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Application Of Fuzzy Logic To Assess The Degree Of Aptitude Of Professionals In The Areas Of Management

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Abstract:
Background*: Companies are increasingly specializing in the Human Resources sector, especially in the area of recruitment and selection of people, where it is with great responsibility that a screening is carried out in search of the profile that will bring the expected result, according to the profile that the company aims to adhere to to fill the vacancy. To the detriment of difficulties in recruiting and selecting the performance of people in order to determine the best profile for the requested vacancy. This work is considered relevant in informing that the present study aims to create a Fuzzy inference model for evaluating people's performance, based on multiple quantitative criteria, so that it can be used by the Human Resources sector of organizations. In this context, the work is justified by pointing out a new perspective of analysis through the candidate's competencies implemented in a Fuzzy interference model with the objective of evaluating and analyzing the candidate's competencies at the time of the recruitment and selection process, verifying if the candidate's profile is adequate for the exercise for the management area.*
Materials and Methods*: The Methodological Process of the research was developed in three phases: 1. Indicators of the degree of aptitude of professionals in the areas of management; 2. Fuzzy "Inference" System Modeling; 3. Proposed Model Experiment. Each phase consists of three stages until you reach the results obtained from the research.*
Results*: Fuzzy logic is a system that admits logical values intermediate between false and true. The following are considered as input variables of the system: ability, knowledge and attitude; as an output variable of professionals in the management areas, comparing them with each other through the inference levels: VLow, Low, Average, High and VHigh. For the development of the Fuzzy system, the main competencies that served as input to the inference model were identified. In this way, the Fuzzy system helps in directing and analyzing the decision-making of the appropriate profile for the position.*
Conclusion: *Conclusion: The proposed model obtained satisfactory results for the analysis of the performance classifications that a profile can obtain. From the data that was entered into Fuzzy Logic, the model was able to generate information to improve the decision-making process by optimizing the choice of the most appropriate profile.*
Key Word*: Performance appraisal; fuzzy logic; competency-based management; recruitment and selection of people.*

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I. Introduction

In the areas of selection and recruitment of people in the area of management, companies are facing high levels of competitiveness, which forces them to improve their management practices, so it is notable that new innovations have brought capacity. The Human Resources (HR) sector has faced these changes and successive advances in the way of working with employees, as one of the reasons was the advancement of technologies that imposes sudden changes, altering devices, utilities and results, and that according to Santos et al., (2020), point out that in the skill dimension, planning capacity is the most requested skill, in the aptitude dimension to proactivity, and in the knowledge dimension, the mastery of specific concepts in the area as the most demanded competencies, making these characteristics more accurate for the analysis of the candidate's profile.

An important issue that has been sought is people who have professional qualification as a requirement for employability, thus adding to their professionalism and to the company, because, according to Chiavenato

(2020), it points out that the people sector consists of the planning, organization, development, coordination, and control of techniques capable of promoting a means that allows the people who collaborate with it to achieve individual goals directly or indirectly related to work, thus, the company achieves a collective growth of people in companies. According to Lacombe (2020), he observes the connection between the individual and the corporate collective regarding the growth and survival of the company, due to its ability to attract, select, train and correctly position, in the present, people with the potential to act as an integrated team in the company.

It is of great importance that companies achieve their goals with the right suitability of people in the management area at the operational level, if companies do not achieve their goals, it can generate losses in the company's costs, derived from the selection process for the position (PONTES, 2021).

Each company has a certain weight in the reliability of an action, therefore, they need to pay attention to the mechanisms of employees at the time of selecting candidates, analyzing whether they are cohesive with the company's intentions and with the values disseminated by it in processes where it is important to assess human reliability for selection. Thus, it is extremely important to know how to select the best professionals, who in turn, need to be in accordance with the company's expectations and ideals. Both technical and behavioral competencies must be taken into account. Akita (2021) characteristics such as trust, creativity, respect, flexibility, leadership, and patience are fundamental for a good work environment and greater performance of activities.

Finally, this work has as its main objective the implementation of a fuzzy inference model for the evaluation of the candidate's skills, aiming to support decision making in the selection and recruitment process in the area of operational level management.

