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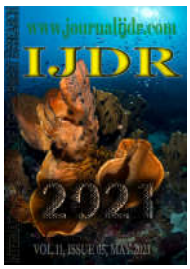

RESEARCH ARTICLE OPEN ACCESS

MARKET SHARE STRATEGIC ANALYSIS OF A PRIVATE HIGHER EDUCATION INSTITUTION USING THE FUZZY SWOT METHODOLOGY

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ABSTRACT

This article presents a methodology that uses the variables used in the SWOT model (Strengths, Weaknesses, Opportunities and Threats), based on the subjective opinions of several experts. The presented methodology (Fuzzy SWOT), is an automated system to aid decision making, whose output is the viability of a business. The implemented system presented conservative results, allowing the decision maker to maximize his business. This system also makes it possible to carry out sensitivity analysis in order to assist the decision maker, which are the variables that most impact the business.

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INTRODUCTION

In Brazil, private higher education institutions are very important, especially for their economy. Given that there are thousands of these institutions, with thousands of employees, it is essential that they carry out studies on their strategies. There are several challenges for these organizations, especially related to competition. The occurrence is the essence for the success or failure of these institutions, in order to adapt their activities to maximize their performance, as Ferreira, E. P., Gruber, C., Merino, E. A. D., Merino, G. S. A. D., & Vergara, L. G. L. (2019). For Porter (1989) and Planejamento Estratégico (2015-2020), it is necessary to have a competitive strategy to create value, advantages to survive, such as differentiating courses, formulating innovative marketing strategies and new business models. The differentiation of courses, faculty, among others, is valued by customers, even though their prices are higher, resources that cannot be imitated that neutralize competitors; any company can improve its profitability, using a management system, by carrying out activities that add value to them. As Redação Escola de E-commerce (2020), the SWOT (Forces, Strengths, Opportunities, Weaknesses and Threats) methodology is highlighted, to aid decision making, to assist companies in identifying strengths, weaknesses, opportunities, and threats related to competition in business or project planning.

Although the use of SWOT is quite common and popular, it still has some structural problems. The most important are the lack of considering doubtful and uncertain factors, lack of prioritization of actors and strategies and many extractable strategies. This article tries to solve some of the problems, following the fuzzy approach to internal and external factors (in the form of fuzzy membership functions). The algorithm presented in this article prioritizes and extracts the most significant strategies based on the intensity of the effect, using Mamdani's fuzzy inference system.

Swot Model

According to Al-Araki, M. (2013) and Writing School of E-commerce (2020) and Strategic Planning (2015-2020), with this tool, the company will be able to organize and detail the Strengths, Weaknesses, Threats and Opportunities of your business. According to the Newsroom Escola de E-commerce (2020), the internal points of the SWOT Matrix are the internal strengths and weaknesses of a business. In other words, everything that your enterprise has an advantage or disadvantage in relation to the competition. According to the Leadempresarial Newsroom (2020), the forces are basically all that the company has to offer; Weaknesses are all that the company has to do with problems. In this case, the company dosen't have to worry about coinciding with its competitor or not, the important thing

is to know what needs to change. According to Ferreira et al. (2019), Opportunities are all chances motivated by some external factor, that is, outside the control of the enterprise, which can be well used to leverage the business and Threats are all problems that can be caused by some external factor of the enterprise, which must be bypassed.

Fuzzy Model: According to Oliveira Junior et al (2008) and Tanscheit (2013), the concept of fuzzy logic has been studied since the 1920s. Fuzzy logic was first formulated by Lotfi Zadeh, a professor at the University of California at Berkeley, in the mid-1960s. He noted that conventional computer logic was unable to manipulate data representing subjective or unclear human ideas. This observation emphasized the gap between mental representations of reality and the usual mathematics of their representations, based on binary logic, precise numbers, differential and similar equations. In the 1980s, fuzzy control became a major industry in Japan and other countries where it was integrated with household appliances, such as vacuum cleaners, microwave ovens and video cameras. Such devices could automatically adapt to different conditions, for example, a vacuum cleaner would apply more suction to an especially dirty area. One of the benefits of fuzzy control is that it can be easily implemented on an ordinary computer. Lotfi Zadeh, noted that, unlike computers, human decision making includes a range of possibilities between YES and NO. According to Tanscheit (2013), the term fuzzy refers to things that are not clear or are vague. In the real world, we often encounter a situation in which we cannot determine whether the state is true or false, fuzzy logic provides very valuable flexibility for reasoning. Thus, we can consider the inaccuracies and uncertainties of any situation. A fuzzy set A defined in universe X is characterized by an ordered pair containing the element and its membership function, $m_A(x)$, which maps the elements of X to the interval [0.1]. In this way, the membership function associates each y element belonging to X with a real number in the interval [0.1], which represents the degree of membership of the element y to the set A, that is, as much as possible for the element y belong to set A.

