Methodology applied to managerial decision-making in the context of COVID-19

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Abstract

Purpose – This paper aims to propose a methodology for managerial decision-making based on scenario planning and a multi-criteria approach.

Design/methodology/approach – The methodology consists of two stages, one referring to scenario planning and the other to multi-criteria decision-making. The methodology was applied to a company in the Brazilian agribusiness sector, aiming to help managers face the current situation of the COVID-19 pandemic.

Findings – The proposal addresses a set of simple methods for developing a scenario analysis based on different approaches. Although the methodology may allow the future addition of new, perhaps more robust strategies, the purpose of the analysis is not only to tell the decision maker which strategy should be adopted, but also to provide greater knowledge about the problem and possible scenarios.

Originality/value – The contribution of this research is to propose a structured and easily applicable methodology that can help managers in the future planning of their companies, especially when faced with complex decisions and high level of uncertainty.

Keywords Scenario planning, Multi-criteria decision-making, COVID-19

Paper type Research paper

1. Introduction

Contemporary global challenges – climate change, disruptive technological transformation, global migration and ultimately the SARS-CoV-2 pandemic – make it difficult to implement demand forecasting models. These challenges generate disruption in the economic structure, changes in consumption patterns, limited processing capacity of the human brain in decision-making and difficulties in finding alternatives to solve problems. However, methodologies

based on decision theory help decision makers deal with complex challenges and problems, and make better rational choices (Gomes, Gomes, & Almeida, 2009).

The impact of the crisis on firms' revenue had more variation attributed to industry differences, and less discrepancy in terms of size (Bennedsen, Larsen, Schmutte, & Scur, 2020). Non-essential industry and the transportation sector were also negatively affected due to government restrictions on manufacturing operation and social isolation, bringing about a sharp drop in the demand for transportation modes (Rio-Chanona, Mealy, Pichler, Lafond, & Farmer, 2020). On the other hand, demand for products from health and technology sectors increased amid the pandemic (Sharma, Adhikary, & Borah, 2020).

These changes have led companies to adopt different production and product distribution strategies. In this study, strategies are defined as courses of action that can help decision makers achieve their goals (Goodwin & Wright, 2004). Consequently, the managers of these companies were pressured to make survival decisions in the prevailing scenario. The literature review showed that the main factors that influenced managers' decision-making of these companies are: contractions in production (Mckibbin & Fernando, 2020), diversification in supplier selection (Fernandes, 2020), investment in technologies (Sharma *et al.*, 2020), collaboration among supply chain members (Sharma *et al.*, 2020), increasing unemployment rate (Coates, Cowgill, Chen, & Mackey, 2020), government policies (Bennedsen *et al.*, 2020) and demand variation (Rio-Chanona *et al.*, 2020). However, factors such as "demand variation," "exchange rate variation" (Schneider, Cassol, Leonardi, & Marinho, 2020), "financial instability", "government policies" and "raw material availability" were among the most relevant in this research.

The objective of this paper is to propose a methodology for managerial decision-making based on scenario planning and a multi-criteria approach. Thus, a prescriptive or normative methodology that guides managers in their best choices is proposed, offering paths, methods and conceptual schemes that are useful in the decision-making process (Bell, Raiffa, & Tversky, 1988). As an example, the methodology will be applied to a company in the agribusiness sector, considering the current period of the COVID-19 pandemic. This research makes a theoretical contribution as it builds its own methodology, based on scenario analysis and multi-criteria decision-making, grounded on literature models. The research makes a practical contribution by providing a structured methodology that may support managers in the future planning of companies, especially when faced with complex decisions that are replete with uncertainties. Thus, the methodology considers the analysis of a set of factors that have hindered several decisions in the corporate environment (amidst a pandemic), and that can contribute to developing new research in the field of decision analysis.

2. Proposed methodology for scenario building
The proposed scenario building methodology is a hybrid model of methods for building and evaluating scenarios and the multi-criteria methodology. First the scenarios are built, and then a multi-criteria decision analysis (MCDA) methodology is applied to analyze the performance of the possible strategies in the different scenarios. The goal is to apply the methodology to a real case. However, the choice of methods is justified first, to then be applied to a case.

Scenarios are narratives of possible paths to the future considering the uncertainties, trends and risks present. The objective of building different scenarios is to consider all the present circumstances, so that, through knowledge about the context, it is possible to evaluate alternative strategic decisions that must be taken in a given period.

Quantitatively formed scenarios use probabilities and simulations as basis for structuring, involving the risks within the context. In the literature, there are several applications of scenario building in the supply chain, studies that even address the current moment of crisis (Klibi & Martel, 2012; Ivanov, 2020). Although there is knowledge that the current pandemic is a singular

event with several particularities (Ivanov, 2020), using probabilistic tools continues to be based on data (still under construction), that is, on the history of facts.

