

## *The relationship between organizational culture and the performance of a technology startup: A Fuzzy Cognitive Maps based analysis*

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### **ABSTRACT**

*New organizations, such as startups, are more exposed to failure due to their vulnerability when arriving the market. Therefore, monitoring and managing performance indicators becomes essential, since they enable the achievement of strategic objectives. However, this process is impacted by the organizational culture, which guides the company's behavioral patterns. Therefore, this paper proposes the use of fuzzy cognitive maps to quantify the causal relations between Hofstede's cultural dimensions and the performance of a technology startup. The employed methodology is composed of three stages: literature review, computational model development and conduction of an illustrative application. It is classified as quantitative, axiomatic and normative, since it proposes a model from the identified gaps and the opinions of specialists, suggesting an approach that integrates the research concepts. The results indicate that the time for development is the most impacted indicator by culture. It can be concluded, therefore, that it was possible to consider the inherent subjectivity to the evaluation of the causal relations between culture and performance by applying the fuzzy cognitive map. Hence, action plans can be proposed to foster improvement initiatives that promote the culture-performance alignment.*

**Keywords:** *Organizational Culture; Performance Management; Fuzzy Cognitive Map; Startup.*

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## 1. INTRODUCTION

### 1.1 Justification and research question

One of the main motivations for analyzing and managing the performance of a startup is the fact that new organizations are more exposed to failure, as they are more vulnerable in the period of their formation (STINCHCOMBE, 1965). It is also observed that the world is going through an unprecedented period of entrepreneurship, which leads to new requirements in terms of managerial practices and to the conclusion that, although the techniques for performance management of large organizations have been improved in the last century, there is a lack of similar approaches adapted for newborn companies (RIES, 2012).

The particular relevance of leadership in the context of startups relates to the strong relationship between the behaviour of the leader with strategic vision and the performance of a new enterprise (CHAMMAS; HERNANDEZ, 2019). Ensley, Hmieleski and Pearce (2006) argue that the individual characteristics and behaviour of leaders can become imprinted into the organizational culture of firms, which is then institutionalized and difficult to later modify. Chatterji *et al.* (2019) state that organizational culture has a profound impact on the behaviour of individuals and is closely linked to leadership.

Organizational culture refers to the standardized way in which individuals react to internal problems and deal with external relations relevant to their organization (SCHEIN, 2010). Therefore, it has a direct impact on performance (GORDON; DITOMASO, 1992). Culture guides behavioral patterns well enough to be transmitted to new organizational members and those who refuse to accept it are subject to being controlled by the forces that derive from it (SCHEIN, 2010).

Kaplan and Norton (1993) state that performance management is essential to achieve the organizational objectives defined by the strategic planning. Thus, managers which are capable of deploying these objectives into coherent performance indicators make it feasible to identify improvement gaps, so that they can be effectively surpassed (MARTINS; COSTA NETO; 1998).

However, the complexity in describing and analyzing the cause and effect relationship between organizational culture and performance derives from the inherent subjectivity that regards this task. To overcome this issue, the use of computational intelligence techniques and

computational processing of human language (computing with words) is recommended (ZADEH, 2001). Among the computing with words techniques, according to Lima Junior, Osiro and Carpinetti (2013), fuzzy logic and its variations stand out in most applications related to decision support.

To model cause and effect relationships, the cognitive map stands out for its flexibility and efficiency in handling systems where complex interactions occur (FURNARI, 2015). Fuzzy Cognitive Maps (FCMs) are neuro-fuzzy systems capable of incorporating experts' knowledge, uncertainty and of providing a graphical representation easily interpreted by humans (SALMERON; PAPAGEORGIU, 2012; KONAR; CHAKRABORTY, 2005). They are structured by nodes, which indicate the most relevant factors of a decisional situation, and links between these nodes, which model their relations (KOSKO, 1986).

In this direction, few studies propose models to aid entrepreneurs for improving new businesses performance. Chammas and Hernandez (2019) seek to assess the leadership influence in startups results. Chatterji *et al.* (2019) explore whether advices founders receive influences startup performance. Seo, Kim and Lee (2018) address the effects of knowledge assets on startups outcomes. Rompho (2018) seeks to investigate the use of performance measures in startup firms. Gelderen, Frese and Thurik (2000) study the relation between strategy and startups results. However, they do not model the impact of organizational culture on startups performance. In addition, they do not address the inherent uncertainty in new business ventures.