II. Material And Methods

The Methodological Process was developed in three phases: 1. Identification of the degree of aptitude of professionals in the areas of management; 2. Fuzzy "Inference" System Modeling; 3. Experiment of the Proposed Model, with its respective stages: Phase 1 (definition of the inference levels of the indicators), Phase 2 (Development of Fuzzy Sets, Development of "Inference" and Simulation Rules in MatlabR2013 software), Phase 3 (Compilation of the Indicator Aggregation Algorithm, Simulation of 3D Results and Analysis of Obtained Results). Table 1, presents the Methodological Process.

Table 1 - Methodological Process

PHASES	STEPS
1. Identification of the degree of aptitude of professionals in the areas of management	1.1 Definition of the inference levels of the indicators
2. Fuzzy "Inference" System Modeling	2.1 Development of Fuzzy Sets
	2.2 Development of the Rules of "Inference"
	2.3 Simulation in MatlabR2013 software
3. Proposed Model Experiment	3.1 Compilation of the Indicator Aggregation Algorithm
	3.2 Simulation of Results
	3.3 Analysis of the Results Obtained

Phase 1. It consisted of the identification of the indicators of the degree of aptitude of professionals in the areas of management for the evaluation of a certain assertive profile for a certain position, in which a Fuzzy inference model was adapted as a support in decision making. This stage aims to identify the candidate with adequate competence of professionals in the areas of management having potential performance in their role.

Phase 2. The MatLab R2019a – Fuzzy Toolbox Student version software is used to specify the input and output variables, with their respective ranger's, pertinence function types with their respective linguistic levels.

Phase 3. The results obtained are compiled for the final definition of the candidate's performance. In the second phase, stage 2.3, the Student MatLab R2019a – Fuzzy Toolbox software was used to compile the indicator aggregation algorithm.

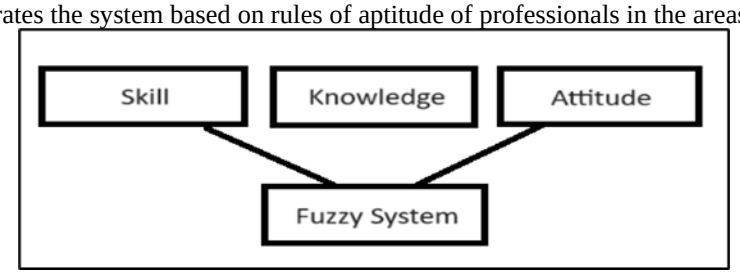
To create a Fuzzy rule-based system, it was necessary to define an input processor (or fuzzifier), a set of linguistic rules, a fuzzy inference method, and an output processor (or defuzzifier), which generates a real number as output.

III. Result

Identification And Description Of Input Variables – Fuzzyfication

The input variables of the fuzzy rule-based system were "Ability", "Knowledge" and "Attitude", which make up the individual's competency set. As shown in Figure 1, with the fuzzy inference model.

Figure 1 - Illustrates the system based on rules of aptitude of professionals in the areas of management.



Source: Rabaglio (2008)

Table 2, shows the summary of the entire evaluation process of this Phase.

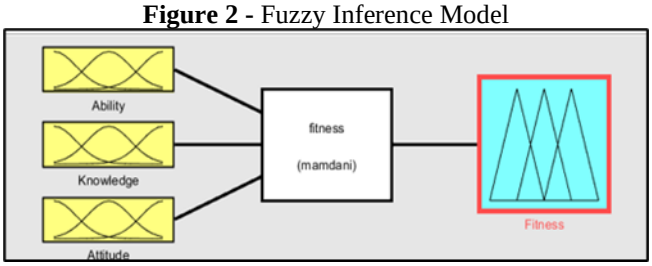
Table 2 - Evaluation Process/ Ingredients of Competence

INDICATORS	ASSESSMENT ITEMS	METRICS
1.1 ABILITY	It is the ability to know how to do, that is, it is the use of knowledge in our daily lives to develop the position, such as having a leadership spirit, good communication, and the ability to work in a team.	Low: [0 0 25 50] Average: [25 50 75] Discharge: [50 75 100 100]
1.2 KNOWLEDGE	Evaluate the capacity of knowledge for the desired position, that is, what has been taught in schools, universities and educational institutions.	Low: [0 0 25 50] Average: [25 50 75] Discharge: [50 75 100 100]
1.3 ATTITUDE	Evaluation of the individual's behavioral competence in wanting to do, being in the exercise of his/her activities, based on the determined knowledge.	Low: [0 0 25 50] Average: [25 50 75] Discharge: [50 75 100 100]

The Fuzzy "Inference" System was developed in order to evaluate the appropriate profile for specific positions through the indicators in the following criteria: 1.1 Ability; 1.2 Knowledge; and 1.3 Attitude.