Given the impossibility of applying a quantitative manner, qualitative scenario building is selected, that is, using uncertainties as the basis for structuring. The goal is to create a variety of scenarios quickly, yet consistently. Given the current pandemic context, the method of 'Extreme Worlds' is not applicable (Goodwin & Wright, 2004; Montibeller, Gummer, & Tumidei, 2006), because only two scenarios do not represent the variety needed for a detailed analysis considering all the variables in the current crisis moment. A fast and effort-saving method (Ram, Montibeller, & Morton, 2011) is a viable alternative, as the scenarios are formed by varying the uncertainties, considering their best and worst state. However, when dealing with a considerable number of uncertainties, the number of generated scenarios becomes high, making it more difficult and effortful to further analyze the strategies. Thus, in the proposed method, only the variation of uncertainties is applied, in their best and worst form, throughout the scenarios. An alternative method applied by Martinez, Lambert, and Karvetski (2011) generates a pertinent number of scenarios by combining emerging conditions. However, this combination is based on the authors' opinion, which ends up reflecting personal opinions in scenario building, an undesirable trait for the present study. The driving forces method is a pertinent application as it brings relationships (positive or negative) between uncertainties into scenario building (Sadatsafavi, Kim, Anderson, & Bishop, 2019). However, this application requires high effort and time, making its full application unfeasible. This method is also employed in a simpler and faster way by Goodwin and Wright (2004), which makes it possible to associate the two approaches. Thus, the proposed method applies the relationship of uncertainties to each other, considering the methods developed by Sadatsafavi *et al.* (2019) and Goodwin and Wright (2004).

Based on these models, a nine-step-method is proposed. The first three steps focus on scenario building, and the others on MCDA. In the **first step**, the influencing factors found in the moment of crisis are defined in the literature review; these factors are incorporated as uncertainties in scenario building. The **second step** is to understand how such uncertainties are interrelated, as performed in the study by Sadatsafavi *et al.* (2019). From this relationship, the group is divided into two sets of uncertainties that are interrelated.

The **third step** in the building is to define scenarios. These will be formed by joining the two sets. The proposed approach is to combine the best and worst possible situation of each set into four scenarios. Therefore, all the uncertainties identified will be present in all the scenarios, leading to a rich set of possible future situations, based on the literature review performed. This method aims to build the scenarios simply, quickly and based on the collected material. Its set is defined as $C = \{c_1, \ldots, c_n\}$, where n varies from one to four.

MCDA has been increasingly adopted as a methodology associated with scenario planning (Ram *et al.*, 2011; Goodwin & Wright, 2004; Montibeller *et al.*, 2006). To develop it, the objective of the analysis needs to be defined. In the present study, the objective is to assist the case study company's decision-making amid the crisis generated by COVID-19, that is, to overcome the present moment with the least possible loss, whether financial or social. Once the objective has been defined, the **fourth step** of the proposed methodology is to build the value tree so that the analysis criteria are defined. The criteria have the function of measuring the different strategies' performance across scenarios, so that the organization's expected objective is reached, which in this case is to overcome the current crisis with the least possible loss. To assign criteria, all performance factors that are relevant to the problem should be listed, whether they are quantitative, such as the company's fixed costs, or qualitative, such as the well-being of employees.

To structure the value tree, macro criteria are listed first based on the defined objective. They are then detailed into more specific criteria, so that they can be measured (Goodwin &

Wright, 2004). This process should be conducted together with the decision maker as he or she will know what the organization's points of interest are.

In order to evaluate whether the value tree represents the points of interest that must be addressed, Keeney and Raiffa (1976) suggest that five factors should be observed: completeness, operationality, decomposability, absence of redundancy and minimum size. The process of forming the value tree is essential for the decision maker to understand the problem more clearly. Once the value tree is developed, the set of criteria is defined as $Z = \{z_1, \ldots, z_j\}$.

The *fifth step* is when the company defines possible strategies (A_k) that can be adopted in the moment of crisis. The set of strategies will be denoted $A = \{a_1, \ldots, a_k\}$. The *sixth step* of the methodology is to define the value that each criterion has among the strategies in each scenario. Considering criterion z_j, the decision maker should be asked: "*Given scenario c_n, which of the strategic options do you believe will achieve the best performance for criterion z_j?*" A value of 100 should then be assigned for the best strategy in relation to the criterion, and 0 for the worst. The intermediate values are assigned through a second question to the decision maker: "*How much will this particular strategy increase performance if it is chosen instead of the worst one listed?*" For example, if two strategies, A and B, were defined as being the best and worst, respectively, their values will be 100 and 0. To define the intermediate value for strategy C, the decision maker must consider how much this strategy will increase the performance if it is chosen over strategy B (worst ranked). If the value for strategy C is, for example, 40, it means that the improvement in performance by adopting strategy C instead of B was about 40% as attractive as the performance improvement of using strategy A over B (Ram *et al.*, 2011). These values are defined as v_{knj}.

To define the criteria weights, some studies do not consider variation between scenarios, that is, a criterion has the same weight in all scenarios, a characteristic that facilitates the method application (Montibeller *et al.*, 2006; Goodwin & Wright, 2004). However, when applied to real problems, not varying the weights among the scenarios brings several disadvantages to the study, making the evaluation less rich. Therefore, to define the weights among the scenarios, the most used method is to repeatedly ask the decision maker his/her opinion about the scenarios (Ram *et al.*, 2011). However, this attribution is tiring as the decision maker must list several values, and since it is a repetitive process, such an association might lead to confusion and result in analysis errors.