It is worth mentioning that in a search conducted in the Scopus and Web of Science databases, no studies were found related to the quantitative analysis of the causal relationship between culture and performance in startups. In a conducted literature review, Zanon and Carpinetti (2018) highlight the positive results obtained by applying FCMs to multiple fields and call for more applications in Operations Management, which is the case of the present study. Thus, the execution of this research is justified by the absence, in the literature, of studies that propose the use of fuzzy cognitive maps to analyze the relationship between Hofstede's cultural dimensions and the performance of startups.

Therefore, the research question that guides the development of this study is: how do factors of organizational culture impact the performance of a startup?

The FCM technique was implemented in MATLAB® and a pilot application to illustrate the model behavior in practice was conducted based on the real case of a technology

startup that develops management systems to small businesses and which has recently received venture capital investments. The main contribution is the introduction of a novel quantitative model that promotes the alignment between organizational culture and startup management, internalizing culture as a driver for performance improvement efforts.

### *1.2 Objective*

The general objective of the work is to propose the use of fuzzy cognitive maps to map and quantify the causal relationships between organizational culture and the performance of startups.

Thus, by determining the general objective, the following specific objectives can be deployed:

- I. To perform a literature review to find the most relevant aspects of both theoretical constructs: organizational culture and startup performance.
- II. To identify potential points of correlation between the constructs.
- III. To structure and computationally implement a fuzzy cognitive map based on the identified correlation points.
- IV. To conduct an illustrative application for guiding future research related to the use of the FCM-based model in practice.

## **2. LITERATURE REVIEW**

### *2.1 Organizational culture*

Three main reasons can be cited regarding why organizational culture should receive attention in the context of startup management: first, because culture is more difficult to manage than other factors, such as technology or information; second since culture influences the general behavior of individuals in terms of information sharing, teamwork (therefore, also in organizational learning capacity) and risk tolerance, among others; finally, because culture impacts performance (CAO *et al.*, 2015). Groysberg *et al.* (2018) affirm that culture is among the main managerially available factors for improving organizational effectiveness, since it expresses goals through values and beliefs and guides activities through shared premises and norms. In an empirical research focused on investigating the relationship between culture,

quality management and improvement initiatives, Gambi *et al.* (2013) highlight that culture is as a key component for organizational performance.

Organizational culture, according to Schein (2010), refers to the basic premises assumed by a group, developed after having learned to deal with their problems of external adaptation or internal integration, and which have become valid enough to be passed on to new members, so they can identify and address their new problems. Culture, therefore, refers to the underlying values, beliefs and principles expressed in the form of management structure and practices (CADDEN *et al.*, 2015).

To analyze how culture manifests itself in organizations, models are developed in order to materialize its main aspects and make it manageable (BORTOLOTTI; BOSCARI; DANESE, 2015). For assessing organizational culture, the cultural dimensions defined by Hofstede (2011) were considered. This is justified since, according to Cadden, Marshall and Cao (2013), one must be able to deconstruct organizational culture into tangible elements to understand its impact on performance. Thus, each of the Hofstede's dimensions represent culture deconstructed in determinant aspects. In addition, as they constitute independent factors, cultural dimensions fit the fuzzy cognitive map nodes and interrelationships model. Hofstede (2011) defines each dimension as follows:

- **Power distance** refers to the degree of power distribution. High power distance indicates hierarchical organizations and low power distance is associated with horizontal ones.
- **Uncertainty avoidance** refers to the level of organizational tolerance to uncertainty. A low index means uncertainty acceptance and a high index is associated with discomfort and resistance.
- **Individualism vs. collectivism** refers to the degree in which people in an organization tend to act as a group or as an individual.
- **Masculinity vs. femininity** refers to the degree of aggressiveness, assertiveness and competitiveness present in the organization. In cultures characterized by masculinity there is the presence of conflict and denial, while in cultures of femininity there is presence of negotiation, consideration and consensus.
- **Long vs. short term orientation** refers to the connection of the past with current and future actions. Long-term orientation means focus on future accomplishments while short term is associated to appreciation of the past and traditions.

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- **Indulgence vs. restraint** refers to the degree of gratification versus regulation. Indulgence organizations are worried about freedom of leisure and enjoyment while restraint organizations are not.