- $m_A(x) = 1$ indicates that x is completely compatible with A;
- $m_A(x) = 0$ indicates that x is completely incompatible with A;
- $0 < m_A(x) < 1$ = indicates that x is partially compatible with A, with degree $m_A(x)$.

In Fuzzy Inference Systems, the four reasoning processes are identified: fuzzification of the entries, creation of the rules base, inference and defuzzification, according to Tanscheit, R (2013). In a Fuzzy System, non-fuzzy or accurate inputs, resulting from measurements or observations (data sets, for example), are considered, which is the case for the vast majority of practical applications. The system, following the theory of fuzzy sets, has the essence of generating output values without the need for precise inputs. Fuzzy logic systems follow the nonlinear mapping of an input vector, X, in a scalar, y, capable of incorporating both objective and subjective knowledge. Objective knowledge is used in the formulation of problems and is explained by mathematical models. Subjective knowledge, on the other hand, represents linguistic information that is usually impossible to quantify using traditional mathematics, these systems have as main characteristics: modeling complex problems with nonlinear properties; knowledge modeling in a similar way to how experts express the decision-making process and the ability to model involving multiple experts and possible conflicting information.

CASE STUDY

This paper presents a development of a smart specialist system to automate the viability of a Private Higher Education Institution, using a Mamdani fuzzy inference system to aid decision making in innovations risks. The software Matlab (2016) was used to implement the system.

This system uses the variables of the SWOT Model as inputs, to estimate the economic viability of this kind of business. The input variables are:

- Strengths (internal and external)
- Opportunities (internal and external)
- Weaknesses (internal and external)
- Threats (internal and external)

The output variable is a grade risk for the business opportunity. As the variables are subjective, a Fuzzy model was used for the modeling. Input variables include:

Strengths (product brand, location, facilities, financial strength) - in case that the business is an educational institution, it must include the number of professors with a doctoral degree in the institution, the academic and technological production of the professors and partnerships with other institutions; courses with differentials, recognized by the students and by the market, observed by the course scores in the SUCUPIRA evaluation, carried out by the Coordination for the improvement of higher education personnel, CAPES, and in the Ministry of Education of Brazil, MEC; the relevant academic and technological production, recognition of the course by the market.

Weaknesses (absence of a business strategy, this variable includes the software needed to carry out good research), lack of integration with companies; lack of an information system that facilitates academic activities (such as the sharing of didactic material, disclosure notes, the issuing of school transcripts, etc.); the absence of a continuous policy of financial support for participation in national and international congresses makes it difficult to update the knowledge of the area and the potential collaboration with researchers from other institutions, the lack of a website with information on the master's programs and the activities carried out by teachers and alumni seriously compromises the dissemination of these programs, little institutional dissemination of the publications made by the teachers of the house, the lack of a regular program of academic seminars reduces the networking of teachers and students, in addition to preventing the latter from expanding the range of potential projects for the dissertation, incipient use of tools such as R and Python in the quantitative courses of the Masters. The mastery of such tools would give students an important differential and allow for gains of scale in the preparation of dissertations.

- **Opportunities** (international partnerships with leading schools, exchanges for teachers and students, funding from research support agencies), the offer of new professors with a doctorate degree, bringing executives from large companies closer to the academic activities of the house (through events such as lectures, debates, invitations to teach classes etc) in order to improve the dissemination of programs in these companies and in the media and also to strengthen partnerships, restructure some electives in order to update the program in view of the demands that the students will have in the job market, creation of a regular academic seminar program, creation of a website to increase the visibility of the master's programs as well as to stimulate the exchange of students with foreign institutions.
- **Threats other competing institutions** (prices charged for services, economic crisis, digital economy), the prospect that in the medium term companies and the government will continue to invest little in the training of their employees, the growing offer of online graduate courses , excellent quality made available by some of the best institutions in the world can make a master's degree more expensive in terms of perceived demand, reduced size of the labor market in one state when compared to another, uncertainty about the effect of the corporate changes, such as the sale of the brand.