In order to simplify this process for the decision maker, the *seventh step* is to define the criterion weights using the baseline scenario methodology, called C_0 (Hamilton, Lambert & Valverde Jr., 2015; Karvetski, Lambert, & Linkov, 2009). The choice of the baseline scenario should be anchored on a moment in time, past or current, that the decision maker is most familiar with to associate values. After defining this scenario and its respective weights among the criteria, the decision maker will use it as a basis for defining the weights in the other scenarios, determining if the values increase, decrease or have the same relevance in relation to the baseline scenario. For example, if for one of the scenarios a certain criterion Z_j is more important in relation to the baseline scenario; its value will be adjusted to a higher value. For such an adjustment, an alpha variable (α) will be used that will admit different values, corresponding to these changes in criteria relevance between the scenarios. For example, the coefficient can assume the values of $\alpha = \{1/9, 1/3, 1, 3, 9\}$ and, in order to facilitate the definition by the decision maker, this can be transformed into a qualitative scale, that is, the values correspond to an easier language for the decision maker, for example: high and moderate decrease, no change and moderate and high increase, respectively (Hamilton, Lambert & Valverde Jr., 2015). The set of values in a scenario should be normalized so that the sum of the weights equals 'one'.

In the *eighth step*, the calculation of the strategies' performances among scenarios is performed. After defining each variable, the sets below are defined:

(1) Scenarios – $C = \{c_1, \ldots, c_n\}$;

(2) Criteria – $Z = \{z_1, \ldots, z_j\}$;

(3) Strategies – $A = \{a_1, \ldots, a_k\}$.

Thus, the expected performance of a given strategy k in a scenario n is given by:

$$\text{Performance } (a_k, c_n) = \sum_j v_{knj} w_{nj}$$

The variable v_{knj} represents the value of each of the criteria j for that strategy k in scenario n. The variable w_{nj}, on the other hand, represents the respective weight of criterion j in scenario n.

After the strategies throughout the scenarios have their performances defined, the **ninth step** is to compare and aggregate the results of different scenarios to identify the most robust strategy. One way to perform the aggregation of results is to associate probabilities to the scenarios; however, this method goes against the philosophy of scenario planning (Korhonen, 2001) since, as they are incomplete descriptions, their set does not represent the entire probabilistic space, and therefore it is not appropriate to apply probabilities (Goodwin & Wright, 2004).

A widely used method to define the most robust strategy in scenario planning is to calculate the regret of each of the alternatives. According to Lempert, Groves, Popper, and Bankes (2006), the regret is the difference between a strategy's performance and its highest possible value in a certain future moment, that is, the loss one has when adopting such a strategy instead of the one with maximum performance. Thus, considering a strategy k in a certain scenario n, where $k \in A$ e $n \in C$, defined by a value m, this loss is given by:

$$\text{Regret}_m(a_k, c_n) = \text{Max}_{a'}\left[\text{Performance } \left(a'_k, c_n\right)\right] - \text{Performance } (a_k, c_n)$$

Where strategy a'_k determines among all strategies the one with the optimal performance in scenario c_n (Ram *et al.*, 2011). A decision is considered robust when such a loss is minor, compared to the other possible strategic options among the set of plausible futures (Lempert *et al.*, 2006). In addition, it is essential that the strategy does not have high discrepancies in loss values between scenarios, therefore the most robust strategy for the problem can be found through an analysis considering these two points.

3. Case study

The case study company operates in two markets, fertilizer and grain, in the Midwest and North of the country. In the fertilizer segment, the company imports raw materials from different countries around the world through the port of Santarém in Pará. The inputs are mixed and processed in the factory, packaged, and distributed mainly to customers in Mato Grosso. In the grain segment, the company buys commodities for export through the port of Santarém, from customers who buy the fertilizers. That is, the fertilizer customers are the grain suppliers for export. The purchase of raw materials and the sale of fertilizers are made in dollars, so that the exchange rate risk is reduced. The grain trade was adopted by the company to optimize truck load, thus the company acquires a competitive advantage in relation to the price paid for goods in freight. The company's strategy choice model focuses on production and financial resources rather than logistics.

Two interviews with the decision maker were conducted remotely (due to the pandemic) to collect data. The decision maker has 20 years of experience in the industry and has worked as director of operations for the company for six years. The theory was first presented in a simple and intuitive way for the decision maker to gain knowledge of the fundamentals to identify and measure the necessary aspects. The first interview lasted two hours, and at first,

the context of this study and definitions of scenarios, criteria and strategic options were presented. After the first interview, the scenarios were formed and the value tree was built together with the decision maker, thus defining the criteria for the evaluation. The second interview lasted three hours and the theoretical basis for defining the criteria values and their respective weights among the scenarios was firstly presented. After this collection, all the data were obtained for the analysis. During the entire process, doubts were clarified by talking to the interviewee over the phone.