## 2.2 Startup performance management

Ripsas and Tröger (2014) define a startup as a young company, with less than 10 years old, guided by an innovative business model and thriving for significant growth. Blank and Dorf (2012) highlight that these firms explore and organize sustainable and expandable business models, while severely lacking resources in comparison with other companies. Therefore, inconsistent decision-making could lead the startup to fail (GIARDINO; WANG; ABRAHAMSSON, 2014) and this process is affected by uncertainty (TANRISEVER; ERZURUMLU; JOGLEKAR, 2012).

Chatterji *et al.* (2019) further highlights that many young technology startups are knowledge-intensive with their key inputs being their employees, which implies that management of human capital have an outsized effect on performance. The authors consequently affirm that ineffective management of the key resource which human capital is could dampen growth and even threaten startup survival. Hence the importance of quantitatively assessing the influence of culture, which is intensively human capital driven, over performance.

Performance, in turn, is associated with the achievement of results (SONNENTAG; FRESE, 2002) and with consistent measurement, considering a certain period of time as reference (FERNANDES; FLEURY; MILLS, 2006). Generally, performance is assessed in different aspects, such as financial or operational (SINK; TUTTLE, 1993). However, there is still a gap when considering other perspectives on performance, such as the perception of value by the customer (ZANON *et al.*, 2020). The historical purely financial focus on operations needs to change to a multidimensional perspective due to the relevancy of aspects such as strategy deployment and organizational learning (BITITCI *et al.*, 2011).

In order to operationalize measurement, performance indicators are established to quantify the efficiency or effectiveness of actions and processes, being usually monitored by management structures such as performance measurement systems (ZANON; ULHOA, ESPOSTO; 2020). Performance indicators are of informative nature, guided by organizational

objectives and aim to enable the formulation of action plans for more assertive decision making (LOHMAN; FORTUIN; WOUTERS, 2004; NEELY; GREGORY; PLATTS, 2005).

The indicators are therefore verifiable variables that measure and represent the current progress of an organization, or part of it, through specific reference scales (GUIMARÃES *et al.*, 1998). To each performance indicator is assigned a goal, that corresponds to the desired standard or value to be achieved (CARBONE *et al.*, 2009). Thus, the application of indicators supports the analysis of organizational performance, since they provide the possibility to compare the previously set goals with the current scenario (BRANDÃO; GUIMARÃES, 2001).

### *2.3 Fuzzy cognitive maps*

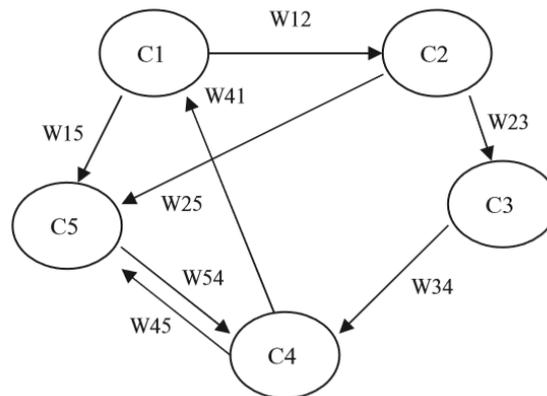
The fuzzy cognitive map is a soft computing technique that incorporates ideas from artificial neural networks and fuzzy logic, allowing the relationship between concepts to be represented linguistically with an associated fuzzy set rather than requiring them to be precise (Feyzioglu *et al.*, 2007). Fuzzy cognitive maps can be defined as graphs associated with weights quantified by fuzzy numbers, usually involving feedbacks and consisting of nodes and directional links that connect them. The nodes represent concepts that describe the modeled system and the links represent cause and effect relationships between the concepts. In the context of FCM theory, the fuzzy value of a concept denotes the degree to which the specific concept is active in the general system, usually limited to a normalized range of [0, 1]. In addition, the values of the system's links reflect the degree of causal influence between two concepts and are generally attributed linguistically by experts (KOSKO, 1986).