FUZZY-SWOT system has used MATLAB (2006), as shown in Figure 1.

The system displays the input variables: internal forces, internal opportunities, internal weaknesses, internal threats, external strengths, external opportunities and external weaknesses and external threats. The system output variable is a grade of risk.

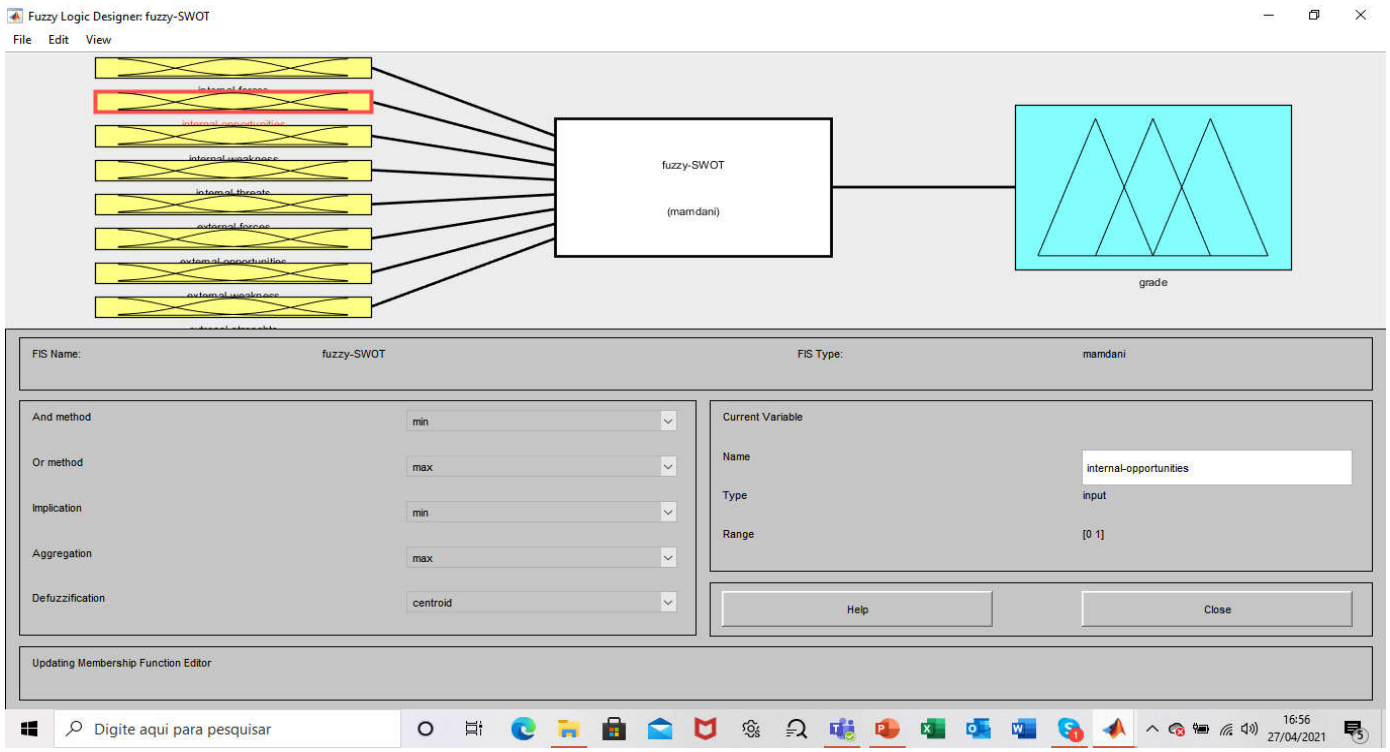

Figure 1. FUZZY-SWOT System

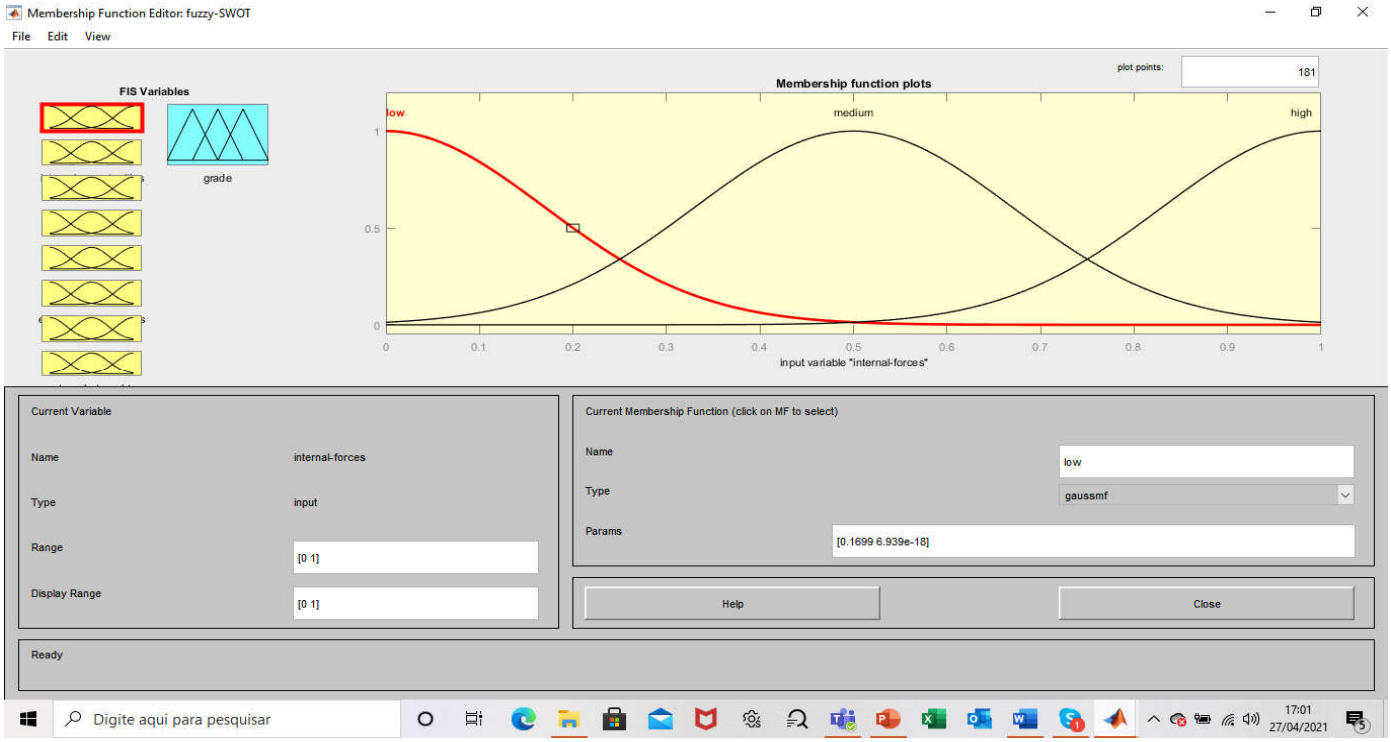

Figure 2. Membership Gaussian functions for input variables

The system displays the input variables: internal forces, internal opportunities, internal weaknesses, internal threats, external strengths, external opportunities and external weaknesses and external threats. The system output variable is a grade of risk. The image of all variables was the interval [0.1]. For each of the variables, three (03) membership Gaussian functions were used, representing low, medium and high values. Figure 2 shows one of the variables, internal forces, as an example. In figure 3, the output membership Gaussian functions variable is shown. The rules base presented in figure 4, was obtained according to the opinion of ten (10) specialists in the area of education, three (03) specialists in the financial market and seven (07) specialists in retail trade. Data were collected in 2019, containing twenty (20) closed and one open question. The rule base is a collection of rules of type IF…THEN. One example of a rule is: if internal strenghs is low, and internal opportunities is low, and internal weakness is low and internal threats is low, then the risk grade of the business is low. Figure 4, presents the rule base of this system. With this, it is possible to predict the viability of the business result. Figure 5 presents an example for the business result. If all input variables are high, and the external opportunities variable is low, the result will be average, indicating that the investments should be made in medium time. This machine, automatically gives the response to support the decision makers.

