DEVELOP A FUZZY INFERENCE MODEL TO MEASURE THE QUALITY OF PROJECT MANAGEMENT PROCESSES IN A THIRD SECTOR INSTITUTION

Juliana Câmara de Souza[1]
Manoel Henrique Reis Nascimento[2]
Federal University of Pará[1]
Institute of Technology and Education Galileo of the Amazon[2]

Abstract

The contemporary business environment seeks continuous improvement to remain competitive in the market, as customers increasingly demand quality products or services. In this perspective, this paper presents a methodology aimed at evaluating the quality of processes in the project management sector in a Third Sector Organization, based on the Fuzzy mathematical model. For this, linguistic variables (input) were developed according to information obtained from company Y, which enabled the application of the Fuzzy Logic method, in order to determine the output variable, which in this case is quality. After determining the rules, it was possible to obtain results that show that the developed fuzzy model has the potential to help improve the quality of processes.

Keywords: Processes, Quality and Fuzzy Logic.

I. INTRODUCTION

The current economic situation and continuous technological revolutions, combined with scientific ones, impacted the structure of organizations, resulting in new scenarios at every moment, making companies seek to improve their actions based on these transformations, choosing the best strategy and aiming at future of the business. In this trend, the development and improvement of sectors and processes have defined the contemporary models that non-profit and profit institutions permeate, improving the quality of their products or services, and encouraging the improvement of project management. This virtual world gave a new look to the dynamics of organizational functioning (ARAUJO, 2019).

Amid this dynamism, the positioning of corporations, facing the challenges and opportunities arising from a market that increasingly demands flexibility to meet the demand of customers, investors and society, is that the project area emerges, a field of the company that aims to work with well-defined activities, since everything that is developed has a beginning, middle and end. Project is a temporary effort undertaken to create a unique product, service or result (GUIA PMBOK, 2017).

In the business field, there are organizations specialized in working with Project Management, with the objective of managing projects from other public or private corporations, but specifically in the

execution stage. Soon, the focus will be on the fulfillment of what was planned during the project's elaboration, and linked to that, come the eventual processes that must be controlled in an organized way, aiming at quality and seeking to fulfill the project's goals and objectives.

For KEELING (2019), managing a project will imply the use of a good basis to define and plan all the work to be performed, conduct the execution of activities (putting the plan into practice), verify and control the performance of the execution and ensure that the specified and controlled characteristics are delivered in the project result, whether that result is a good or a service. The execution of the project is a very important point of work, as this is when there is greater activity by people and the use of financial resources. Therefore, processes must be managed, controlled and coordinated to achieve results compatible with the project's purpose.

The processes present in the project execution phase are directly linked to the operational level, integrating human, technological and financial resources so that the combination of these efforts causes synergy between skills, techniques and tools, generating more reliable and higher quality procedural methods . Process is the transformation, with added value, of resources into something expected (MARCHALL, 2012).

Business processes are workflows that meet one or more goals of the organization and provide added value from the perspective of the end customer (SORDI, 2014). Quality is another point, and it must be considered when the company proposes to take care of other companies' projects, since at this point there will also be an impact on the expectations of the interested parties (stakeholders). Therefore, establishing quality standards will certainly add value to the final product and satisfy the expectations of potential buyers. According to BASSAN (2018) there are many concepts about Quality, and these have been evolving along with new customer requirements, along with new methods and along with current industrial technologies.

In the midst of this context in which organizations permeate the improvement of their processes to achieve quality and minimize negative impacts during project management, it is intended to present a Fuzzy model aimed at measuring the quality of processes, considering that non-compliance generates undesirable results for the organization and improvement in methods will result in a competitive advantage in the corporate environment in which the company operates. In this sense, this study proposes to stimulate discussions about the insertion of the Fuzzy Model in the evaluation of the quality of the processes carried out in the project sector in the third sector institutions, promoting a critical reflection on the subject in question.

Thus, when the project management sector presents satisfactory results, it improves decision making and, consequently, increases competitive advantage, in addition to improving the procedural structures that are so important in the routine of business organizations.