The same steps described in the methodology are followed in the case study. The **first step** is to incorporate the influencing factors present as uncertainties for scenario building (Table 1). Only the uncertainties "Demand variation" and "Government policies" were corroborated with the literature review. The interviews revealed other uncertainties that are present in the sector. Therefore, the uncertainties identified in the agribusiness sector, and which will be addressed in the case study are financial instability, exchange rate, demand variation, government policies and raw material availability.

Financial instability refers to the uncertainty of bank aid through credit lines. As a result of the crisis onset, banks restricted or eliminated credit lines both to the company in question and to its customers and suppliers, leading to high financial instability to the entire supply chain. However, after the situation was normalized, banks started to provide credit lines again, despite running the risk of not receiving debt payments at the beginning of 2021, due to the dearth of financial companies' recovery in the sector. Thus, there is the uncertainty of normalization, or not, of credit lines supply in the first quarter of 2021. The exchange rate variation is an uncertainty present not only at a moment of crisis; however, it becomes more uncertain due to the global pandemic scenario. The dollar appreciation or devaluation are uncertainties that directly impact the entire agribusiness sector. As cited by Rio-Chanona et al. (2020), variations in the demand of the sectors occur in the current moment of crisis; however, it is important to emphasize that the variation in demand, in this case, is given by the availability of capital from customers and suppliers, and not by changes in consumer behavioral patterns. As all the exchange rate factors and credit lines directly affected the purchasing power of companies in the sector, demand was uncertain as it was not possible to predict whether customers and suppliers would have capital to maintain their planning. In addition to the government policies mentioned by Bennedsen et al. (2020), those that will be addressed in the case study refer to government intervention, or not, regarding the renegotiation of bank debts. As occurred at the beginning of the pandemic, the Central Bank intervened by extending the deadline for customers to renegotiate their debts, and consequently, the payments. Thus, depending on the future scenario, there was uncertainty as to whether government intervention to help companies would occur again. After the pandemic second wave reached Europe, there was a risk to supply of raw materials to produce fertilizers, as 95% of the inputs are imported. The interruption of supply can be caused by restrictions in the European producer market or shipping restrictions to

Uncertainties	Description	Reference
Financial instability	Restriction of bank credit lines	Case study
Exchange rate	Dollar variation	Case study; Schneider et al. (2020)
Demand variation	Fluctuation of demand due to the purchasing power of suppliers and customers	Rio-Chanona et al. (2020)
Government policies	Government intervention regarding debt renegotiation	Bennedsen et al. (2020)
Raw material availability	Supply interruption due to the second wave of the pandemic in Europe	Case study

Source(s): Prepared by the authors

Table 1.
Case study
uncertainties definition

importing countries such as Brazil. Brazilian agribusiness sector restrictions are not considered as a possible uncertainty, because at the beginning of the pandemic the sector was designated as essential, so if a new wave of the pandemic hit the country, the sector would maintain its regular activities, as it did during most of the social isolation period.

The *second step* is to understand how uncertainties are interrelated. These uncertainties are divided into two factors: internal and external. The internal factors refer to the Brazilian economic situation and involve the following uncertainties: financial instability, exchange rate, demand variation and government policies. As banks restrict or eliminate credit lines due to their clients' payment defaults, the companies that need this financial support begin to restrict their manufacturing and their transactions with clients and suppliers, directly affecting the sector's demand. In view of this, the government can intervene or not, through government policies directed at banks, demanding, for example, that they postpone the payment of debts or renegotiate them with clients. Furthermore, the appreciation of the dollar can negatively affect the sector via increased production costs as there are imported inputs; in addition, banks may limit credit lines to customers and suppliers. The external factor refers to the international situation that will directly affect the company in question, involving the uncertainty of raw material availability. As a result of the uncertain pandemic situation in Europe in the upcoming months, there is the of risk raw materials shortage for the manufacture of agricultural fertilizers.

The *third step* in the building is to define the scenarios (Figure 1). These are formed by combining the best and worst situations of internal and external factors in four different
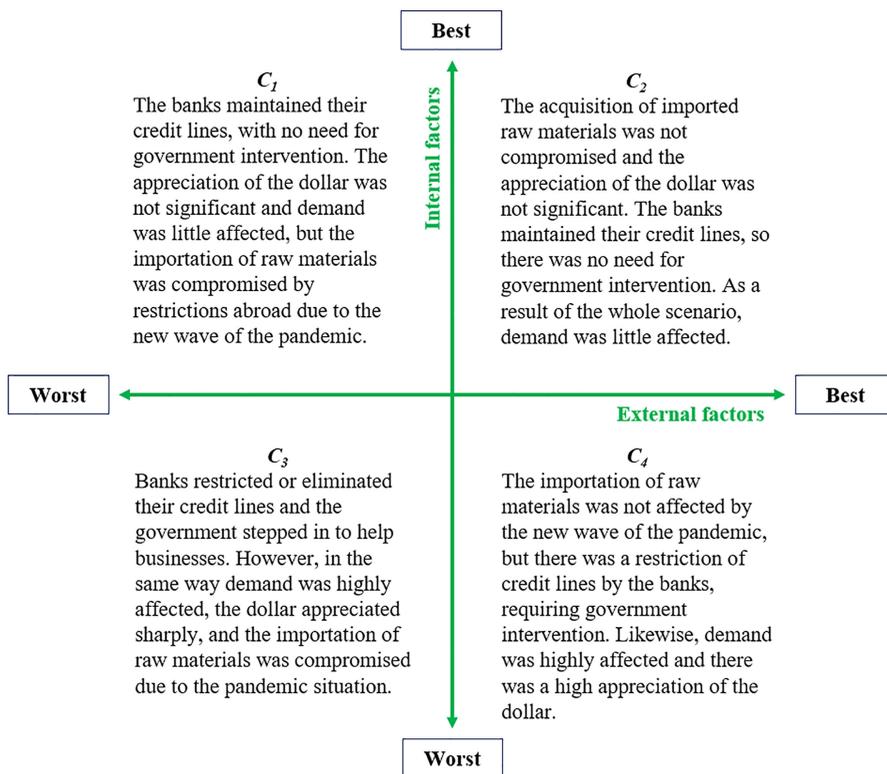

