.3	12.5
CSF_{40}	2.6.5 Strategy	28.6	28.6
CSF_{41}	2.6.5.1 Strategy clarity	50.0	50.0
CSF_{42}	2.6.5.2 Connection with the business strategy	50.0	50.0

Source: Authors.

The importance degree equal to zero for Financial resources (FPV_3) represents, according to the decision-makers, the lack of relevance of the economic aspects when the startup is still in the initial stages of the business development process.

Different from the development stage, in the maturity stage, the Financial resources (FPV_3) with 8.9% was considered by the decision-makers a relevant aspect capable to be influential in the startups business management.

Table 6: Financial resources (FPV_3) CSF and substitution rates.

CSF_i	Description	Substitution rates w_i (%)	
		Development stage	Maturity stage
	FPV_3: Financial resources	**0.0**	**8.9**
CSF_{43}	**3.1 Economic indicators**	**0.0**	**83.3**
CSF_{44}	3.1.1 Net margin	0.0	20.0
CSF_{45}	3.1.2 Revenue growth	0.0	20.0
CSF_{46}	3.1.3 Return over investment	0.0	20.0
CSF_{47}	3.1.4 Rapid liquidity	0.0	20.0
CSF_{48}	3.1.5 Break-even-point	0.0	20.0
CSF_{49}	**3.2 Planning level**	**0.0**	**16.7**

Source: Authors.

For the maturity stage, the Organizational resources (FPV_4), with 38.3%, is the most important FPV. The greatest importance level found for Organizational resources is the Market knowledge (W_{50} = 58.2%) related to the startups' context, followed by the adoption of Management practices (W_{73} = 34.0%) and the Incubator support (W_{70} = 7.8%) provided.

Table 7: Organizational resources (CSF and substitution rates.

CSF_i	Description	Substitution rates w_i (%)	
		Development stage	Maturity stage
***FPV4* Organizational resources**		**22.1**	**38.3**
$\boldsymbol{CSF_{50}}$	**4.1 Market knowledge**	62.0	58.2
CSF_{51}	4.1.1 Market knowledge in relation to customers	14.3	43.0
CSF_{52}	4.1.1.1 Level of knowledge	0.0	15.6
CSF_{53}	4.1.1.2 Location	0.0	12.5
CSF_{54}	4.1.1.3 Feedback	0.0	12.5
CSF_{55}	4.1.1.4 Forecast	0.0	14.1
CSF_{56}	4.1.1.5 Preference	0.0	14.1
CSF_{57}	4.1.1.6 Prospecting	100.0	15.6
CSF_{58}	4.1.1.7 Market research	0.0	15.6
CSF_{59}	4.1.2 Market knowledge in relation to competitors	85.7	36.9
CSF_{60}	4.1.2.1 Level of knowledge	16.7	18.2
CSF_{61}	4.1.2.2 Segment	16.7	18.2
CSF_{62}	4.1.2.3 Forecast	16.7	14.5
CSF_{63}	4.1.2.4 Competitors releases	16.7	16.4
CSF_{64}	4.1.2.5 Competitors prices	16.7	16.4
CSF_{65}	4.1.2.6 Other solutions	16.7	16.4
CSF_{66}	4.1.3 Market knowledge in relation to suppliers	0.0	20.1
CSF_{67}	4.1.3.1 Suppliers definition	0.0	33.3
CSF_{68}	4.1.3.2 Quality of suppliers products	0.0	33.3
CSF_{69}	4.1.3.3 Problems with suppliers	0.0	33.3
$\boldsymbol{CSF_{70}}$	**4.2 Incubator support**	25.3	7.8
CSF_{71}	4.2.1 Services	50.0	50.0
CSF_{72}	4.2.2. Infrastructure – use	50.0	50.0
$\boldsymbol{CSF_{73}}$	**4.3 Management practices**	12.7	34.0
CSF_{74}	4.3.1 Marketing	0.0	65.6
CSF_{75}	4.3.1.1 Planning level	0.0	15.7
CSF_{76}	4.3.1.2 Prices strategy	0.0	17.5
CSF_{77}	4.3.1.3 Marketing indicators	0.0	66.8
CSF_{78}	4.3.1.3.1 Total of clients	0.0	26.0
CSF_{79}	4.3.1.3.2 Customer portfolio	0.0	24.1
CSF_{80}	4.3.1.3.3 Satisfaction level	0.0	23.6
CSF_{81}	4.3.1.3.4 Budget rejection	0.0	26.2
CSF_{82}	4.3.2 Processes	0.0	22.9
CSF_{83}	4.3.2.1 Adoption of production process	0.0	50.0
CSF_{84}	4.3.2.2. Fitness of physical space	0.0	50.0
CSF_{85}	4.3.3 Adoption of management practices	100.0	11.5

Source: Authors.