Linguistic variables can be determined and associated with fuzzy numbers to capture the subjective judgment of a decision maker in a quantitative way (ZADEH, 1973). Thus, imprecision is considered by the possibility of the same element belong to more than one set simultaneously, which comes from the parameterization of pertinence functions (ZADEH, 1965). Fuzzy numbers are described by their respective pertinence functions, being the triangular and trapezoidal the most commonly used function types (LIMA JUNIOR; OSIRO; CARPINETTI, 2013). Therefore, let  $l$ ,  $m$  and  $u$  be real numbers. Thus,  $F$  consists of a triangular fuzzy number if  $l$  is its lower value,  $m$  its medium value and  $u$  its upper value ( $l < m < u$ ), being  $F$  is given as  $F = [l, m, u]$  (ZIMMERMAN, 2010).

Most of the cause and consequence relationships are affected by uncertainty and, therefore, difficult to be analyzed, especially when they are not directly measurable (PAPAGEORGIU; STYLIOS, 2008). In this way, fuzzy cognitive maps are computational tools used to handle and overcome the presence of subjectivity in these cases (KOSKO, 1986). For structuring an FCM, firstly the system's concepts importance should be identified and the causal relations between them should be assessed, through fuzzy linguistic variables (SALMERON; VIDAL; MENA, 2012). Thus, the initial state vector and the relationship matrix, which consist in the required inputs for the FCM execution, are respectively determined.

Figure 1 brings a simplified view of an FCM, with C1, C2, C3, C4 and C5 being its nodes and W12, W15, W23, W25, W34, W41, W45 and W54 the weights of the relations between them (PAPAGEORGIU; STYLIOS, 2008). It is worth noting that an activation function is required in order to operationalize the FCM process: the function performs iterative calculations between the node's importance and the causal relations values, being the sigmoid and the hyperbolic tangent functions the most commonly used ones (BAYKASOGLU, GOLCUK, 2015).

**Figure 1** – Simplified structure of a fuzzy cognitive map.



Source: Papageorgiou and Stylios (2008).

Equation 1 demonstrates how the system activation occurs, where  $V_t$  corresponds to the initial state vector after each iteration,  $e_{ji}$  the relationship matrix and  $f$  the activation function.

$$V_{t+1} = f \left( V_t + \sum_{\substack{j=1 \\ j \neq i}}^N e_{ji} \cdot V_t \right) \quad (1)$$

The definition of suitable linguistic terms should help decision makers in evaluating the interactions between variables. They are usually set as causal intensity qualitative measures associated with fuzzy numbers in a normalized scale: “very low”, “low”, “medium”, “high” and “very high”. Therefore, the values of the initial state vector will be in the [0,1] range, which justifies the application of the sigmoid function for activating the system, as in Equation 2 (BUENO; SALMERON, 2009). In this equation, the lambda value corresponds to a constant defined by the system designer. Kang *et al.* (2016) state that values of  $\lambda$  equal to or close to 1 are ideal, since they provide the possibility of differentiation between the results after convergence of the system, providing better interpretability. In summary, the system activation consists in iteratively multiplying the initial state vector and the relationship matrix within the chosen activation function, used to monotonically map these values evolution.

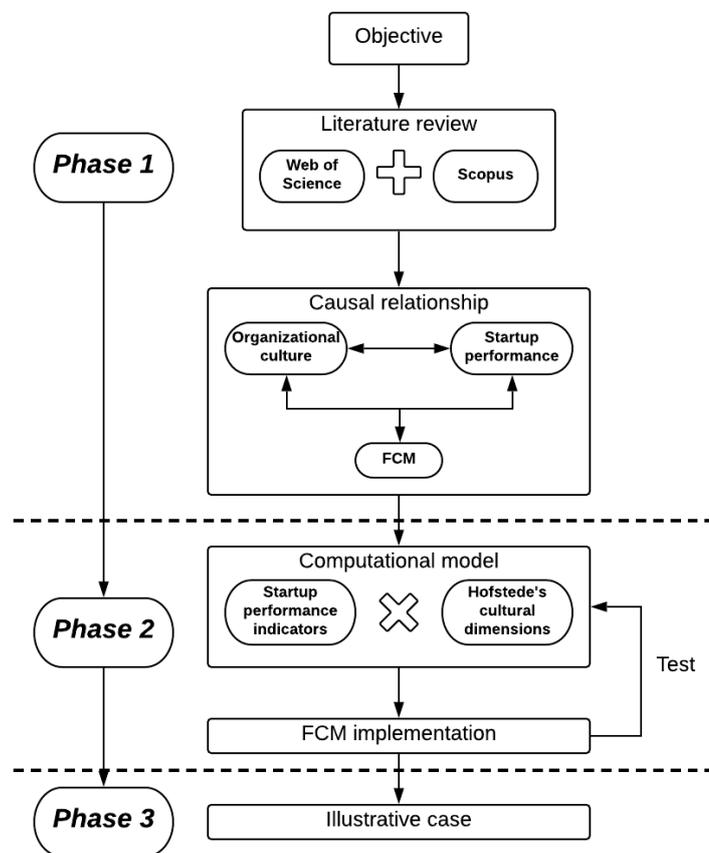
$$f = \frac{1}{1 + e^{-\lambda x}} \quad (2)$$