The system has three inputs and one output. Both input and output have amplitude in the range [0 100]. The inputs and outputs are collected based on the analyzed results. Figure 2, shows in more detail the specified Fuzzy inference model, with its rangers.

Figure 2 - Fuzzy Inference Model



Source: Author Own (2024)

Ability– Fuzzyfication

Used to measure the ability to apply knowledge in practice, that is, it involves putting into practice what one has in theory.

The input linguistic variable "Ability" consists of three levels of inference, two with trapezoidal shapes and one triangular (Figure 3).

Figure 3 - Relevance function for the Skill input variable

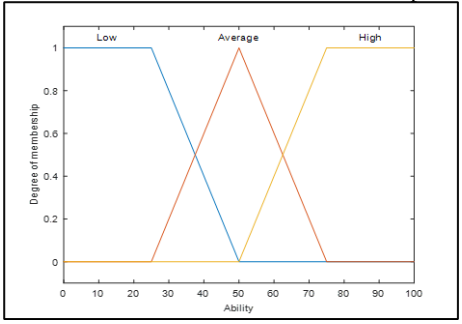


Table 3, shows the linguistic values specified for the Low, Average, and High inference levels.

Table 3 - Numerical Values of the "Ability" Variable

INPUT VARIABLES- Skill		
LINGUISTIC VALUE	**NUMERICAL VALUE**	**FORMAT**
Low	[0 0 25 50]	trapmf
Average	[25 50 75]	trimf
High	[50 75 100 100]	trapmf

Knowledge– Fuzzyfication

In this indicator, it is possible to verify the theoretical and practical understanding of the work to be performed, what was actually learned in schools, at work and in life in general.

The input linguistic variable "Knowledge" consists of three levels of inference, two with trapezoidal shapes and one triangular. Figure 4, shows the trapezoidal and triangular structures, according to linguistic values: Low, Average, High, according to Table 4.

Figure 4 - Relevance function for Knowledge input variable

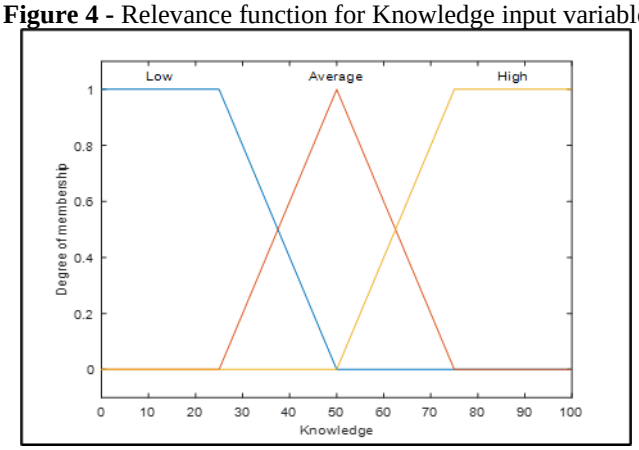


Table 4 - Numerical Values of the "Knowledge" Variable

INPUT VARIABLES- Knowledge		
LINGUISTIC VALUE	**NUMERICAL VALUE**	**FORMAT**
Low	[0 0 25 50]	trapmf
Average	[25 50 75]	trimf
High	[50 75 100 100]	trapmf

Attitude– Fuzzyfication

An indicator that represents the employee's willingness to act positively and proactively, it is what determines whether or not they will exercise the skills of certain knowledge.

The input linguistic variable "Knowledge" consists of three levels of inference, two with trapezoidal shapes and one triangular. Figure 5, shows the trapezoidal and triangular structures, taking into account linguistic values: Low, Medium, High, according to Table 5.