The second highlighted FPV in the development stage is Social resources (representing 29.3% of the importance degree. The most significant CSF is the Technical scientific networks (where the interactions with research centers and educational institutions are the aspects considered for startup's success.

For Human resources (the relative importance is equal to 16.2% and 22.1% for Organizational resources (with the greatest influence found, respectively, for the Entrepreneurial orientation and Market knowledge factors). Both are relevant to increase the knowledge about the market context, the main direct competitors, to improve the level of competitiveness and growth conditions of the startups during the development stage.

Table 8: Social resources (FPV_5) CSF and substitution rates.

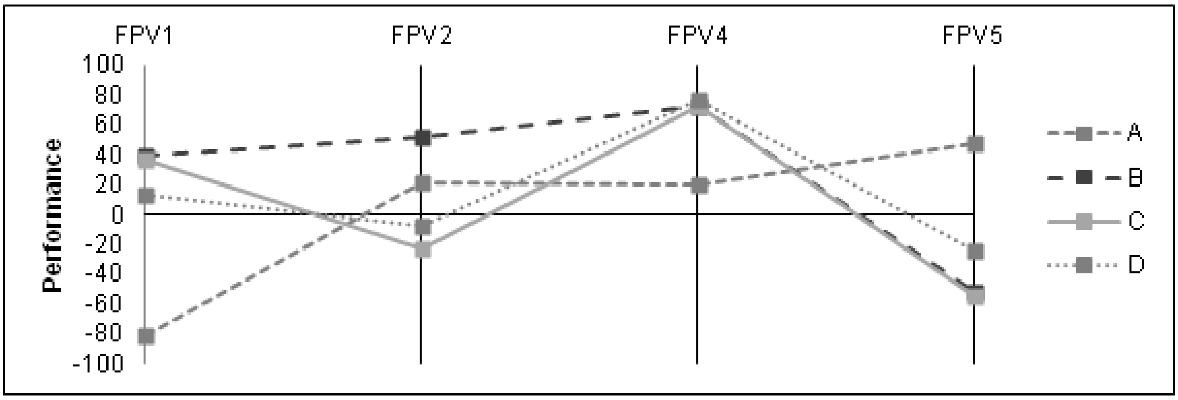
CSF_i	Description	Substitution rates w_i (%)	
		Development stage	Maturity stage
	FPV_5 : Social resources	**29.3**	**13.1**
CSF_{86}	**5.1 Technical-scientific networks**	**61.9**	**61.4**
CSF_{87}	5.1.1 Partnerships with development institutions	7.7	14.8
CSF_{88}	5.1.2 Technological transfer	15.4	13.0
CSF_{89}	5.1.3 Interaction with research institutes	76.9	72.2
CSF_{90}	5.1.3.1 Collaborators universities	20.0	20.5
CSF_{91}	5.1.3.2 Collaborator researcher	20.0	17.9
CSF_{92}	5.1.3.3 Product origin university	20.0	20.5
CSF_{93}	5.1.3.4 Interaction with the university in product development process	20.0	20.5
CSF_{94}	5.1.3.5 Use of university laboratory	20.0	20.5
CSF_{95}	**5.2 Business networks**	**38.1**	**38.6**
CSF_{96}	5.2.1 Interaction companies and incubators - inside	25.0	29.4
CSF_{97}	5.2.2 Interaction companies and incubators - outside	25.0	23.5
CSF_{98}	5.2.3 Relationship with companies in the surroundings	25.0	23.5
CSF_{99}	5.2.4 Relationship with companies outside surrounding	25.0	23.5

Source: Authors.

To collect the information about startups status for the 99 CSFs, the "Instrument 2" was applied, using value function score Z_i (β) as input data required to assess the global performance evaluation (V(β)).

Figure 3 shows a comparison of the performance obtained for the development stage startups ((β = A, β = B, β = C, and β = D) in each FPV. A competitive performance level (V(β) between 0 and 100) is verified for three startups: V(A) = 12; V(B) = 24; and V(D) = 10. However, *Startup* C presented a compromising performance V(C) = -1, a not satisfactory value very close to the minimum value (V(β) = 0) to consider a competitive startup.

Figure 3: Development stage Startup A, B, C, and D performance for each FPV.



Source: Authors.