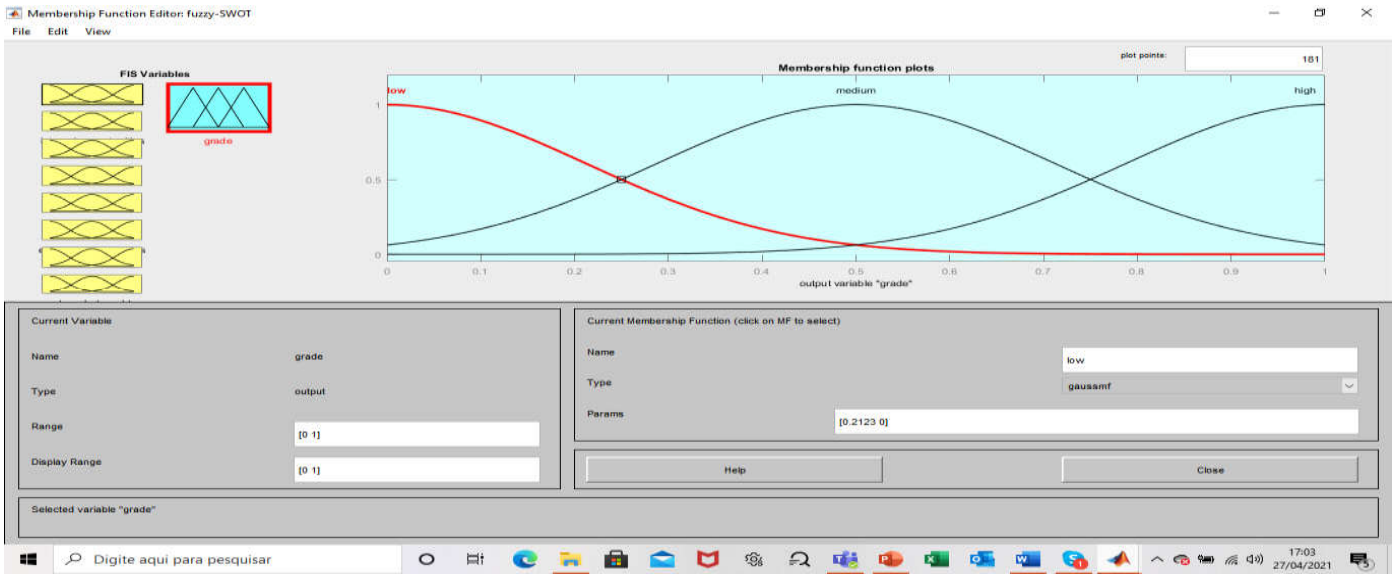

Figure 3. Membership Gaussian functions for output variables

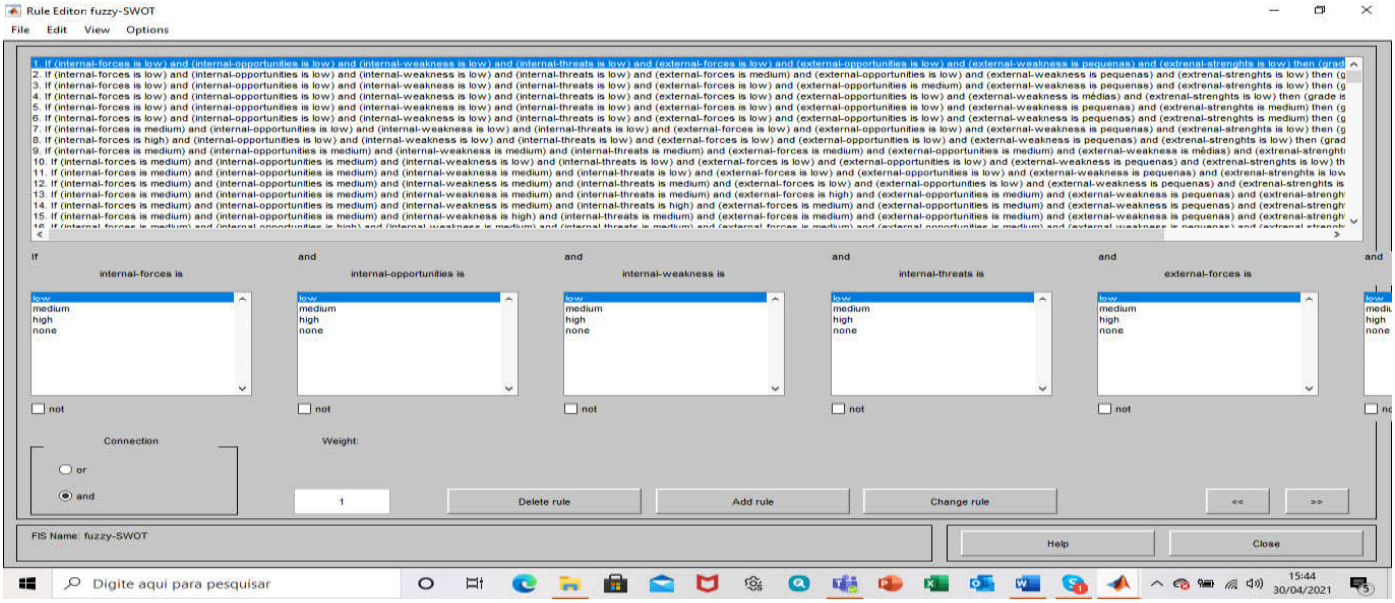

Figure 4. Rule Base

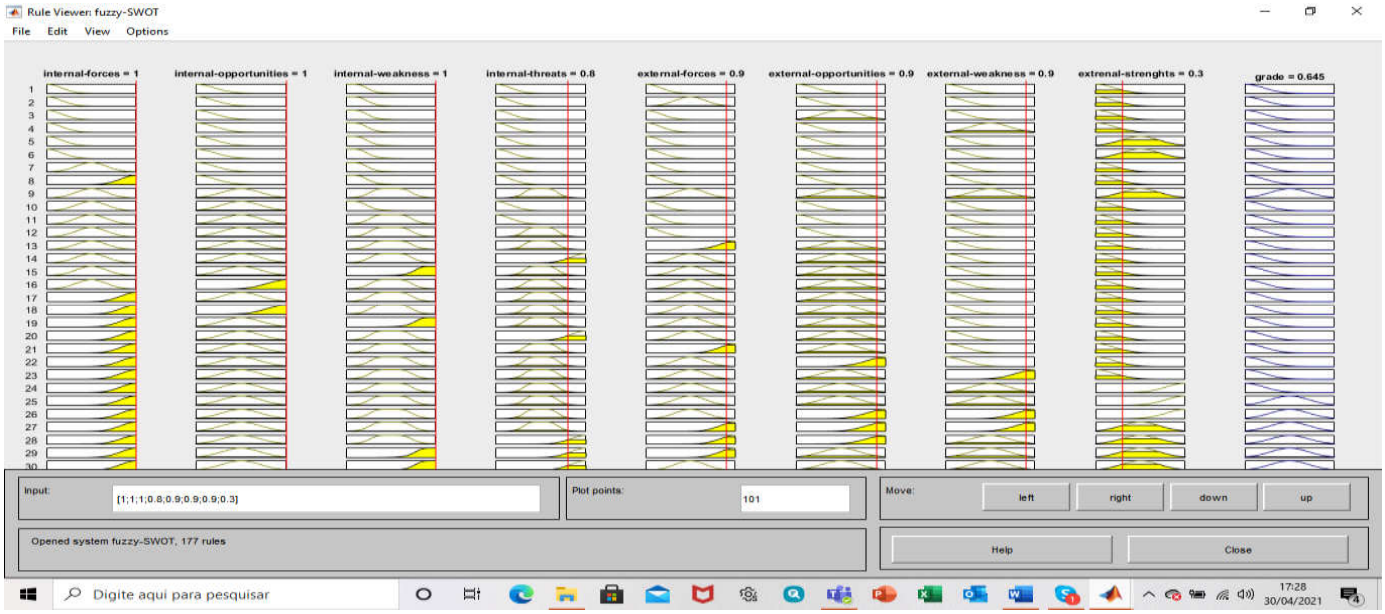

Figure 5. An example for the business result

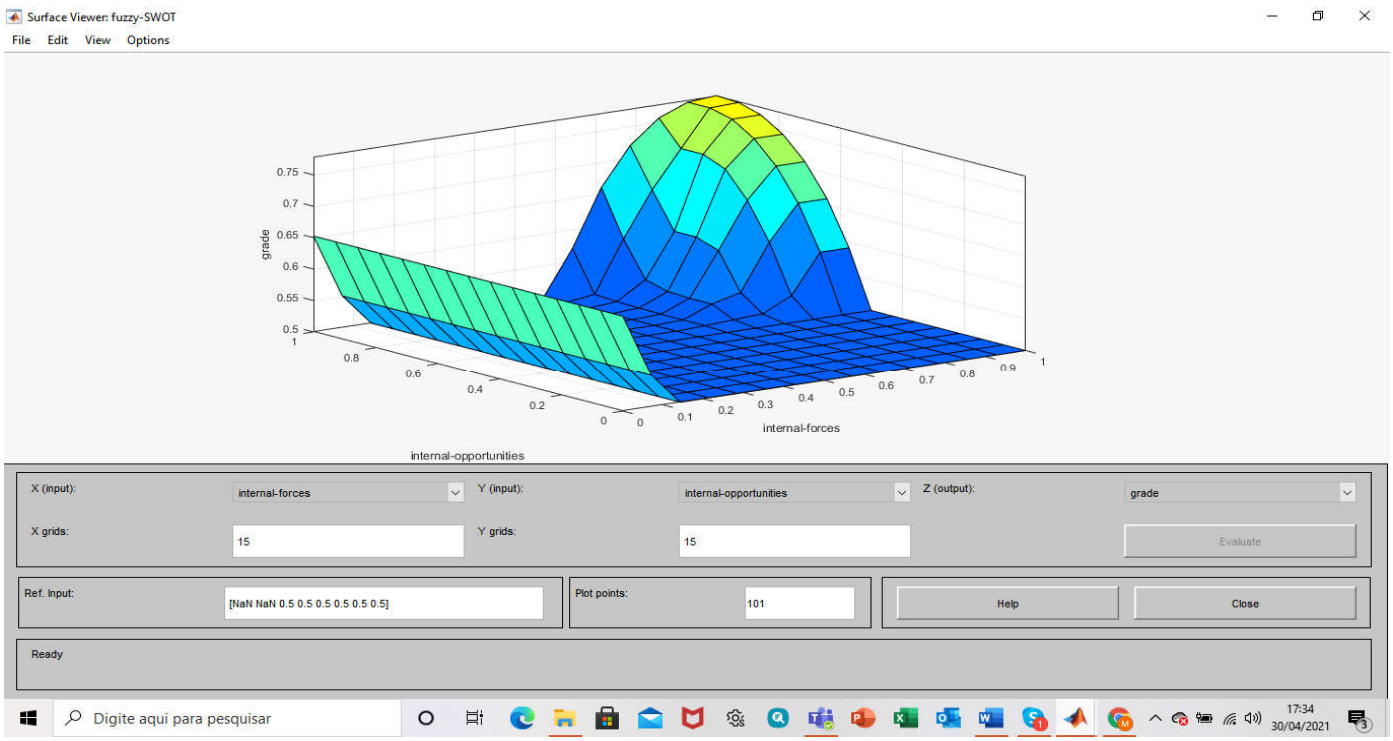

Figure 6. Sensitivity analysis example

The system also allows for sensitivity analysis, as shown in Figure 6. In the case illustrated here, there are internal opportunities versus internal forces, and the expected value of the response can be analyzed. This graph can be changed for any set of two variables in the model in order to verify the sensitivity of the response.

CONCLUSION

The FUZZY-SWOT system was tested and proved to be adequate and with conservative responses. Conservative responses can be interpreted as the lower limit of risk in the business value, allowing the decision maker to increase the value, after the sensitivity analysis. The great advantage of sensitivity analysis is to maximize the business value according to each variable. Another advantage of the system is to treat experts' opinions as linguistic variables. This work illustrates a decision support machine tool for management, and it is possible to highlight the integration of subjective opinions of experts, both from the point of view of the company and that of its employees, facilitating the elaboration of innovations, maximizing the growth of the company as well as the quality of the life of its employees. It is noteworthy that the FUZZY-SWOT system can be used for any type of business. It is suggested that future research uses the methodology to aid decision making in health companies, agricultural industries, among others.

Conflict of interest: There is no conflict to disclose.

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