### 3. METHODOLOGICAL PROCEDURES

According to the classification proposed by Bertrand and Fransoo (2016), the present research can be classified as quantitative axiomatic normative, as it proposes a model based on the identified research gaps and on the opinions of experts, culminating in an approach that integrates the addressed theoretical concepts. According to Morabito *et al.* (2018), the quantitative axiomatic normative research is based on models that prescribe a decision for a given problem. This is the case of the approach proposed in this study, which aims to promote the development of action plans as a result of assessing the impact of organizational culture on startup performance. Figure 2 illustrates the phases of the methodological procedure.

This methodological procedure has as main advantages the depth which it provides to the research theme to be studied, resulting from the incorporation of the fuzzy set theory to the computational model. The disadvantage is that, since it contemplates the conduction of an illustrative application, generalizations cannot be made. This limitation can be surpassed by the expected expansion of this paper it in future new studies.

**Figure 2** – Methodological procedure of the research.



Source: the authors.

### 3.1 Phase 1

The first phase of the methodological procedure consists of three stages. In the first stage, the objective of the work was defined based on the research objects: organizational culture and startup performance. These research objects were selected to be the focus of this study since to analyze the cause and effect relationship between them is of practical and theoretical relevance. This comes from the fact that no proposition was found using the fuzzy cognitive map technique to handle the uncertainty inherent to newborn companies'

environment, especially when considering the role of organizational culture. In the second stage, a literature review was conducted on the topics of organizational culture, startup performance and FCMs on the Web of Science and Scopus databases. In the third stage, a detailed analysis on how to structure a FCM specifically to address the research problem was conducted, based on the results of the conducted review.

### *3.2 Phase 2*

The second phase consists in the development of the computational model that integrates the research constructs. This model was implemented in the MATLAB® software. Based on the FCM algorithm and on its planned structure in the previous phase, a step-by-step approach was proposed to analyze how the Hofstede's (2011) cultural dimensions impact the performance indicators of a given startup. This computational model has as inputs the evaluations of experts from the startup, made with the support of linguistic terms associated to fuzzy numbers. This enables that the data obtained can be processed quantitatively by the FCM.

### *3.3 Phase 3*

The third phase consists in the conduction of an illustrative application, to demonstrate how the proposed model works and to guide future real applications. The presence of this phase on the research procedure is justified by the explorative character of this study, since no results were found in the literature proposing a similar approach in this context. It is important to note that this paper is part of a broader project, in which a real application is expected as a future activity.

In this phase, the intensity of the relations between the cultural dimensions and the startup's performance indicators should be assessed, along with the current level of performance of each performance indicator in the startup operation. The first consists in the FCM relationship matrix and the latter consists in the initial state vector. Both are obtained according to the perceptions of experts from the startup through the set linguistic terms associated with fuzzy numbers. The proposed approach can also contemplate group decision making. For this, the evaluations of multiple experts should be converted to their respective fuzzy numbers which should finally be aggregated. Thus, with the collected data, the computational algorithm can be executed so that the final result of the FCM can be obtained.

These results, output of the MATLAB® application, were then processed in order to make clear how the FCM values converged to the final state vector, illustrating the system dynamics and how the received cultural influence by the startup performance indicators was calculated.

#### 4. RESULTS AND DISCUSSION

The application was conducted in a Brazilian startup located in the city of São Paulo, with approximately 2 years old. The company has now more than 4,000 clients and has recently received venture capital investments. It focuses on providing technology management tools for beauty salons, barbershops, spas and other related business establishments. The customers (business owners or managers) receive a credit and debit card payment machine as well as scheduling, financial control, and inventory software. As with other startup, the one in analysis in this pilot application also has to survive and compete in an environment with lack of precise data and uncertainty.