Figure 1.
Description of
scenarios

Source(s): Prepared by the authors

scenarios. Thus, the first scenario (C_1) will have the internal factors favorable to the business environment, but with unfavorable external factors. Therefore, this scenario has a non-significant dollar valuation, maintenance of bank credit lines with no need for government intervention, little variation in demand; however, with a compromise of raw materials imports due to restrictions abroad and the new wave of the pandemic. The second scenario (C_2) is the most optimistic, that is, both internal and external factors are favorable. On the other hand, the third scenario (C_3) is the most pessimistic, considering the worst possible situation. The last scenario (C_4) presents a high appreciation of the dollar, restrictions on bank credit lines, government intervention, high variation in demand (internal factors), but no restrictions on imported raw materials supply (external factors).

The **fourth step** is to build the value tree with the company's decision maker to define the criteria. Having the conducted interviews as starting point, the value tree was built according to the company's strategic vision (Figure 2).

Source: Prepared by the authors.

In the **fifth step**, possible strategies to be adopted in the moment of crisis are defined. Considering the rise in commodity prices at the moment, producers are investing more in their crops and, consequently, buying more fertilizers. Most suppliers of fertilizer raw materials have already fixed prices for next year; however, for a portion of inputs the price is still uncertain. The proportion is 70% set prices, 30% uncertain prices. Given this scenario, according to the company's director, there is the possibility of adopting two strategic alternatives:

A_1. Take on the uncertainty risk of 30% on the raw materials used to produce fertilizers, and thus actively participate in the whole market.

A_2. Investing only in the 70% of raw materials with a fixed price, thus missing a portion of the market.

The difference between the two strategies is in assuming or not the risk in raw material pricing. By taking that risk, the company has the possibility of making 100% of its products available to the market. This occurs because some products contain, for example, three raw materials, one of them with an uncertain price. Therefore, by adopting the first strategy, the company is able to offer the product on the market, unlike if it the second strategy was adopted, where one of the necessary raw materials would be missing. According to the company director, there would be a 30 to 40% reduction in sales if there was no investment in all raw materials, that is, by adopting the second strategy.

The **sixth step** consists of measuring the values of each criterion among the strategies and scenarios. Since there are only two strategic options, a value of 100 will be attributed to
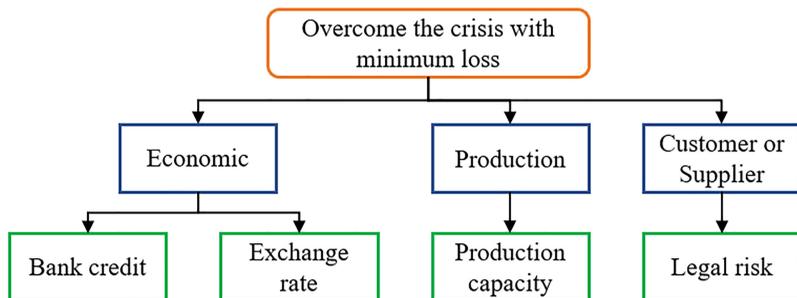

Figure 2.
Value tree for criteria
definition

Source(s): Prepared by the authors

the one the decision maker considers most adequate in that criterion and scenario, and a proportional value between 0 and 100 will be attributed to the other option. To this end, the director asked the following question: *"How much does the worst strategy, if chosen, change the performance compared to the best strategy listed?"*. Table 2 shows the performance between the two strategies for each scenario. In cases where the decision maker did not identify a change in performance, both strategies remained at the maximum value. The values in Table 2 represent the variable v_{knj}.

The ***seventh step*** refers to defining the weights of each criterion among the scenarios, given a baseline scenario. The baseline scenario used for the analysis will be the moment prior to the crisis, that is, the scenario the company was experiencing prior to the COVID-19 pandemic. This baseline scenario aims to bring to the decision maker mind a moment already experienced, about which there is knowledge on priorities, so that with this starting point the attribution of weights to other scenarios is facilitated, being performed only by adjusting defined values. This methodology brings a less tiring approach to the definition of the weights and greater understanding by the decision maker since a moment already known by him/her will be considered.