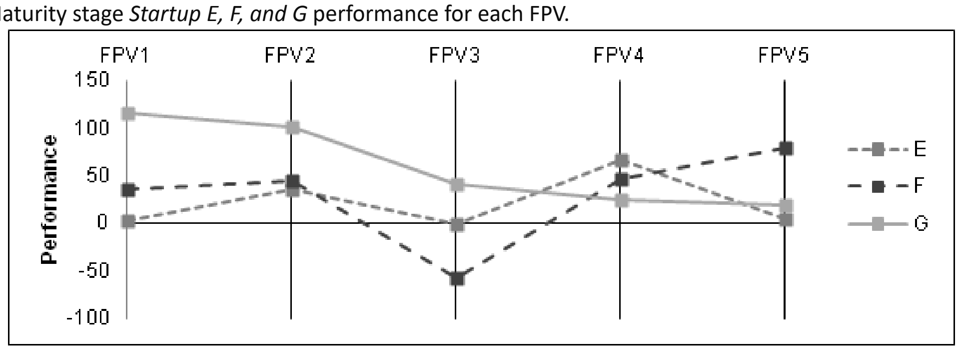
Only for Organizational resources (FPV_4) all startups in the development stage shown a competitive performance, a fact explained by the high performance obtained for the factor Incubator support (CSF_{70}). Moreover, for Startup B, C, and D, the iteration between these startups with research institutions, incubators, other startups, and business entities a satisfactory performance was not achieved, resulting in a poor performance for Social resources (FPV_5) aspects. Regarding Human resources (FPV_1), *Startup A* obtained a compromising result (V(A) = -81), a fact explained by the low-performance levels registered in the factors Professional experience (CSF_4) Z_4 = -150 and Educational background (CSF_5) Z_5(A) = -200, which negatively influences the global performance evaluation.

The compromising level of *Startup* C may be explained by performance levels lower in FPV_2 (-22) and in FPV_5 (-52), which have higher substitution rates. For *Startup* B, despite the poor performance in FPV_5 (-52), the results of FPV_1 (40), FPV_2 (52), and FPV_4 (78) are satisfactory, achieving a higher level of competitiveness compared to the other development-stage startups.

Figure 4 shows a comparison of the performance obtained for the maturity stage startups (β = E, β = F, and β = G) in each FPV. All three startups reached a competitive performance level, with a global performance equal to V(E) = 36, V(F) = 40, and V(G) = 58. Only the FPV_3 (-58) measured for *Startup F* results in a non-competitive performance level, based on the poor performance achieved for CSFs Economic indicators (CSF_{43}) and Planning level (CSF_{49}), where Z_{43}(F) = -80 and Z_{49}(F) = -200.

Despite being in the maturity stage with three years of the incubation process, *Startup E* is not competitive for FPV_1 (-2). The growth of the entrepreneurial skills of the stakeholders was not significant and, also, weak human resources planning. A similar result was found for FPV_5 of *Startup E* (4) and *Startup G* (20), where few interactions with educational institutions or other incubators were developed over the years, which reduce substantially the global performance of both startups.

Figure 4: Maturity stage *Startup E, F, and G* performance for each FPV.



Source: Authors.

Startups living in the maturity stage present higher performance levels. This is a logical observation since this is the main goal of a business incubator. However, some commonalities could be observed, as little or no development of interactions between startups or with another incubator, which compromised the results for assessing Social resources (FPV_5) and indicated the need for the ITSM (incubator selected to be studied) to promote actions encouraging the establishment of networks. Low investment in the development of new products is a critical factor to generate new technologies.

Based on the results obtained through the global evaluation, some recommendations and improvement goals were described for non-competitive startups ($V(\beta) < 0$) and/or for startups with the worst results in the two incubation stages. According to the results presented, *Startup C* (currently located in the development stage) was the unique non-competitive startup ($V(C) = -1$), and *Startup E* is the maturity stage startup with the worst global performance result ($V(E) = 36$).

For *Startup C*, which showed compromising performances for Technological resources FPV_2 (-22) and Social resources FPV_5 (-52), a mean value between “Neutral” and “Good” performance level equal to 50 was established as a target value to be reached in FPV_2 and FPV_5. The objective is to change the *Startup C* performance from a compromising level to a competitive level.

According to the results found for CSF located in FPV_2 and FPV_5, some improvement recommendations are proposed to reach the target value, as the development of, at least, one product. Also, invest 5% of financial resources in research and development, register a patent (product or software), show a growth in the level of innovation, and create a partnership with different research institutes and other startups. If *Startup C* would proceed with the adjustments presented, the overall performance changes from $V(C) = -1$ to $V(C) = 47$.

