Swot Analysis Implemented with Fuzzy Inference to Support Decision Making

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Abstract

Current market conditions require organizations to understand the business environment in order to achieve strategic planning and decision-making processes. An organization's competitive advantage is associated with an understanding of how to determine the potential of these companies when examining internal and external conditions (insertions) and the effort to meet customer needs. Among the many tools that contribute to this understanding, the SWOT analysis stands out, which can assist organizations to better understand the internal and external environment and formulate strategic plans in a collaborative way. This work aimed to implement an evaluation model for SWOT analysis using fuzzy inference methods. The adopted methodology started from a survey on the internal and external characteristics of the organization, definition of the linguistic criteria of the SWOT matrix, correlation between the variables found and elaboration of the fuzzy inference system for crossing the inputs. The approach proposed by the Fuzzy Inference model for the SWOT matrix proved to be simplified and efficient for a better collection of information that allows the prediction of the future environment, enabling reasoned strategies resulting from the model presented.

Keywords: Swot Matrix; Fuzzy Inference; Strategic Positioning;

1. Introduction

The current market scenario requires organizations to understand the business environment to enable the process of strategic planning and decision making. A competitive advantage for organizations is linked to knowing how to determine the potential of these companies when checking the internal and external scenario, which are inserted, associating with the effort to meet the needs of customers. Among so many tools that support this understanding, the SWOT analysis is highlighted, which assists the organization in obtaining a better view of the internal and external environment and collaborates in the planning of strategies by positioning the organization's resources in four regions: Strengths, Weaknesses, Opportunities and Threats [1, 2].

The SWOT analysis is characterized by its simplicity in application, which has become common since the 1960s [3], and its approach contributes to strategic planning to maintain the organization's balance to any changes in the environment and to maintain the organization's stability to be able to survive all the time [4].

SWOT analysis has been applied in several fields today [5-7], which has changed the way the tool is developed [8-10].

A study applied the SWOT analysis for the advancement of energy waste clusters in Latvia [11]. Another study determined advantages and disadvantages of franchises [12]. A research was carried out on the development strategy of reverse logistics in the automotive sector based on SWOT analysis [13]. Another work developed permeates on technical-economic criteria and environmental suitability of hydrothermal processes for the treatment of biogenic residues using SWOT analysis [14]. Nikolaou and Evangelinos used the SWOT matrix to develop policy recommendations for the industry in order to adopt environmental management practices [15]. Yuan applied the SWOT matrix for construction waste management [16]. Zhikang adopted SWOT analysis for planned maintenance strategy [13]. Application of enhanced SWOT analysis in public management oriented to the future of technology can also be cited as work developed [17].

Through the application of the SWOT analysis, variables of the organization are categorized in relation to expert estimates, having as an advantage the consideration of potentials and barriers to establish the target and criteria whose function is to minimize risk to the organization. [18].

In this context, the SWOT analysis has become a widely used management tool, in which it allows a broader view of the conjuncture in which the organization is inserted, providing an integrated analysis that can benefit it to develop with the development of strategies that aim to overcome existing challenges or those with a future propensity.

Although the usual use of this tool, flaws are still detected, of which Hill and Westbrook list that only the qualitative analysis of the factors is considered; that there is no priority for various factors and strategies; that the number of factors are various, which will exponentially increase the number of strategies adopted and selecting the appropriate strategy will be even more difficult; and also does not consider the imprecision of the factors [1].

This study proposes to implement a model based on the theory of fuzzy sets for situational analysis with the application of the SWOT tool to support the structuring of strategic planning and decision making.

2. Literature Review

2.1 About Swot Analysis

SWOT analysis has its origins in the work of business policy academics at Harvard Business School from the 1960s [1]. Its use is dated, for the first time, by Kenneth Andrews who explained the strategic adaptation between the company's resources and capacity and the external environment [2, 19].

Kenneth Andrews' work has been very influential and popularized because it is a decision support tool, which is commonly used to systematically analyze strategic situations and identify the level of organizations in their internal and external environments, in which these are identified. factors and strategies are developed, built on strengths to eliminate weaknesses [12].

Second [20] the SWOT method "is an abbreviation for four focuses of analysis, considering strengths (objectives achieved, strong aspects, benefits, satisfaction); weaknesses (difficulties, failures, weak aspects, discontent); opportunities (untapped capabilities, ideas for improvement) and threats (adverse context, opposition, resistance to change) ".

In the understanding of the different components of SWOT and their respective concepts, it is possible to emphasize two levels of impacts and consequent assessments, which are: competitive dimensions and issues of an internal nature, such as objectives and profitability [7].

SWOT analysis is defined as an analytical tool that should be used to categorize important factors that determine the development of a particular organization within the market scenario [21]. This tool is based on the principle of investigation and analysis of the internal environment, consisting of the strengths (S), weaknesses (W); and external environment established by the opportunities (O) and threats (T), as shown in Figure 1, and the arrangement of the combination of the elements of the matrix corresponds to the combination of several factors, with the objective of finding its advantages, taking advantage of the opportunities to correct weaknesses and respond to threats at the strategic level [22].

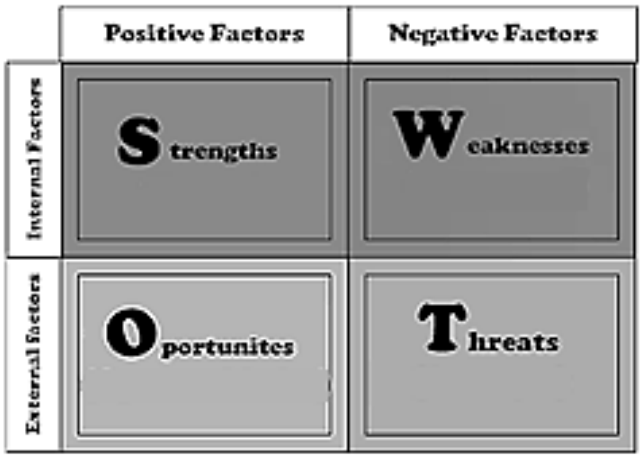

Figure 1. SWOT matrix.
Source: [23]

For an organization to be aware of its reality, it is necessary to recognize its strengths and weaknesses, the threats and opportunities that the market can offer. Due to its analytical capacity, the SWOT matrix has been widely used in several business sectors, guiding effective decision making [24].

According to [4], the traditional technique of SWOT analysis is conducted by brainstorming and group discussions, whereas the current techniques are composed of 8 steps, which can be mentioned: (1) information collection; (2) mapping each condition to strength, weakness, opportunities or threats, (3) defining SWOT statement weights, (4) establishing rates, (5) performing score calculations, (6) assessing position in the quadrant , (7) definition of strategies, (8) presentation of results.

However, the result of the SWOT analysis is often just a list or an incomplete qualitative examination of internal and external factors [25]. For this reason, the SWOT analysis cannot comprehensively assess the strategic decision-making process [26].