For the measurement, the director first defined the weight of each of the criteria in the baseline scenario C_0. Afterwards, the decision maker defined if the relevance of each of the criteria was higher or lower in the scenarios, compared to the baseline. The scale for defining relevance had five levels, namely: high decrease (AD), moderate decrease (MD), no increase (SA), moderate increase (MA), high increase (AC) (Table 3).

The qualitative scale was transformed into a quantitative one, and then the weights of the criteria in the baseline scenario were adjusted for each of the other scenarios using the coefficients $\alpha = \{1/4, 1/2, 1, 2, 4\}$. The set of values for each scenario was normalized so that the sum of the weights equals 'one'. Considering the determination of the criteria values and their respective weights among the scenarios, the ***eighth step*** is to proceed with the performance calculation of each strategy in each scenario (Table 4).

The ***ninth step*** of the proposed methodology is to evaluate the strategies between the scenarios by calculating the regret, as shown in Figure 3. The objective is to measure the loss of adopting a given strategy instead of the one with maximum performance.

In Figure 3, the regret values are given by the difference between the performance of a strategy and the highest value reached in each future moment. Thus, in the fourth scenario,

Criteria	Scenarios			
	C_1	C_2	C_3	C_4
Bank credit (Z_1)				
A_1	60	100	72	78
A_2	100	100	100	100
Exchange rate (Z_2)				
A_1	100	100	72	100
A_2	100	100	100	100
Production capacity (Z_3)				
A_1	70	100	88	100
A_2	100	80	100	84
Legal risk (Z_4)				
A_1	100	100	100	100
A_2	100	100	100	100

Source(s): Prepared by the authors

Table 2.
Criterion Values in
each of the Strategies
and Scenarios

for example, strategy A_1's regret value will be the maximum performance reached in that scenario (98.5) minus its own performance (89.8), that is, regret equivalent to 8.7. Similarly, when calculating the regret for strategy A_2, the value zero is obtained, since it was the alternative that obtained the best performance in that scenario.

The most robust strategic option for the decision-making of the company is strategy A_2 that is, investing only in raw materials with a fixed price, therefore not fully participating in the market. This alternative obtained a higher frequency of regret values close to or equal to zero, besides presenting a low oscillation of scores among the scenarios.

4. Discussion and implications of the methodological proposal

The proposed methodology contributes to the scenario planning theory combined with multi-criteria decision analysis (Goodwin & Wright, 2004), especially considering the context of the COVID-19 pandemic, by analyzing various uncertainties, strategies and criteria in the decision as follows:

(1) Uses a baseline scenario to adjust the weights, bringing robustness to the methodology, as the definition of the base – regardless of the moment to be considered – is medium to long term. For example, the study could have used the current moment experienced by the company as a baseline scenario; however, due to the decision maker's greater familiarity with the moment prior to the pandemic, the baseline scenario was defined as a past situation. Thus, the main issue is the variation of criteria relevance in the baseline scenario, regardless of which one it is, for the possible futures.

(2) It is based on a simple and intuitive structure for the decision maker. Thus, even if the decision maker has no knowledge of the study's theoretical base, data collection

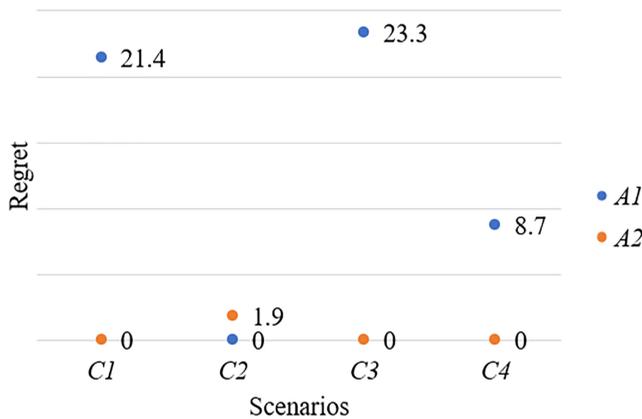| Criteria				Scenarios		
		C_0	C_1	C_2	C_3	C_4
Z_1	Bank credit	10	AC	SA	AC	AC
Z_2	Exchange rate	7	AC	MA	AC	AC
Z_3	Production capacity	4	MA	MA	AC	MA
Z_4	Legal risk	5	MA	MA	AC	AC

Table 3.
Criteria relevance ratio in the four scenarios

Note(s): AC = High increase; MA = Moderate increase; SA = No increase
Source(s): Prepared by the authors

		Scenarios			
		C_1	C_2	C_3	C_4
Weights (criteria)					
Z_1	Bank credit	0.47	0.24	0.38	0.42
Z_2	Exchange rate	0.33	0.33	0.27	0.29
Z_3	Production capacity	0.09	0.19	0.15	0.08
Z_4	Legal risk	0.12	0.24	0.19	0.21
Performance (strategies)					
A_1	Risk in pricing	78.6	100.0	76.7	89.8
A_2	No risk in pricing	100.0	98.1	100.0	98.5

Table 4.
Standardized criteria weights and strategy performance across scenarios

Source(s): Prepared by the authors

Figure 3.
Distribution of the
regret values of each
strategy among the
scenarios

Source(s): Prepared by the authors

occurs more practically and quickly, and is understood by all parties. For the definition of criteria, the value tree was defined in such a way as to contemplate the fundamental objectives (criteria) according to the decision maker. The criteria weights follow a qualitative approach, making the process simple, fast and with consistent data that reveal the decision maker's preferences.