Four decision makers were involved in this application: the startup founder and Chief Technical Officer (CTO), the human-resources management leader, the account manager and the operations leader. As Table 1 shows, based on Hofstede’s definitions, the four decision makers reached a consensus regarding the start-up organizational profile.

**Table 1** – Startup’s cultural profile.

<b>Cultural dimension</b>	<b>Diagnosis</b>
Power distance	Low power distance
Uncertainty avoidance	Low uncertainty avoidance
Individualism vs. collectivism	Individualism
Masculinity vs. femininity	Masculinity
Long vs. short term orientation	Short term orientation
Indulgence vs. restraint	Indulgence

Source: the authors.

After this procedure, the four decision makers identified the performance indicators to be inserted in the model, listed and described in Table 2. As a startup, the company does not have a structured performance measurement system. However, it has few but well-defined indicators, which guide decision making and strategy actions.

**Table 2** – Startup’s performance indicators.

Indicator	Code	Definition
Customer acquisition cost	CAC	It is the ratio between the cost of expenses and the number of new customers over a given period.
Time for development	TD	It is the time taken for the development of a technological product.
Customer satisfaction	CS	It is the evaluation, by the customers, on the services provided and the products purchased.

Source: the authors.

Therefore, for data collection, Table 3 presents the defined scale, so that the fuzzy cognitive map inputs could be obtained. It associates triangular fuzzy numbers to linguistic terms. Thus, the startup experts were able to choose between the terms null (N), very low (VL), low (L), medium (M), high (H) and very high (VH).

**Table 3** – Linguistic terms and their respective fuzzy numbers.

Terms	<i>l</i>	<i>m</i>	<i>u</i>
N	0	0	0
VL	0	0,3	0,3
L	0,3	0,4	0,5
M	0,5	0,6	0,7
H	0,7	0,8	0,9
VH	0,9	1	1

Source: the authors.

Therefore, 9 criteria were considered in the FCM: the CAC, TD and CS indicators along with the six Hofstede’s cultural dimensions. Then, specialists reached a consensus, using linguistic terms, in assessing the current performance of the startup in each one of the indicators. Thus, the initial state vector was obtained, containing the criteria weights, as shown in Table 4.

**Table 4** – Initial state vector.

Initial state vector	
Low power distance	N
Low uncertainty avoidance	N
Individualism	N
Masculinity	N
Short term orientation	N
Indulgence	N
CAC	VL
TD	M
CS	H

Source: the authors.

Then, the specialists assessed the influence that each of the cultural dimensions have on the three indicators, from the same scale presented in Table 3. Thus, the relationship matrix was obtained, as shown in Table 5.

**Table 5** – Relationship matrix.

Relationship matrix	CAC	TD	CS
<b>Low power distance</b>	L	H	H
<b>Low uncertainty avoidance</b>	L	H	VH
<b>Individualism</b>	VH	M	H
<b>Masculinity</b>	H	VH	L
<b>Short term orientation</b>	VL	H	VL
<b>Indulgence</b>	L	M	M

Source: the authors.

Thus, the linguistic terms in Tables 4 and 5 were converted to their respective fuzzy numbers and then their defuzzification was conducted. The applied defuzzification method was the center of area:  $CoA = \frac{(l + 2m + u)}{4}$ , where CoA corresponds to the final defuzzified numbers. Table 6 and Table 7 show the results of the defuzzification process and, as both consist in the required inputs for the FCM execution, Equation 2 was applied for activating the system. In this study, for the sigmoid activation function,  $\lambda = 0,7$  was considered, since this value enabled the convergence of the system in an acceptable number of iterations and provided results granularity.

**Table 6** – Defuzzified initial state vector.

<b>Initial state vector</b>	
Low power distance	0
Low uncertainty avoidance	0
Individualism	0
Masculinity	0
Short term orientation	0
Indulgence	0
CAC	0,225
TD	0,6
CS	0,8

Source: the authors.