Figure 5 - Pertinence Function for Attitude Input Variable

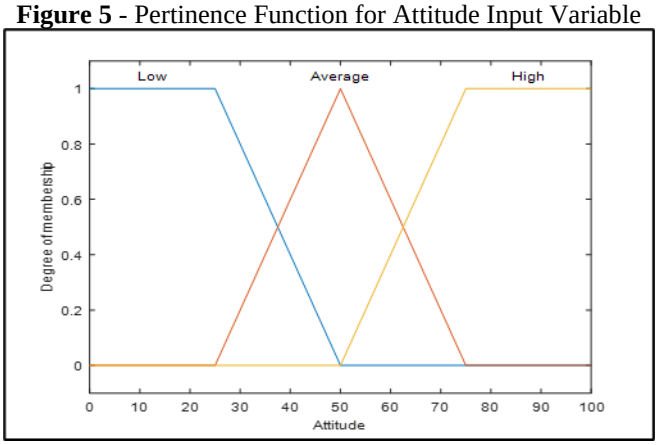


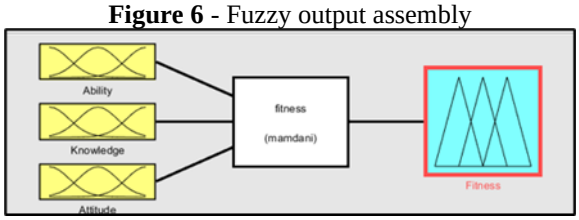
Table 5 - Numerical Values of the "Attitude" Variable

INPUT VARIABLES- Attitude		
LINGUISTIC VALUE	**NUMERICAL VALUE**	**FORMAT**
Low	[0 0 25 50]	trapmf
Average	[25 50 75]	trimf
High	[50 75 100 100]	trapmf

Identification And Description Of Output Variables – Defuzzyfication

In defuzzyfication, the controller contains one (1) output variable. Figure 6, shows the output (Performance) with a range from 0 to 1. The pertinence functions employed are trapezoidal and triangular, with equidistance between the regions of maximum pertinence to the sets (apices of the functions) at "1" on the ordinate axis. The intersections of the functions represent the half-pertinence to each adjacent set, with the value of "0.5" on the ordered axis. Thus, in Figure 6, the Fuzzy system is visualized. The modeling used the standardized Min-Max operators of the Mamdani "inference", with centroid "defuzzyfication".

Figure 6 - Fuzzy output assembly



Candidate's Aptitude

In the exit function, the final performance of a specific candidate is evaluated, detailing their performance. This process assists in decision-making based on the aspects of Skill, Knowledge, and Attitude. With the results obtained, it is possible to define the choice more precisely during the recruitment and selection process, identifying the most appropriate profile for the position in the management area.

The linguistic variable "Aptitude" consists of five levels of inference, with shapes, two trapezoidal and three triangular. Figure 7, shows the trapezoidal and triangular structures, taking into account the following linguistic values: MBaixa, Low, Medium, High and MAlta.

Figure 7 - Relevance function for output variable APTITUDE

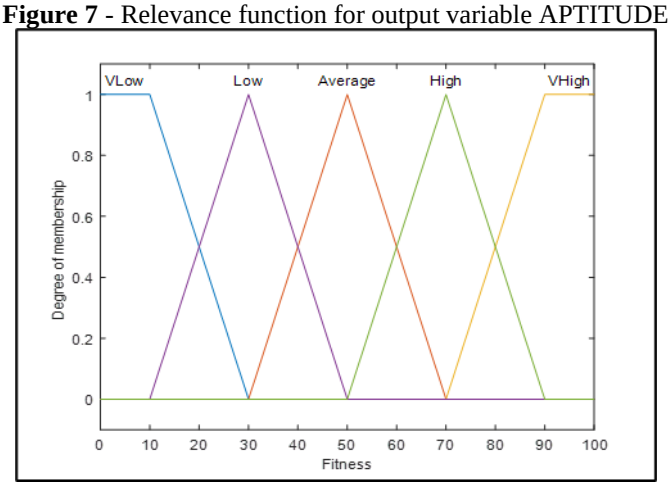


Table 6, shows the values specified for the defuzzyfication of the relevance functions of the "Aptitude" variable:

Table 6 - Numerical Values of the "Aptitude" Variable

OUTPUT VARIABLES- APTITUDE	
LINGUISTIC VALUE	**NUMERICAL VALUE**
VLow	[0 0 10 30]
Low	[10 30 50]
Average	[30 50 70]
High	[50 70 90]
VHigh	[70 90 100 100]

The defuzzyfication made it possible to map the pertinence functions of the product's Performance variable, according to Table 6 and Table 7, showing precise information regarding Decision Making and translating the sets into fuzzy logic format.