(3) It proposes to evaluate four different scenarios. Usually, the literature is limited to two or three scenarios (for example, the "Extreme World" method – Goodwin & Wright, 2004), which brings little contribution to the definition of scenario planning (Montibeller *et al.*, 2006).

However, some considerations must be presented regarding the use and definition of scenario planning, so that the methodology can be applied without impairing the precepts of the theory:

(1) Scenario planning is a technique or constitutes a set of methods (combining MCDA, for example) used to support strategic decision-making by developing a set of narratives called scenarios (Montibeller *et al.*, 2006). Scenario planning should be relevant to the decision maker in describing generically different futures at a given time (Schoemaker, 1995). A scenario is not a prediction of the future; multiple scenarios are portrayals of a variety of plausible futures (Goodwin & Wright, 2004). Furthermore, the combined use of the scenario planning technique and MCDA is promising when considering the evaluation of strategic options (Montibeller *et al.*, 2006). Therefore, since scenarios are essentially strategic in nature and limited to a long-term view, it is not advisable to apply the proposed methodology in decision-making processes for a short-term horizon.

(2) Scenario planning is an alternative way to deal with uncertainty, usually encapsulated in complex decision-making, because scenarios highlight the reasoning behind judgments about the future, and give explicit attention to sources of uncertainty without trying to transform this uncertainty into probability (therefore, it is important to consider trends and the behavior of actors in the future) (Goodwin & Wright, 2004). Thus, the case study allowed such uncertainties to be analyzed in the agribusiness sector.

It is a fact that the proposition of scenario building should come after identifying uncertainties and the definition of strategies and objectives (Montibeller *et al.*, 2006). However, the case study showed it would take a long time to identify the uncertainties and especially the strategies, given the sector's overly complex and vulnerable environment. Therefore, it was decided to follow Goodwin and Wright's (2004) sequence: first the scenarios are created, then the strategies and objectives. However, the ranking of strategies was applied to each scenario, varying the weights among the scenarios, contrary to what was proposed by Goodwin and Wright (2004). In addition, the sets of uncertainties were varied among the scenarios and the methodology differs from others in which the variation of uncertainties follows author's opinion, as in Martinez *et al.* (2011) – an undesirable trait in the study developed.

The proposal aims to support the decision maker when faced with managerial decisions. It is understood that the benefit is to clearly support the decision maker in his decisions in a structured manner. This means that the proposal allows the decision maker (interviewee, in this case) to become aware of the interactions between key components of a strategic decision. The proposal may be further beneficial to: (1) facilitate comparison of the results with past decision-making; (2) apply the method to a group decision-making process (other directors and senior managers can compose a group of decision makers); (3) create new strategies and consider new objectives; and (4) evaluate other scenarios. Thus, although the number of scenarios to evaluate strategic options may increase and require further studies, given the complexity and uncertainty of events such as this, the use of morphological analysis is suggested for the analysis of a larger number of scenarios (see Ritchey, 2006).

5. Conclusion

It can be concluded that the proposed methodology addresses a set of simple methods to develop a scenario analysis based on different approaches. Although the methodology may allow for future addition of new, perhaps more robust strategies, the objective of the analysis is not only to show the decision maker which strategy should be adopted, but also to provide deeper understanding on the problem and possible scenarios. Therefore, the practical case allowed a critical analysis of the methodology versus the existing models in the literature and the structured methodology allowed the decision maker a deeper and more robust analysis based on the data brought up by the interviews.

During the development of the research some limitations were identified. The first one is that there are few Brazilian studies on the effects of COVID-19 pandemic on business decision-making, particularly empirical works: most are works developed in the health area. For this research, we highlight the study by Schneider *et al.* (2020) that addresses a theoretical reflection on a set of indicators in the areas of agriculture and agribusiness, in both national and global contexts. Therefore, the literature review performed for the identification of the influencing factors was almost entirely based on foreign studies, which may generate a non-representation of the Brazilian reality. For this reason, only two of the influencing factors were used in the case study, and the others were incorporated through the decision maker's account of the current situation of the agribusiness sector. Another limitation relates to data collection since, even though the methodology was simplified to facilitate the decision maker's understanding, there were still difficulties in measuring criteria values between strategies and scenarios. Finally, the results obtained by the study are limited to a specific case at a single point in time.