Currently, startups are in a highly competitive scenario, by increasingly competitive markets, which implies the adoption of goals aimed at the excellence and startup differentiation. Additionally, a similar analysis was proposed for the startup in the maturity stage with the worst global performance result, even *Startup E* showed a positive result ($V(E) = 36$). The adjustments and the current $Z_t(E)$ value for the CSFs with the most critical results ($Z_t(E) \leq 0$) are presented in Table 9. With the adoption of the proposed recommendations, it is expected that the results for the 18 CSFs are sufficient to achieve a competitive performance level ($Z_t(E) = 100$), which is an excellent result.

Table 9: Adjustment actions for *Startup E.*

CSF_i	Current $Z_i(E)$ value	Adjustment
42	0	Establish a better link between innovation strategy and business strategy
44	0	Increase net margin to around 50%
47	-250	Increase liquidity to more than 100%
48	0	Have a break-even-point higher than zero
55	0	Establishing a greater knowledge of the market that allows making better demand forecasts
56	-100	Knowing the preference of the consumer market
58	-150	Establish a means of market research
63	-100	Anticipating the competitor's launches
65	-100	Present other solutions with anticipation to the market
78	-100	Have more than 50 clients
81	-200	Present a budget rejection rate of less than 25 percent
87	0	Have at least one partnership
88	-100	Have at least one partnership
90	0	Have at least one partnership
91	-100	Have at least one partnership
92	0	Have at least one product
94	-150	Use the laboratories of the research institution
97	-150	Have at least one partnership

Source: Authors.

If all proposed goals are achieved, the global development of *Startup E* reaches a global performance evaluation V(E) = 116, value 222% higher than the global performance measured by the proposed modeling (V(E) = 36). This fact puts *Startup E* in an excellent position and can be considered very competitive mainly in comparison with the other two maturity stage startups (*Startup F:* V(F) = 40 and *Startup G*: V(G) = 58). The best result is verified for Increase liquidity (CSF_{47}), where the measured value has grown from 0% (Z_{47}(E) = -250) to more than 100% (Z_{47}(E) = 100)).

4 CONCLUSIONS

The article presented a model for startups performance evaluation within a standard incubation process through a performance measurement system. The proposed objective has been achieved. Based on the measurement method, the results showed the level of performance reached by the studied startups, considering the organizational life cycle stage. Thus, the tests showed that the performance measurement system developed can be replicated to other startups. Such an application can be commercial, through consultancies, as scientific, to identify new patterns of results in other startups.

The bibliography presented and the three sequential steps of the methodological process were fundamental for the consolidation of the performance measurement system. The Resource-Based View (RBV) theory was used to develop the decision tree, demonstrating the hierarchical relation between CSFs and the five FPV proposed: Human resources; Technological resources; Financial resources; Organizational resources; and Social resources. The FPVs are at the top of the decision tree structure. The results are quantitatively associated with the performance of the startups, in the first instance, concerning each CFS, allowing in a second moment the verification of the conditions of the startups for the FPV, which are the top of the decision tree and respond directly to the objective of performance measurement proposed for the study.

We consider studies of this type essential for the evolution of a startup and, also, a fundamental tool for the management of technological incubators. An analysis does not exist without measurement. Thus, the diagnosis of possible improvements in the management of a startup is only possible by monitoring its current situation, which is one of the main focuses of the proposed performance measurement system.

This research proved to be adaptable to the decision context, thus being amenable to be used in different scenarios, and it can be characterized as a wide performance measurement system that is not just centralized to economic and financial aspects, besides being able to produce knowledge and increase understanding of the decision-maker regarding a specific decision context. As seen during the implementation period, only one of four startups in the developing stage showed unsatisfactory results. For the maturity incubation stage, all startups were competitive.

As recommendations for future work, we suggest the exploitation of other management tools such as Balanced Scored Card and Performance Prism, from the perspective of multi-criteria analysis to the suitability of the proposed model to these other tools, or association with other methodologies supported by the MCDA, as Data Envelopment Analysis (DEA) and Analytic Hierarchy Process (AHP). Also, the development of a model for performance evaluation is based on other techniques such as De Oliveira Lacerda et al. (2011).

Natural limitations were found during this research, mainly related to some communication difficulties with the decision-makers and a lack of information given by the startups selected.

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1. Definition of research problem	√	√			√
2. Development of hypotheses or research questions (empirical studies)		√			
3. Development of theoretical propositions (theoretical work)	√				
4. Theoretical foundation / Literature review	√		√		
5. Definition of methodological procedures	√	√	√		
6. Data collection	√			√	
7. Statistical analysis	√		√	√	
8. Analysis and interpretation of data	√	√	√		√
9. Critical revision of the manuscript			√	√	√
10. Manuscript writing	√		√		
11. Other (please specify)					