**Table 7** – Defuzzified relationship matrix.

Relationship matrix	<b>CAC</b>	<b>TD</b>	<b>CS</b>
<b>Low power distance</b>	0,4	0,8	0,8
<b>Low uncertainty avoidance</b>	0,4	0,8	0,975
<b>Individualism</b>	0,975	0,6	0,8
<b>Masculinity</b>	0,8	0,975	0,4
<b>Short term orientation</b>	0,225	0,8	0,975
<b>Indulgence</b>	0,4	0,6	0,6

Source: the authors.

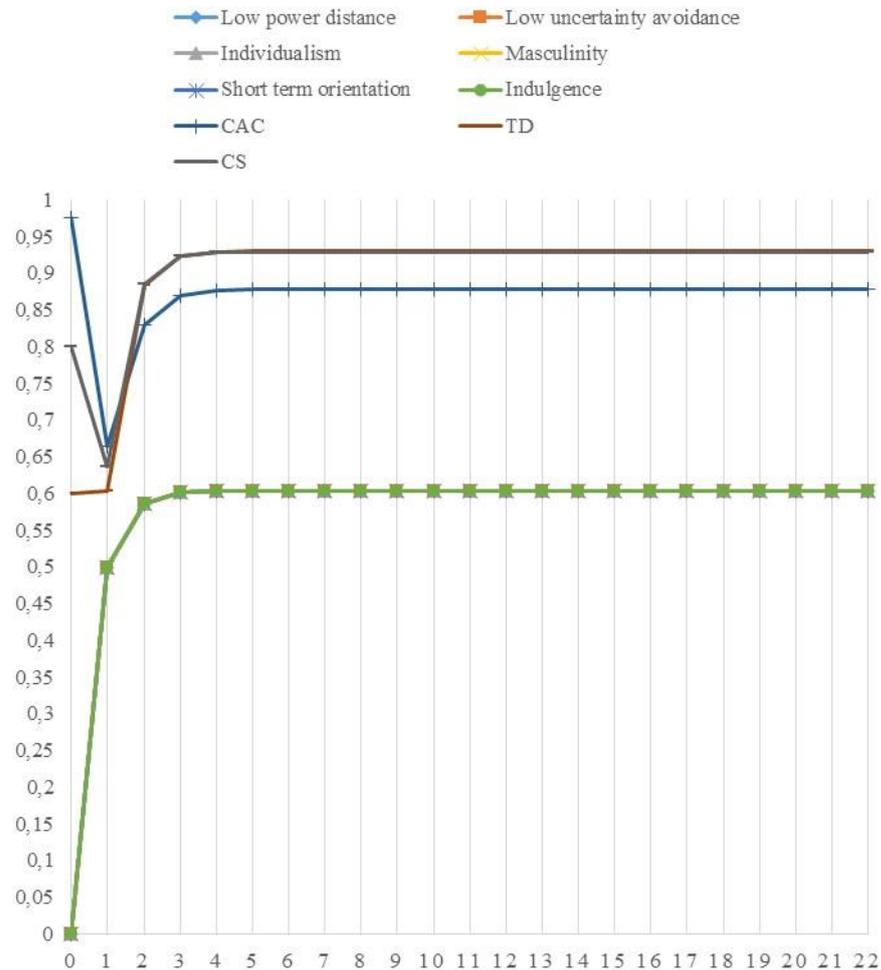
The convergence of the system occurred after 22 iterations, as Figure 3 illustrates, culminating in the final state vector, shown in Table 8.

**Table 8** – Final state vector.

<b>Initial state vector</b>	
Low power distance	0,60
Low uncertainty avoidance	0,60
Individualism	0,60
Masculinity	0,60
Short term orientation	0,60
Indulgence	0,60
CAC	0,87
TD	0,93
CS	0,92

Source: the authors.

**Figure 3 – FCM convergence.**



Source: the authors.

Observing the final values in Table 8, it can be seen that the degree of cultural influence received by each of the startup's performance indicators is calculated. The time for development indicator (TD), for example, proved to be the most affected by the company's culture, since, at the convergence of the FCM process, its weight in the final state vector reached the highest level. Thus, in cases like this, an in-depth analysis of the way in which each dimension affects each indicator is recommended, based on the relationship matrix, so that action plans can be proposed. Experts can therefore use the prioritization provided by this table to direct improvement efforts.