The study also suggests some guidelines for future research. The first is to reapply the study in companies of the Brazilian agribusiness sector. Through the interviews conducted with the decision maker, several opportunities for the application of scenario analysis in the sector were identified, since it is a business where several uncertainties are always present, decision-making is always risky and takes into consideration several factors. Furthermore, it

is recommended to build scenarios qualitatively and after the strategies have been defined (as pointed out by Montibeller *et al.*, 2006). It is also suggested that the scenario analysis methodology may consider probabilities and simulations as input for the decision model, given that there is a history of data. The moment of application of the study should not be extraordinary as the current pandemic environment, since for the association of risks, historical data should be used. Finally, it is advisable to explore the proposal of planning through backcasting, aiming at first to define an ideal future scenario and working in retrospect, identifying the actions, demands and risks that will connect this specified future to the present.

References

Bell, D. E., Raiffa, H., & Tversky, A. (1988). *Descriptive, normative, and prescriptive interactions in decision making*. Cambridge: Cambridge University Press.

Bennedsen, M., Larsen, B., Schmutte, I., & Scur, D. (2020), *Preserving job matches during the COVID-19 pandemic: Firm-level evidence on the role of government aid*. Discussion paper series [No. 588]. Global Labor Organization (GLO), 20 June.

Coates, B., Cowgill, M., Chen, T., & Mackey, W. (2020). *Shutdown: Estimating the COVID-19 employment shock*. Working Paper. Grattan Institute.

Fernandes, N. (2020). *Economic effects of coronavirus outbreak (COVID-19) on the world economy*. IESE Business School Working Paper (WP-1240-E). Available from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3557504 (accessed 25 March 2021).

Gomes, L. F. A. M., Gomes, C. F. S., & Almeida, A. T. (2009). *Tomada de decisão gerencial–Enfoque multicritério* (3rd ed.). São Paulo: Atlas.

Goodwin, P., & Wright, G. (2004). *Decision analysis for management judgment* (3rd ed.). Chichester: John Wiley & Sons.

Hamilton, M. C., Lambert, J. H., & Valverde, L. J., Jr. (2015). Climate and related uncertainties influencing research and development priorities. *ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering*, 1(2), 04015005.

Ivanov, D. (2020). Predicting the impacts of epidemic outbreaks on global supply chains: A simulation-based analysis on the coronavirus outbreak (COVID-19/SARS-CoV-2) case. *Transportation Research Part E: Logistics and Transportation Review*, 136, 101922.

Karvetski, C. W., Lambert, J. H., & Linkov, I. (2009). Emergent conditions and multiple criteria analysis in infrastructure prioritization for developing countries. *Journal of Multi-Criteria Decision Analysis*, 16(5-6), 125–137.

Keeney, R. L., & Raiffa, H. (1976). *Decisions with multiple objectives: Preferences and value tradeoff*. New York: Wiley.

Klibi, W., & Martel, A. (2012). Scenario-based supply chain network risk modeling. *European Journal of Operational Research*, 223(3), 644–658.

Korhonen, A. (2001). Strategic financial management in a multinational financial conglomerate: A multiple goal stochastic programming approach. *European Journal of Operational Research*, 128(2), 418–434.

Lempert, R. J., Groves, D. G., Popper, S. W., & Bankes, S. C. (2006). A general, analytic method for generating robust strategies and narrative scenarios. *Management Science*, 52(4), 514–528.

Martinez, L. J., Lambert, J. H., & Karvetski, C. W. (2011). Scenario-informed multiple criteria analysis for prioritizing investments in electricity capacity expansion. *Reliability Engineering and System Safety*, 96(8), 883–89.

Mckibbin, W. J., & Fernando, R. (2020), *"The global macroeconomic impacts of COVID-19": Seven scenarios*. CAMA Working Paper [No. 19], 2 March.

Montibeller, G., Gummer, H., & Tumidei, D. (2006). Combining scenario planning and multi-criteria decision analysis in practice. *Journal of Multi-Criteria Decision Analysis*, *14*(1-3), 5–20.

Ram, C., Montibeller, G., & Morton, A. (2011). Extending the use of scenario planning and MCDA for the evaluation of strategic options. *Journal of the Operational Research Society*, *62*(5), 817–829.

Rio-Chanona, R. M., Mealy, P., Pichler, A., Lafond, F., & Farmer, J. D. (2020). Supply and demand shocks in the COVID-19 pandemic: An industry and occupation perspective. *Oxford Review of Economic Policy*, *36*(Supplement_1), S94–S137.

Ritchey, T. (2006). Problem structuring using computer-aided morphological analysis. *Journal of the Operational Research Society*, *57*, 792–801.

Sadatsafavi, H., Kim, A. A., Anderson, S. D., & Bishop, P. (2019). Scenario planning application in US highway transportation industry. *Journal of Infrastructure Systems*, *25*(2), 05019002.

Schneider, S., Cassol, A., Leonardi, A., & Marinho, M. D. M. (2020). Os efeitos da pandemia da Covid-19 sobre o agronegócio e a alimentação. *Estudos Avançados*, *34*, 167–188.

Schoemaker, P. J. (1995). Scenario planning: A tool for strategic thinking. *Sloan Management Review*, *36*(2), 25–50.

Sharma, A., Adhikary, A., & Borah, S. B. (2020). Covid-19's impact on supply chain decisions: Strategic insights from NASDAQ 100 firms using Twitter data. *Journal of Business Research*, *117*, 443–449.

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