The traditional technique takes more time and involves a lot of resources. There is an imposition to optimize the time to perform the SWOT analysis, so it is important to automate the process of this tool, in order to make it an easier and faster process, particularly during data analysis [27]. Still on the traditional technique of the tool, it also generally ignores the weighting between the factors, which causes deficiency in the results in the evaluation phase of the process of using the tool, given that there are already techniques of decision support system that includes determining the weight (level of importance) of each of the factors which implies better results [28].

So, according to [29] the SWOT analysis basically consists of establishing the components of the SWOT Matrix, and then crossing the Opportunities with the Strengths and the Weaknesses with the Threats, seeking to establish strategies that minimize and monitor the negative aspects and maximize the potential of the organization.

In the view of [9] the analysis must be made and interpreted in order to unite the key parts, which are the elements of the internal and external analysis, why they will form the diagnosis and it must be reliable and supported by a good source of information, and which is integrated to the needs of strategic management, as they will support the medium and long term in the organization.

The company must reinforce its resources and competences in order to transform the apparent threats into new opportunities.

Strategies for planning through SWOT analysis must maintain the strengths, in the weak points you must have the vision of reducing them, in which you take advantage of opportunities and protect yourself from threats. In this way, the organization will be able to identify the strengths that have not yet been used and the weaknesses that can be corrected [30].

In view of the knowledge of the strengths or weaknesses, and of the opportunities and threats to the organization, the organization can adopt strategies that seek to seek its survival, maintenance or development.

Based on the statements of [30] the steps for using the SWOT technique consist of:

° Formulate a list of managers and key people in the organization - The analysis should use the opinion of these key people in order to inventory important issues for the organization, based on the assumption that the goals and objectives of a company are found in their minds people;

° Develop individual interviews - These interviews should proceed with the gathering of all information with the managers and the key people of the organization. In this phase, the aim is to evaluate the items to be evaluated from the company's point of view, such as opportunities, threats, strengths and weaknesses;

° Organize information - The main idea for organizing information is the SWOT structure itself, through a matrix. In this way, in this evaluation of the interviewees, all relevant situations of the organization will be placed on the agenda, and what is seen as positive in its current operations will be the strengths of the company, what will be seen as negative will be the weaknesses;

° Prioritize issues - In the list of ideas by managers, one should list those that will have the highest priority over others. In this way, it seeks to provide feedback among all the people involved;

° Define the key issues - Once the matrix and the ideas that were prioritized have been structured, what should be done should be established. After this analysis and involvement of all managers and key people, the organization's strategy is defined, in order to leverage the company's objectives for a given period.

The Internal Points are intended to highlight the deficiencies and qualities of the company being analyzed, depending on what it says [6]. This information is within the organization and has immediate and specific implications for the organization's management.

Yet [17] defines that the External Points, aims to study the relationship between the company and the environment in terms of opportunities and threats. It is a complex strengths with which the company and its managers seek to change its implications in order to formulate and implement strategies aimed at constant vigilance and skills to correctly interpret trends and use that understanding to make successful strategies. It can offer opportunities and threats so that the company seeks to take advantage of the opportunities, as well as seeking to mitigate or absorb the threats or adapt to them.

2.1.1 About the SWOT analysis

For [31], the opportunities and threats crossed with the strengths and weaknesses allow an overview, the position in which the organization is, allowing notions about the paths to be followed, emphasizing strategic planning.

By clearly listing the internal characteristics between strengths and weaknesses and in the same way the external characteristics between threats and opportunities comes a combined analysis, overlapping and confronting the situations of the company's business environment with the internal conditions [16].

Table 1 shows the possibilities raised with the crossing, which are: offensive (the company seeks to develop competitive advantages); confrontation (to change the environment in favor of the company); reinforcement (making better use of opportunities); defensive (aims at possible profound modifications to protect the company).

Table 1. Types of Strategy.

OBJECTIVE	ENVIRONMENT INTERNAL	ENVIRONMENT EXTERNAL
Offensive Strategy / Offensive Potential	Strenghts	Opportunities
Confrontation Strategy / Defensive Potential	Strenghts	Threats
Reinforcement / Offensive Weakness	Weaknesses	Opportunities
Defensive Strategy / Vulnerability	Weaknesses	Threats

Source: Adapted from [31].

Table 2 presents the matrix with the factors listed for each environment, with the strengths (1,2 and 3) and weaknesses (1,2 and 3) composing the internal environment and the opportunities (1,2 and 3) and threats (1,2 and 3) composing the external environment, generating a 6X6 SWOT matrix, with 36 crossings.

Table 2. Factors of the SWOT matrix.

EXTERNAL ENVIRONMENT / INTERNAL ENVIRONMENT			EXTERNAL ENVIRONMENT						TOTAL
			OPPORTUNITIES			THREATS			
			OPPORT. 1	OPPORT. 2	OPPORT. 3	THREAT 1	THREAT 2	THREAT 3	
INTERNAL ENVIRONMENT	FORCES	STRENGTH 1							
		STRENGTH 2							
		STRENGTH 3							
	WEAKNESSES	WEAK. 1							
		WEAK. 2							
		WEAK. 3							
TOTAL									

Source: [3].

The great advantage of the SWOT matrix for the elaboration of strategies lies in the crossing of the set of strengths with the opportunities and threats, in addition to the crossing of the set of weaknesses with the same opportunities and threats [32].

Observation of the results of the crossings can demonstrate the level of preparation of the organization to face the future designed and represented in the matrix. At first, it is necessary, therefore, that each of the

factors of the internal environment be considered in relation to the others of the external environment. This technique allows the identification of how the organization is preparing for each of the factors of the internal environment, over which it has full control to capture opportunities or to mitigate the negative effects of threats that the external environment presents [13].

For use of the matrix, as a result of each crossing, a number that represents, according to a measurement rule, how much the factor of the internal environment acts compared to the factor of the external environment must be pointed out. For example, the crossing of Strength 1 (S1) in front of Opportunity1 (O1) appears as S1 X O1, and should receive a value to be pointed out according to the established measurement rule.

For scoring, you must use appropriate questions that place the element of the internal environment in front of the elements of the external environment. The internal factors are responsible for capturing the former and rejecting the latter, which leads to different questions, but with the sole objective of observing the organization in this chosen scenario, or identified by the organization's strategists.[31].

With the established scoring criterion and the questions for the intersections already formalized, each of the intersections is scored to obtain the values for the positions of the SWOT matrix of the exercise.

The score of each crossing alone can do little, but the analysis of each strength, weakness and quadrant can mean a lot. From this analysis, the organization's action needs, strategic objectives and strategies for achieving the vision can be born.

2.2 The Fuzzy System

The concepts of fuzzy sets and fuzzy logic were introduced by Lotfi Zadeh in the 1960s and 1970s. Since then, fuzzy logic has been used in many applications. According to [33], when the complexity of the system increases, the ability of human beings to describe the behavior of the system decreases. He argues that complex problems cannot be translated into numbers, but rather labels on fuzzy sets.