II. LITERATURE REVISION

2.1 - Process Concepts

The improvement of processes within companies has been essential for the alignment of tasks, improving the production process and wasting time due to poorly performed activities, in order to take

advantage of deadlines much more effectively and reduce unpredictability resulting from errors in the structure of the process. According to PIRES (2021), the power of processes is always in their result of greater efficiency in execution.

JESUS AND MACIEIRA (2015) explains which processes should contribute towards restructuring a company to carry out transformation projects that impact on better products or services for customers. Processes, when interconnected, form a structure capable of involving administrative, human resources and production activities in order to add value to interested parties and, consequently, serve customers. Routine operations contribute to the strengthening of processes, reducing failures since the identification of non-conformities is easily noticed and corrected, these immediate reactions ensure that the executions are in accordance with the planning, forming a logical sequence for that task, strengthening the control and knowledge of the executors.

The idea of process is not new, but the understanding that the business needs to serve customers is new, in order not to jeopardize the organization's survival (PRADELLA, 2016).

Figure 1 represents the inputs, which through activities add value to the final product, which is specified as output.

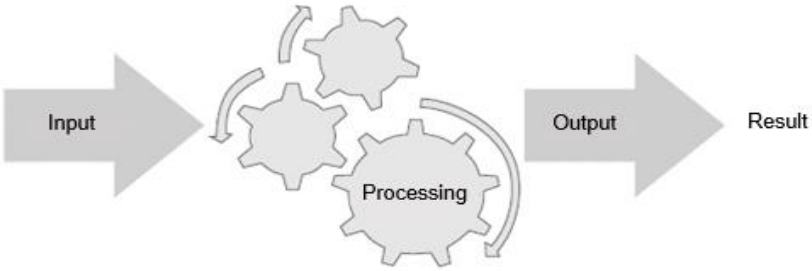


Figure 1: Characteristics of a Process.
Source: PRADELA, (2016).

This figure 1 shows where a process starts and ends, that is, how the sequence of activities occurs until the final result is obtained, with the objective of delivering a product or service that satisfies the customer to the market.

CARPINETTI (2016a, 2019) reinforces that the process is a certain structured and predefined sequence of actions that transform the captured inputs into outputs and offer them to the environment, adding value from the moment it properly handles these inputs.

According to USIRONO (2015) the process is a set of causes that produce a certain effect. The effect is associated with the product or service, while the causes are associated with the inputs used during the process to produce it.

These elements contribute to a better visualization of the progress of the processes, which as such have types that help disseminating among employees and stakeholders the best way to understand the importance of each process in the value addition cycle.

Association of Business Process Management Professionals - ABPMP (2013) classifies the processes into three types:

1) primary: they are the essential or finalistic processes, end to end, which can be interfunctional and interorganizational;

2) support: support primary and management processes, adding value to other processes, but not directly to the customer; and

3) management: designed to measure, monitor, control activities and manage the present and future of the business, also not adding value to the customer.

VALLE and OLIVEIRA (2012) point out that "the primary processes are undoubtedly the most important, as they directly affect external customers. Support staff help or facilitate the execution of primary ones, and managerial staff facilitate their execution, allocating, directing and coordinating resources and means necessary for good organizational performance. For ARAUJO (2019) the processes that justify the existence of the company can be classified as business or essential processes. Business processes, regardless of the type of organization, must be aligned with the organizational strategy, in order to provide increased productivity, better results and achievement of goals (ABPMP, 2013).

2.2 Project Management - PM

The business environment needs an appropriate structure for the development of projects and, consequently, its management must be combined with the implementation of strategic actions, making it a differential in the market competition. Project Management is the application of knowledge, skills, tools and techniques to project activities in order to fulfill project requirements. Project management allows organizations to execute projects effectively and efficiently (GUIA PMBOK, 2017).

For BENNETT (2005), project management is a recurrent theme for all organizations, and several methodologies are emerging to improve the technique. It aims to increase business competitiveness by optimizing the use of resources and facilitating the achievement of results. Arguably, project management in companies has gained ground due to being a way of reacting to contemporary market demands, aiming to improve and flexibilize the processes that permeate projects during their conception and following the execution until their completion. According to GUERREIRO, project management has evolved in recent years, expanding within organizations.