It is also possible to note that this influence of culture over performance is positive, since TD and CS are the performance indicators with most received cultural influence (as

Table 8 shows) and the indicators with best performance (as Table 6 shows). In addition, CAC, the indicator that receive less cultural influence, is also the one with poorer performance, which supports the hypothesis that, for the startup in analysis, despite its turbulent environment of a newborn company, culture is fostering performance.

Therefore, strategies could be structured for improving positive cultural influence over the CAC indicator, which could be done by changing or establishing new processes for managing activities related to it. Finally, as a feedback for the startup, it is suggested that the FCM approach could be executed every time the indicators are reviewed, for scenario simulation by means of what-if analysis.

It can also be noted that the cultural dimensions converge at the same value. This is justified by the fact that, in a fuzzy cognitive map, the criteria have relative weights within the system. Thus, as this study analyzes the impact of culture on performance, the startup performance indicators reach the values corresponding to the level of received cultural impact and the dimensions converge to lower and identical values.

Another aspect that reinforces this new proposition validity refers to the system convergence. Granularity and interpretability of the results were achieved for distinct values of lambda and the system converged within less than 30 iterations for all performed tests. The fact that the system requires a small number of iterations and does not provide inconsistent outputs indicates that the information from the initial state vector and from the relationship matrix is reliable, which also supports the FCM proposition.

## 5. CONCLUSIONS

This paper proposed the application of fuzzy cognitive maps to map and quantify the causal relationships between organizational culture and the performance of startups. To the best of the authors' knowledge, similar studies are not found in the literature. Thus, with the execution of this research, it was possible to fulfill this objective by addressing all the deployed specific ones.

The first specific objective was accomplished with the execution of the literature review present in section 2, which provided the possibility to conclude that Hofstede's cultural dimensions interpretation of organizational culture could be used for providing new

understandings regarding the impact of culture over performance and that a soft computing technique could be applied to process the presence of uncertainty. The second specific objective was accomplished by using the results of the literature review to conclude that the Hofstede's cultural dimensions would fit the FCM structure perfectly, since they consist in culture deconstructed in aspects which would later compose the nodes of the model, along with the startup's performance indicators. The third specific objective was accomplished with the development of the proposition on Figure 2, which enabled the implementation of a FCM to analyze the context of a startup. Finally, the fourth specific objective was accomplished by the conduction of the illustrative application presented in section 4, which detailed every step of this paper's proposition for guiding future research related to the use of the FCM-based model in practice.

Therefore, this study was conducted after reviewing the literature on organizational culture and performance management, which allowed the identification of a research opportunity regarding the analysis of their interface on startups. This review also allowed for the identification of another opportunity, related to the application of the fuzzy theory to handle with the inherent subjectivity when assessing culture. Thus, the cause and effect relationships between culture and performance in a dynamic environment, such as that of nascent companies, were analyzed through the application of the FCM.

Hence, it was possible to answer the research question initially defined in this paper. The results were able to demonstrate how each indicator is affected by each cultural dimension, quantitatively, as well as to order them according to the total influence exerted by culture on each one: TD being the most impacted, followed by CS and CAC. It could also be concluded that for the case of this startup in particular, culture is having a positive effect over performance, fostering the indicators' results. It is concluded, in addition, that it was possible to consider the subjectivity inherent to the assessment of the causality between culture and performance with the use of computing with words and the FCM technique.

As possible implications for practitioners, it is expected that the presented results can provide managers with means to operationalize the alignment between organizational culture and performance management efforts in startups. As theoretical contribution, it is expected that the application of FCMs to analyze the impact of cultural factors on startups' performance can provide novel opportunities regarding how to jointly address both constructs and therefore to expand the knowledge frontier on this subject.

However, as limitations, it is important to note that the conclusions derived from the model application depend on experts' knowledge. The FCM technique also requires the definition of suitable linguistic terms and appropriate corresponding fuzzy numbers, which can affect results. As suggestions for further research, other soft computing techniques can be associated to the model, in order to increase its robustness. In addition, new applications can be conducted for testing the model in practice. Environments where performance criteria are impacted by external or internal factors can benefit from the proposition. For example, supply chain performance indicators are also impacted by organizational culture.

The results obtained are therefore relevant to society, as the proposed model will be applied in the future to real startups. They also have relevance to theory, technique as well as to the Production Engineering and Operations Management domains, as they integrate theoretical constructs in an original and interdisciplinary way, contributing to the expansion of its scope of knowledge and its borders.

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