Depending on what they claim [34] Fuzzy logic as theory is an extension of conventional (Boolean) logic, to introduce the concept of non-absolute truth, and works as a tool to deal with inaccuracies in natural language. Fuzzy mathematics is an attempt to approximate the characteristic precision of mathematics to the inherent vagueness of the real world. The fuzzy number does not arise, usually from real observations, but from more or less known concepts or conceptions.

Second [35], it must be emphasized that fuzzy sets do not eliminate subjectivity, which is a real human phenomenon, however, in most decision-making, the decision maker would be aware of his subjectivity. What the sets do is to allow the subjective phenomenon to be manipulated.

[36] clarify that, in classical mathematics, a subset U of a set S to the elements of the set [0, 1]. U: $S \rightarrow$ [0, 1]

This application can be represented as a set of ordered pairs; the first is an element of S, and the second is an element of the set[0, 1]. This function is called the membership function. The membership function is the characterizing factor of the fuzzy set. It associates an element of the universe with a real number of the interval[0, 1]. The degree of belonging 1 is equivalent to the classic symbol of belonging$\in$, and the degree of belonging 0 is equivalent to the symbol $\notin$ [37].

The fuzzy set theory indicates the degree to which each element belongs to the set. The value 0, or null, indicates that it does not belong, represents the "total non-pertinence"; and the value 1 indicates "total pertinence". Another type of pertinence is given by the intermediate values between 0 and 1. These values represent the "degrees of pertinence" - also interpreted as "degree of veracity" - of the affirmative, that is, this theory transforms the concept of False and True into numbers in the range 0 to 1, where 0 is False and 1, True [38].

A fuzzy set A in a universe X is defined by a membership function (x) $\mu A(x)$: $X \rightarrow [0, 1]$, and represented by a set of ordered pairs $A = \{\mu A(x) /x\}\ x \in X$, Where$\mu A(x)$ indicates how much x is compatible with the set A. A given element can belong to more than one fuzzy set, with different degrees of relevance [25].

The linguistic variable is a variable whose elements are names of fuzzy sets. Its main function is to provide a way to characterize the complexity of the phenomena and lack of clarity. This allows the treatment of more complex systems to be analyzed using traditional mathematical terms [39].

The pertinence functions, commonly represented in the literature by $\mu A(x)$, can take different forms, depending on the concept you want to represent and the context in which they will be used. According to [38], the membership function $\mu A(x)$, Where $0 \leq \mu A(x) \leq 1$, is associated with events xi, on what i ranges from 1 to n. In this way, the fuzzy set is also represented by$A = \{\mu A(xi) /xi\}$, $i = 1, 2,\ldots, n$.

Among the most common forms of fuzzy membership functions, the most used is the triangular fuzzy number (Figure 2) which is represented by the closed interval [a, b] and has the only vertex outside the base determined by the interval [a, b] the point (u, 1), giving the characteristic triangular shape of that number.

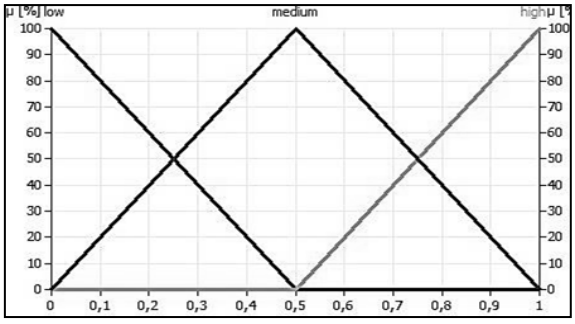

Figure 2. Triangular membership function.
Source: [34].

A trapezoidal fuzzy function (Figure 3) has four parameters a, b, c and d, and we can define it from these four parameters.

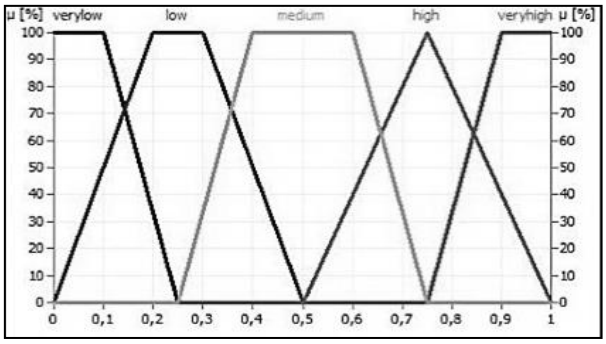

Figure 3. Trapezoidal membership function.
Source: [34]

Gaussian membership functions are characterized by their mean (μμ) and standard deviation (σσ). This type of membership function has a smooth decay and has non-zero values for every domain of the studied variable, as can be seen in Figure 4.

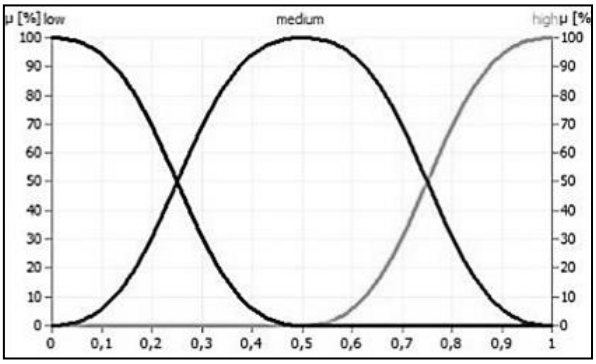

Figure 4. Gaussian membership function.
Source: [34].

The sets that have a single point in X with value μ (x) = 1, are called Singleton Set, as can be seen in Figure 5.

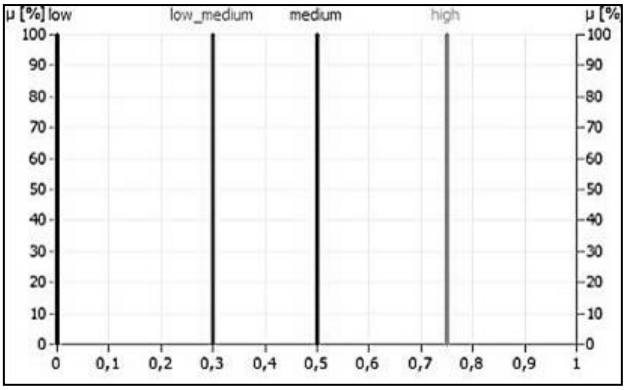

Figure 5. Singleton membership function.
Source: [34].

The functions mentioned - triangular, trapezoidal, Gaussian and singleton (representation of only one point, or crisp) - are the most classic and worked on by several authors.

The fuzzy system allows the identification of the modules that make up this system, thus providing the idea of the information flow within it. Basically, it consists of three stages, as can be seen in Figure 6, in which the functions of each stage are defined.