PRADO (2014) has the following view on PM is a branch of management science that deals with the planning and control of projects. Managing a project briefly means planning its execution before starting it and then monitoring its execution. Encouraging good practices in project management will positively affect sets of processes, making them more effective in achieving goals and leading to satisfactory progress in favor of investors and the general public, making the organization more active, contributing to increased profits and the reduction of errors in projects.

The implementation of project management in organizations, therefore, must emphasize not only tactical issues, but essentially strategic ones. That is, organizational changes certainly imply changing the flow of information and decision-making, the management model and the rules of internal power (CARVALHO, 2021).

This strengthens the companies' need to have robust PM models in their composition, since this administrative practice has been gaining ground, taking root new management models and remodeling processes to achieve goals with greater efficiency.

For KERZNER (2020), project management evolved from a set of recommended processes to a methodology considered mandatory for the company's survival. Companies are now realizing that their entire business, including most day-to-day activities, can be understood as a series of projects.

According to KERZNER (2020) there are six driving ways that lead executives to recognize the need for project management:

1. Capital Projects
2. Customer Expectations
3. Competitiveness
4. Understanding by executives
5. Development of new projects
6. Effectiveness and efficiency

These points help the Strategic Level to see the importance of developing project management and in the current corporate scenario, this becomes an advantage that can be developed to improve practices performed in the environment and increasing the organization's chances of survival.

2.2.1 Project Management Processes

The PMBOK GUIDE (2017), proposes the life cycle and managed through the execution of a series of project management activities, known as project management processes. Each project management process produces one or more outputs from one or more inputs, using appropriate project management tools and techniques. The output can be a delivery or a result. In Figure 2, it is the demonstration of the dynamics that happen with the process during the input, application of tools and techniques, and outputs.

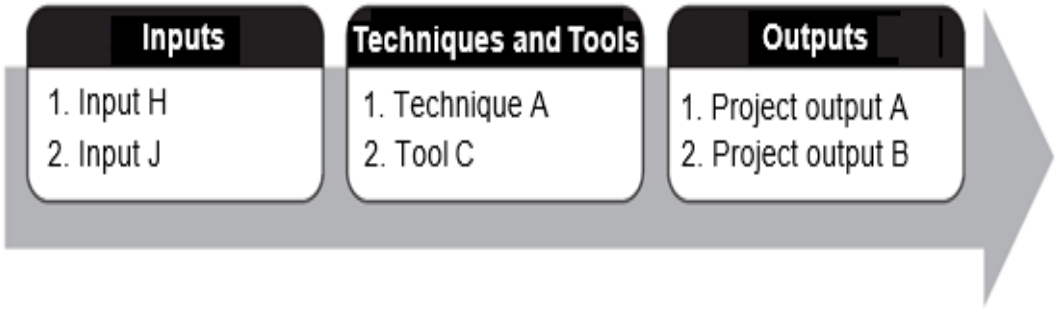


Figure 2. Example Process: Inputs, Tools, Techniques, and Outputs.
Source: PMBOK GUIDE, (2017).

BORGES AND ROLIM (2015) points out that project management work can be structured in processes. In fact, the real efficiency gains in carrying out projects occur when projects are managed following processes.

2.2.2 Project Management Process Groups

PMBOK GUIDE (2017) outlines a group of Project Management Processes and a logical grouping of project management processes to achieve specific project objectives. Process Groups are independent of project phases. Project management processes are grouped into five Project Management Process Groups:

- Initiation Process Group – The processes performed to define a new project or a new phase of an existing project, through obtaining authorization to initiate the project or phase.
- Planning Process Group – The processes performed to define a new project or a new phase of an existing project, through obtaining authorization to start the project or phase.
- Executing Process Group – Process performed to complete the work defined in the project management plan to satisfy the project's requirements.
- Monitoring and Controlling Process Group – The processes required to track, analyze, and control project progress and performance, identify any areas where changes to the plan will be required, and initiate changes accordingly.
- Closing Process Group – The processes to formally complete or close a project, phase, and contract.
- Each group contains a set of processes capable of generating the expected results of project management. Process group refers to the work of project management. (BORGES AND ROLIM, 2015).