Table 7, shows the 27 rules elaborated by the experiment, which had the greatest variation in performance results for better exemplification and strategic analysis.

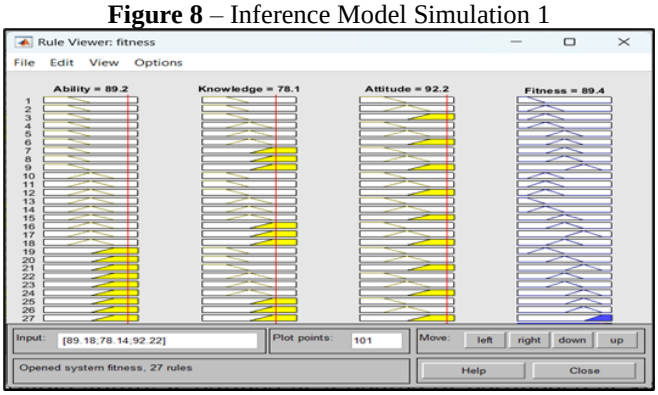
Table 7 - Inference Rules

	Ability	Knowledge	Attitude	Fitness
1	Low	Low	Low	VLow
2	Low	Low	Average	Low
3	Low	Low	High	Low
4	Low	Average	Low	Low
5	Low	Average	Average	Average
6	Low	Average	High	Average
7	Low	High	Low	Low
8	Low	High	Average	Average
9	Low	High	High	High
10	Average	Low	Low	Low
11	Average	Low	Average	Average
12	Average	Low	High	Average
13	Average	Average	Low	Average
14	Average	Average	Average	Average
15	Average	Average	High	Average
16	Average	High	Low	Average
17	Average	High	Average	Average
18	Average	High	High	High
19	High	Low	Low	Low
20	High	Low	Average	Average
21	High	Low	High	High
22	High	Average	Low	Average
23	High	Average	Average	Average
24	High	Average	High	High
25	High	High	Low	Average
26	High	High	Average	High
27	High	High	High	VHigh

SKILL = Knowledge in practice; KNOWLEDGE = Theoretical understanding; ATTITUDE = Willingness to act

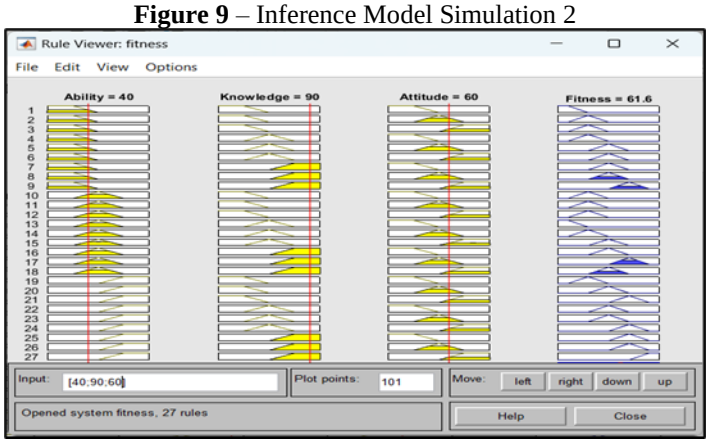
After the imputation of rules, the results are simulated in the MatLab software, identifying the diagnosed performances with moderate inference, with good and excellent result definition. With these simulations, it is possible to have a broader view of the situation in which each indicator interferes with the study's output. Figure 8, shows inference model 1.