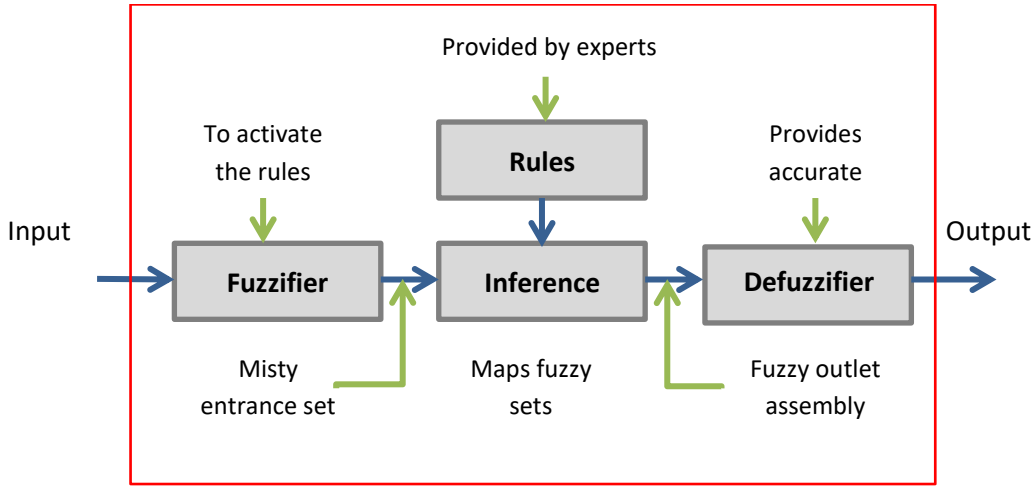

Figure 6. Fuzzy inference system.
Source: [38].

In the figure above, the non-fuzzy input is considered, which is the result of measurements in most practical applications. Therefore, it is necessary to convert these entries into a representation known as fuzzy sets, which is called fuzzification. In addition, in this stage the rules are activated for different situations. In the second stage, the rule base is established, such as the relationship between the input and output variables, which are obtained by the knowledge and experience of the application specialist. Once the fuzzy set of output resulting from the inference process has been obtained, it is necessary to carry out the interpretation of this information, as in practical applications, precise outputs are required, which is performed in the defuzzification stage [40].

Fuzzification is the conversion of the exact entries (real numbers) to the fuzzy domain. The fuzzifier assigns linguistic values (degrees of membership) using membership functions to the input variables. This is considered as a pre-processing step for the input signals, reducing the number to be processed which means less computational effort [41].

Fuzzy rules are logical implications that relate the input fuzzy sets to the output fuzzy sets. They are usually provided by a specialist, in the form of linguistic sentences, constituting a fundamental aspect in the performance of a fuzzy inference system, as shown below[41].

If x is **A** and y is **B**, then z is **C**.

Where A and B are the fuzzy input sets, relative to the part known as antecedents or premises, while C is the fuzzy output set, relative to the part known as a consequent or conclusion [10]. These rules can be

defined in advance or alternatively automatically generated from a database. In the inference stage, the operations of the sets themselves occur, such as the combination of the antecedents of the **If - Then** rules, generating the fuzzy output set.

In the defuzzification process, the interpretation of the fuzzy set of output inferred by the rules is carried out, in order to obtain a numerical value. This is necessary because in practical applications, precise outputs with some physical significance are required.

3. Material And Methods

3.1 Application Of Fuzzy Logic

The data collected in the study is provided by the specialist of a particular organization, based on annual reports prepared by the organization.

With the information about the organizational scenario, tests with the company's classic behavioral analysis tool were observed. Then, simulations were generated based on three stages of fuzzy logic: fuzzyfication, inference and defuzzyfication.

Through the input variables and the behavior based on the sequencing of the creation of rules, it was possible to observe the strategic positioning of the organization through the generation of logical outputs, thus achieving the objective of the study.

3.2 Definition Of Fuzzy Sets

For the construction of the SWOT matrix, the following factors were defined, according to Table 3:

Table 3. Favorable and unfavorable factors in the internal and external environments of the organization.

	Favorable	Unfavorable
Internal environment	• High financial resources • High knowledge of the market • Good marketing skills	• Low investment in research • Low Strategic Orientation • Low communication management
External Environment	• High Market Growth • New business alliances • High performance of allied companies	• Import barriers • Fall in economic activity • Entrance of competitors

According to the provisions in Table 3, the strengths and weaknesses, opportunities and threats were defined, and in Figure 7, the cross between these main factors for building the fuzzy system.

	Strenghts	Opportunity	
S1	High financial resources	High Market Growth	O1
S2	High knowledge of the market	New business alliances	O2
S3	Good marketing skills	High performance of allied companies	O3

	Weakness	Threat	
W1	Low investment in research	Import barriers	T1
W2	Low Strategic Orientation	Fall in economic activity	T2
W3	Low communication management	Entrance of competitors	T3

Figure 7. Crossing of fansfavorable and unfavorable actors in the internal and external environments of the organization.

The crossing between the Strengths and Opportunities generated S1O1, S2O2 and S3O3. The intersection between Strengths and Opportunities generated S1T1, S2T2 and S3T3. The crossing between Weaknesses and Opportunities generated W1O1, W2O2, W3O3. The crossing between Weaknesses and threats generated W1T1, W2T2 and W3T3.

3.2.1 Definition of Fuzzy Sets for SWOT Matrix

For the construction of the fuzzy system, the input variables were defined according to inference, being listed three characteristics S1O1, S2O2 and S3O3; S1T1, S2T2 and S3T3; W1O1, W2O2, W3O3; and W1T1, W2T2 and W3T3 for the offensive potential, defensive potential, offensive weakness and vulnerability factor, respectively.

Table 4 shows the pertinence functions of the proposed system.

Table 4. System Relevance Functions.

Variables	Numeric Range	Linguistic Value
ENTRANCE		
SxO	[0 - 100]	(Little Relevant, Relevant, Very Relevant)
SxT		
WxO		
WxT		
EXIT		
Offensive Potential	[0 - 100]	(Low, Medium, High)
Defensive Potential		
Offensive weakness		
Vulnerability		

Figure 8 exemplifies how the input variable behaves in the system, demonstrating that the variable S1xO1 has three membership functions (FPs), two of which are trapezoidal (Little Relevant and Very Relevant) and one triangular (Relevant).

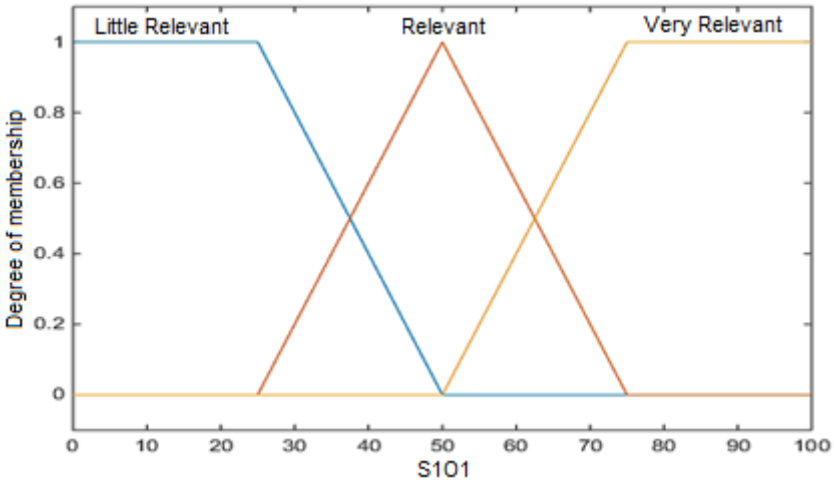

Figure 8. Fuzzy set for the input variable S1xO1.

Figure 9 alludes to how the output variable is admitted in the proposed fuzzy system, considering the Offensive Potential output variable related to the StrengthxOpportunity input (S1O1, S2O2 and S3O3) also has three membership functions (FPs), two of which are trapezoidal (Low and High) and a triangular (medium).

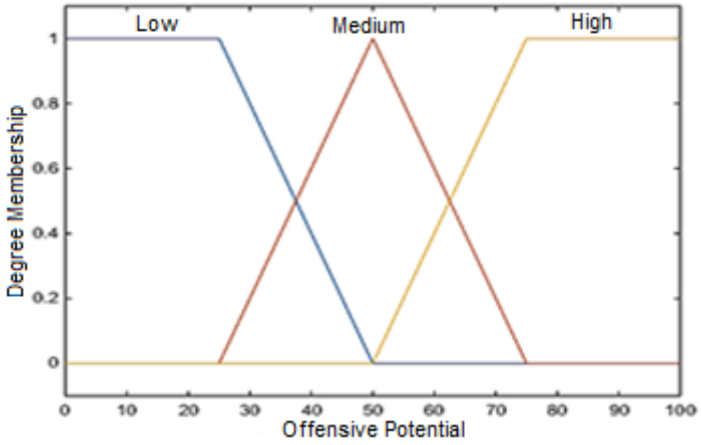

Figure 9. Fuzzy set for the Offensive Potential output variable relative to StrengthxOpportunity.

3.2.2 Definition of Rules

The fuzzy rule is a unit capable of capturing some specific knowledge, and a set of rules describes a system in its various possibilities. Each fuzzy rule, like a classic statement, is made up of an antecedent part (the If part) and a consequent part (the Then part).

The antecedents describe a condition (premises), while the consequent part describes a conclusion or an action that can be sketched when the premises are verified. Background defines a fuzzy region in the space of the system's input variables. The consequents, on the other hand, describe a region in the space of the system's output variables, whatever its conclusion.

This stage of the process considered the degree of relevance of the antecedents for determining the consequent, which refers to the organizational environment (macro and microenvironment), in which 27 assumptions were analyzed resulting in a set of diagnoses converted into fuzzy sets for each input variable.

(S1O1, S2O2 and S3O3; S1T1, S2T2 and S3T3; W1T1, W2O2, W3O3; and W1T1, W2T2 and W3T3) regarding the exit possibilities (Offensive Potential, Defensive Potential, Offensive Debility and vulnerability). Table 5 expresses the evaluations about the situations of each premise and the strategic nature stimulated, considering the fuzzy set for the StrengthxOpportunity entries, considering the offensive potential.

Table 5. Evaluation of the impact of the premises (StrengthxOpportunity) on the strategic positioning.

F	IF	AND		THEN
	S1O1	S2O2	S3O3	Offensive Potential
1	Little Relevant	Little Relevant	Little Relevant	Low
two	Little Relevant	Little Relevant	Relevant	Low
3	Little Relevant	Little Relevant	Very Relevant	Low
4	Little Relevant	Relevant	Little Relevant	Low
5	Little Relevant	Relevant	Relevant	Average
6	Little Relevant	Relevant	Very Relevant	Average
7	Little Relevant	Very Relevant	Little Relevant	Low
8	Little Relevant	Very Relevant	Relevant	Average
9	Little Relevant	Very Relevant	Very Relevant	High
10	Relevant	Little Relevant	Little Relevant	Low
11	Relevant	Little Relevant	Relevant	Low
12	Relevant	Little Relevant	Very Relevant	Average
13	Relevant	Relevant	Little Relevant	Average
14	Relevant	Relevant	Relevant	Average
15	Relevant	Relevant	Very Relevant	Average
16	Relevant	Very Relevant	Little Relevant	Average
17	Relevant	Very Relevant	Relevant	High
18	Relevant	Very Relevant	Very Relevant	High
19	Very Relevant	Little Relevant	Little Relevant	Low
20	Very Relevant	Little Relevant	Relevant	Average
21	Very Relevant	Little Relevant	Very Relevant	High
22	Very Relevant	Relevant	Little Relevant	High
23	Very Relevant	Relevant	Relevant	Average
24	Very Relevant	Relevant	Very Relevant	Average
25	Very Relevant	Very Relevant	Little Relevant	High
26	Very Relevant	Very Relevant	Relevant	High
27	Very Relevant	Very Relevant	Very Relevant	High

4. Results and Discussion

Based on the results obtained, the evaluation criterion was based on three points that consider the degree of importance that each strength, weakness, opportunity or threat has for the company. The second assesses the intensity that each of these same elements is evident in the company. The third indicates the tendency that each element has to increase or decrease over time.

The adopted fuzzy model has the data displayed in the rules viewer to facilitate the interpretation of the inference process and also to demonstrate functions that reflect in the system result.

By varying the input values, it is possible to evaluate the outputs of the proposed model, obtaining a value that allows a correct analysis of the efficiency of the method adopted to support decision making with respect to the type of strategy suggested by crossing the input variables, according to the Figure 10.