Figure 8 – Inference Model Simulation 1



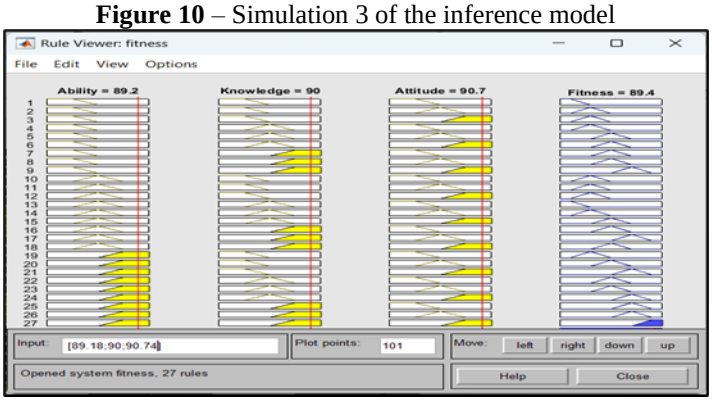
In Figure 8, it is possible to observe that when the variable ability is defined as a degree of pertinence at 89.2, and the variable knowledge is defined as 78.1, the variable attitude is defined as 92.2, and finally the variable aptitude will be identified as a degree of pertinence = 89.4. Figure 9, shows inference model 2.

Figure 9 – Inference Model Simulation 2



In Figure 9, it is possible to observe that when the variable ability is defined as degree of pertinence at 40, and the variable knowledge is defined as 90, and the variable attitude is defined as 60, and finally the variable aptitude will be identified as degree of pertinence = 61.6. Figure 10, shows inference model 3.

Figure 10 – Simulation 3 of the inference model



In Figure 10, it is possible to observe that when the variable ability is defined as degree of pertinence at 89.2, the variable knowledge is defined as 90, and the variable attitude is defined as 90.7, and finally the variable aptitude will be identified as degree of pertinence = 89.4.
Figure 11, Analysis of the behavior of the variables (3D Graph)

Figure 11 - Analysis of the behavior of the variables (3D Graph)

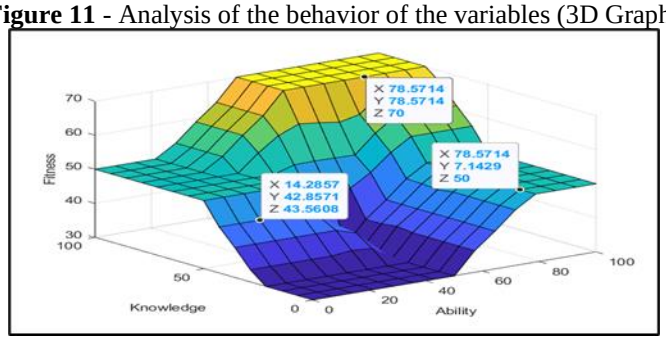


Figure 11 shows the simulation of the results in 3D, which allows us to observe the analysis of the behavior of the variables, and to adjust the Fuzzy sets and the "inference" rules, in order to express the characteristics presented by the experts during the modeling of the problem. Emphasizing that this modeling presented above is of the Aptitude (Output) related to the Inputs knowledge, skills and aptitude and it is possible to generate other analysis models varying the Inputs that were used for the elaboration of the research.

IV. Conclusion

The research described the purpose of the indicators of the input variables (Knowledge, Ability and Attitude) and the output variable (Aptitude) so that the analyses can be made based on them. From these variables, several analysis results were specified: "VLow, Low, Average, High and VHigh", for each indicator, with triangular and trapezoidal functions. Thus, the most significant variables for the research were identified.

The development of the Fuzzy "Inference" System enabled the aggregation of data for the evaluation of the competencies of the profiles in the management area, optimizing the recruitment and selection process through a computational model based on the rules to classify the performance for a better choice of a profile in the management area.

The Fuzzy system was able to show the different performance results when simulated with the different conditions of the input variables and what classification of competencies could be defined. The Fuzzy system can be used to direct the most appropriate profile to the position in the management area, providing support for better decision-making in HR.

The proposed model obtained satisfactory results for the analysis of the performance classifications that a profile can obtain. From the data that was entered into Fuzzy Logic, the model was able to generate information to improve the decision-making process by optimizing the choice of the most appropriate profile. When these research and model data are prepared by trained professionals, they cause the degree of development to be leveraged to even higher levels. It is worth mentioning that the proposed model can be analyzed even by professionals with less experience, as the model helps to reduce the complexity of the study and/or future errors.

Acknowledgments

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