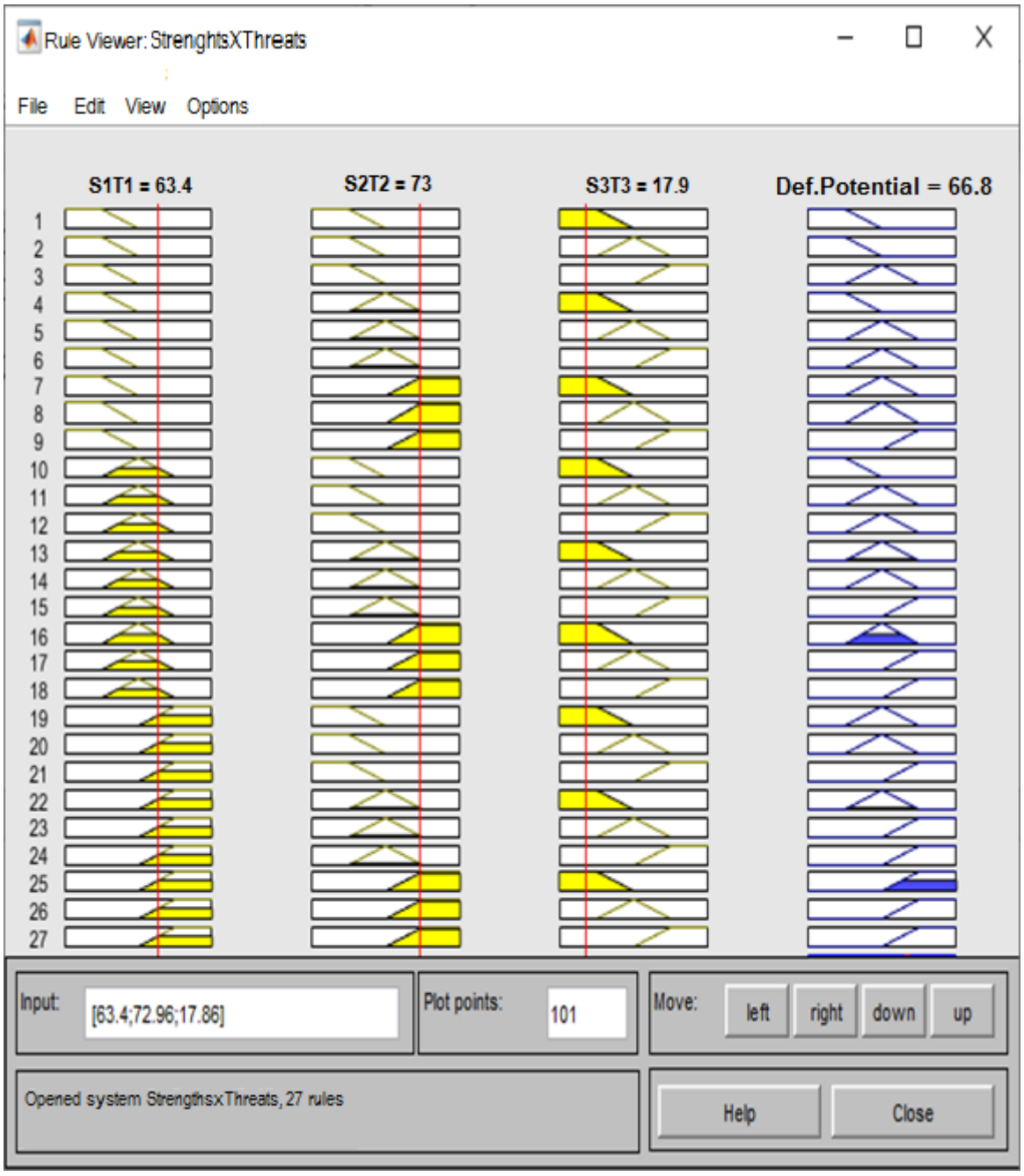

Figure 10. Result demonstrated from the intersection of StrengthxThreat.

For greater clarity of the adopted fuzzy model, hypothetical input values will be defined. Input values resulting from the intersection of StrengthxOpportunity, in which the value adopted for the S1O1 variable is assumed to be 90%; for S2O2 the value of 40%; and for S3O3 equal to 65%, there is a Offensive Potential of 62.9%, that is, this is the percentage considered by the organization to increase and erfect its Strengths for a better use of opportunities.This example can be seen in Figure 11.

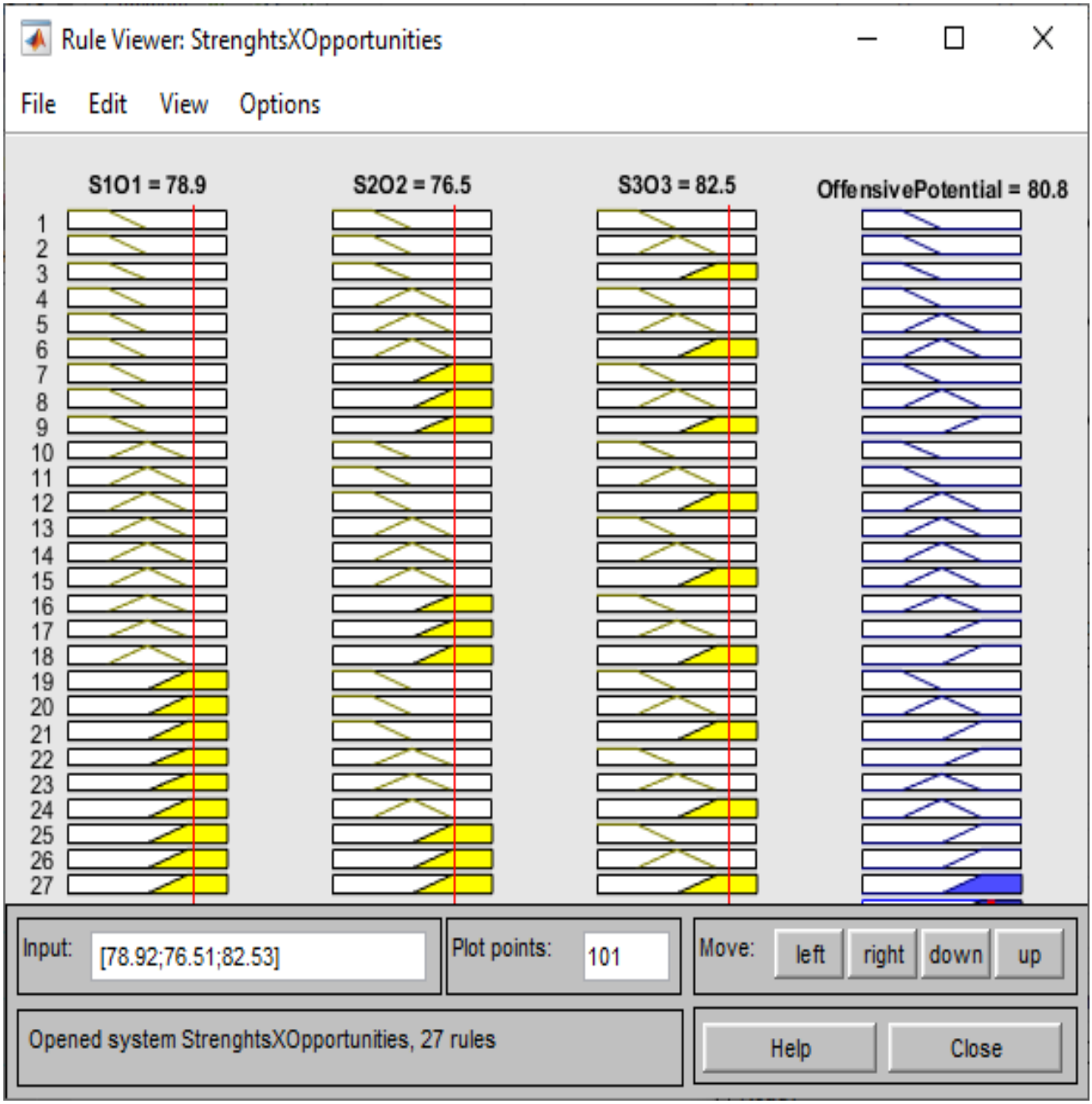

Figure 11. Strategy adopted by the organization from the intersection of StrenghtxOpportunities.

When considering the crossing of the variable StrengthxThreats, for the input variable S1T1, the value of 91% is determined; for S2T2 the value of 87.3%; and for S3T3 the percentage of 92.2%, which determines a Defensive Potential of 80.8%, that is, this is the percentage considered by the organization to reduce threats through its strengths. This other example can be seen in Figure 12.

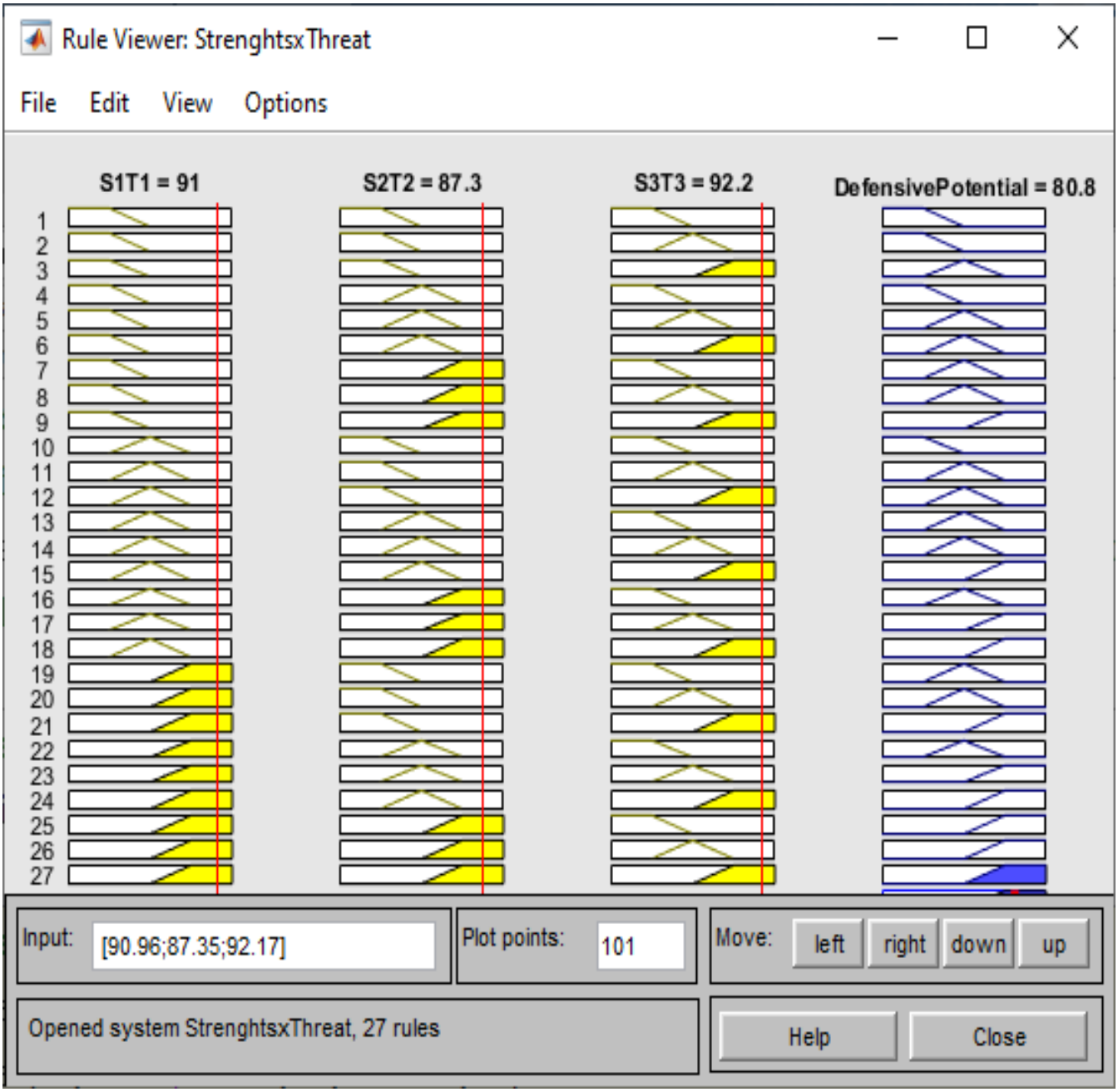

Figure 12. Strategy adopted by the organization from the intersection of StrengthxThreat.

When analyzing the crossing of the variable WeaknessesxOpportunites, for the input variable W1O1, the value of 84.9% is determined; for W2O2 the value of 89.8%; and for W3O3 the percentage of 89.8%, which determines an Defensive Potencial 80.8%, which means how much weakness can cause problems to take advantage of opportunities within the organization. This other example can be seen in Figure 13.

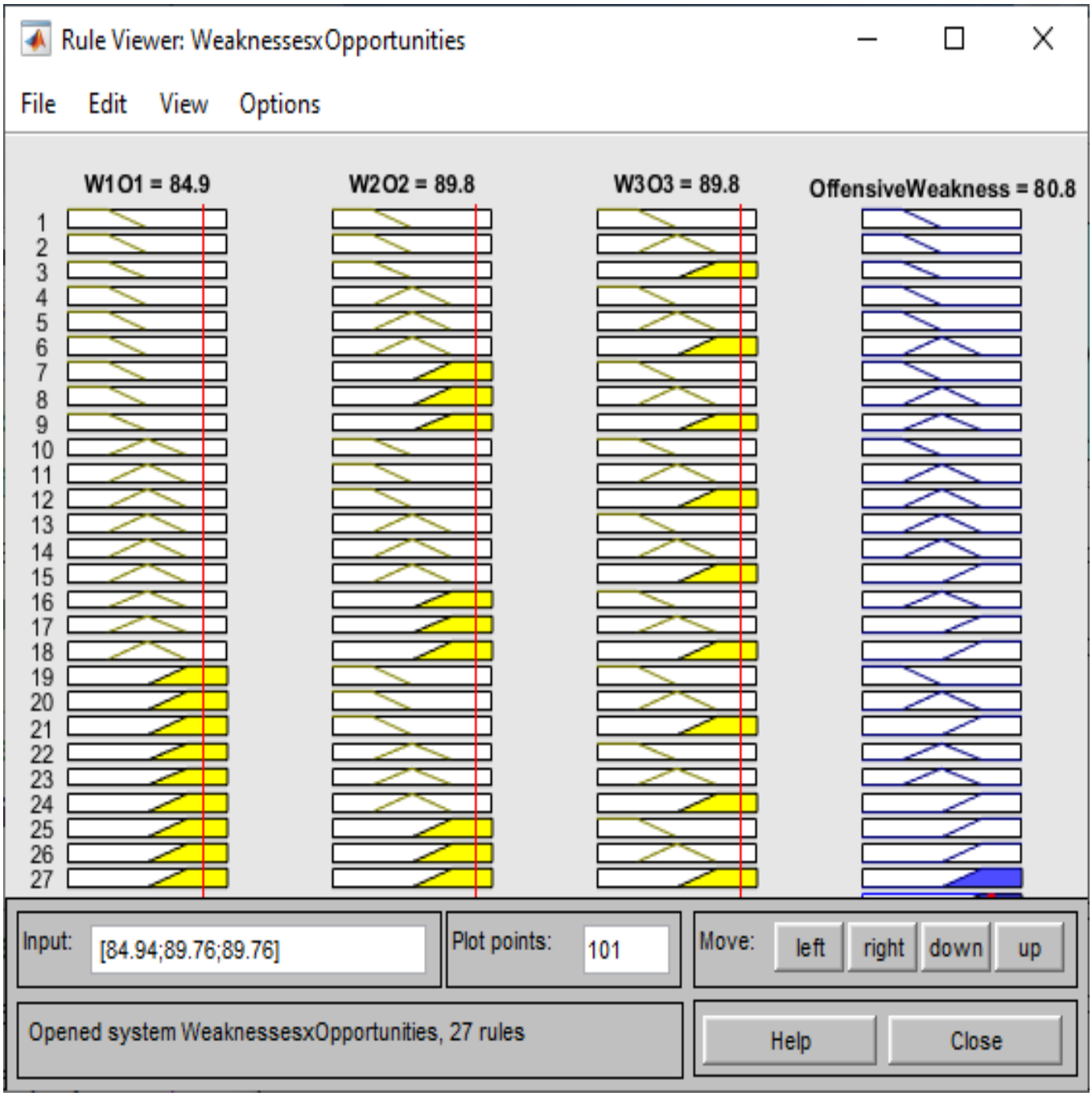

Figure 13. Strategy adopted by the organization from the WeaknessxOpportunities intersection.

When considering the crossing of the variable WeaknessxThreat, for the input variable W1T1, the value of 89.8% is determined; for W2T2 the value of 84.9%; and for W3T3 the percentage of 84.9%, which determines a Vulnerability 75%, suggesting to the organization possible profound changes to protect the company. This other example can be seen in Figure 14.

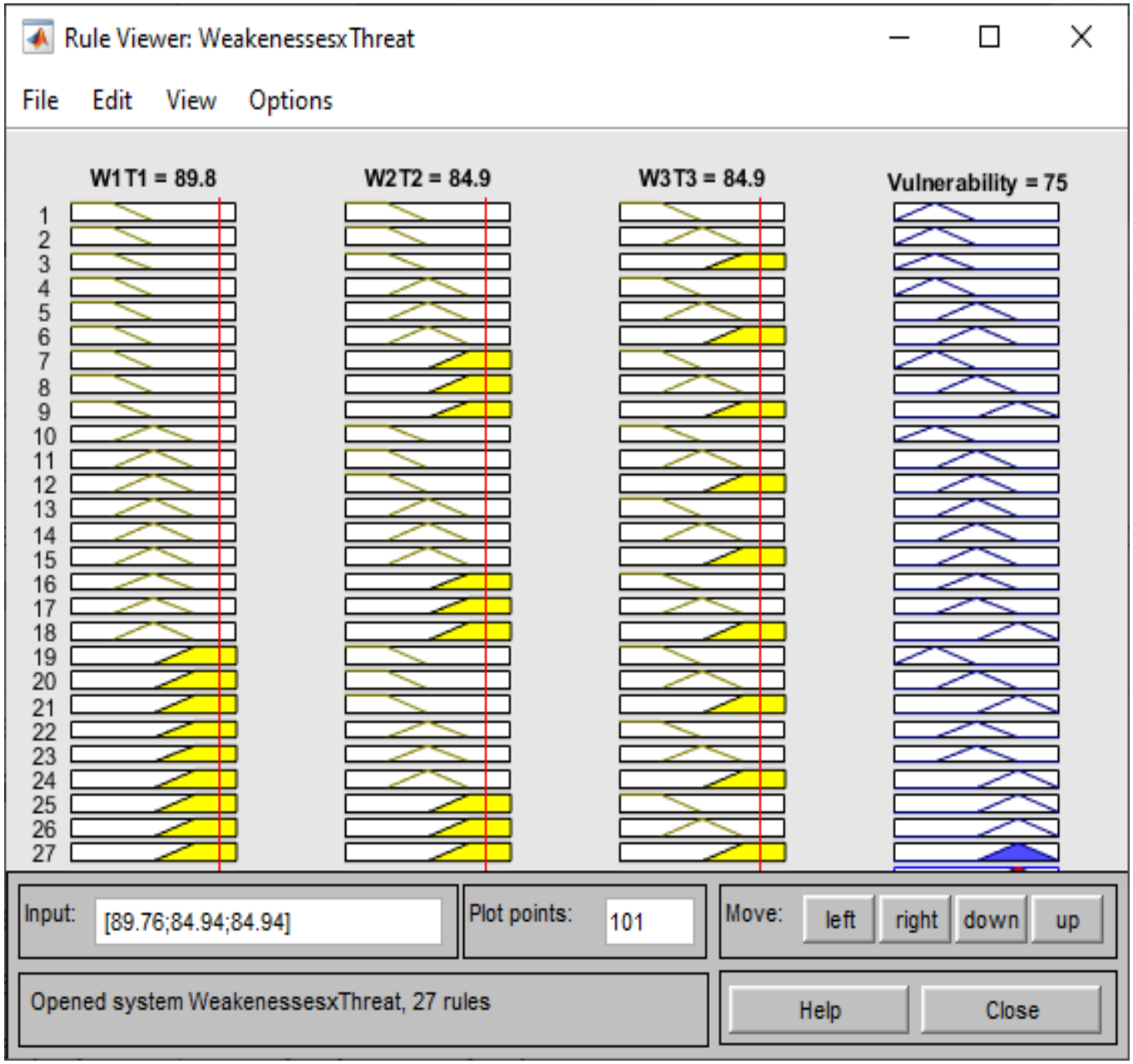

Figure 14. Strategy adopted by the organization from the WeaknessxThreat intersection.

5. Conclusion

The use of technological tools to generate information that assist in decision making has been shown to be increasingly indispensable for successful management. The organizational scenario is constantly looking for ways that make it possible to observe how the external environment behaves at a given moment.

In view of this, the approach proposed by the Fuzzy Inference model for the SWOT matrix proved to be simplified and efficient for a better collection of information that helps in predicting the future environment, enabling reasoned strategies resulting from the model presented.

The analyzes presented in this work clearly demonstrate the stimulus for the strategic planning policy. The SWOT matrix developedusing the computational intelligence technique by means of fuzzy logic it is able to assist in taking advantage of the organization's potentials, capturing opportunities and containing threats

from the external environment, as well as assisting in reducing the weaknesses found, with the intention of promoting the growth of the company that adopts the proposed model.

To theto analyze the efficiency and effectiveness of the proposed system, it was found that the model meets the objectives of the dissertation and that it can be applied in any organization, regardless of its particular characteristics, since the mathematical models are adaptable according to the linguistic variables to be adopted.

Therefore, the main objective of the dissertation was iimplement a Fuzzy assessment model based on SWOT analysis as a resource for decision making.

6. Acknowledgments

To the Postgraduate Program in Process Engineering at the Federal University of Pará (UFPA) and to the Galileo da Amazônia Institute of Technology and Education (ITEGAM) for supporting this research.

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