2.2.3 Project Life Cycle Characteristics

For the PMBOK GUIDE (2017) the projects vary in size and complexity. All projects can be mapped to the following generic lifecycle structure, as shown in Figure 3.

- Project start;
- Organization and preparation;
- Executing project work; and
- Project closure.

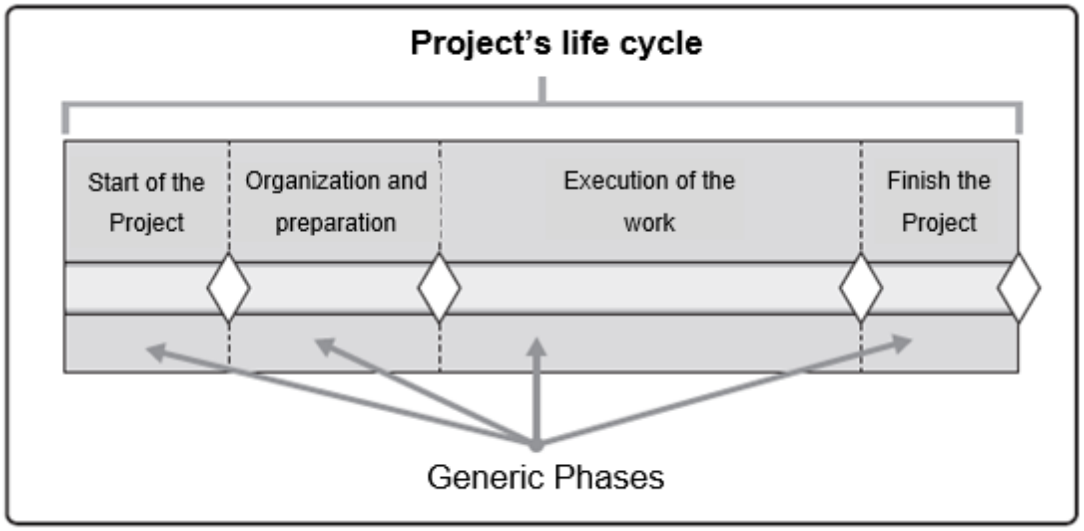


Figure 3. Generic Representation of a Project Life Cycle.
Source: PMBOK, (2017).

The life cycle of a project and the set of phases that the project goes through from its formal beginning to the delivery of its final product (BORGES and ROLIM, 2015).

2.3 Quality Management

The perception of quality in products and services in recent times by customers has required immediate measures from business organizations in order to meet market prospects without increasing costs. Quality is consistent service to customer expectations; in other words, “doing things right”, but the things that the operation needs to do correctly will vary according to the type of operation (SLACK, 2018).

Quality management is seen today, both in academia and in business, as a strategic factor for improving competitiveness and productivity (CARPINETTI, 2016a).

According to CARPINETTI and GEROLAMO (2019), quality management gained a new dimension, expanding to the more upstream and downstream stages of the production cycle, involving the entire organization. According to LOBO (2020) Quality Management is the responsibility of all levels of management, but it must be conducted by the company's top management. Its implementation involves all members of the organization, as it emphasizes economic aspects. For OLIVEIRA (2020), the concept of quality depends on the context in which it is applied, and different perceptions regarding quality can be considered in view of the subjectivity and complexity of its meaning. Quality management should not only be concerned with the quality of the service or the product itself, but also and, mainly, with the way it gets there (BURMESTER, 2013).

Therefore, SANCHES (2019) points out the main concepts that define the idea of quality:

- Excellence: defined as the best you can do. This concept is presented by the Greeks as something absolute, that is, there is a higher ideal. Nowadays, the ideal of excellence translates into the concept of “doing it well the first time”, which shapes quality management seeking superior performance standards. This idea not only demonstrates the concern with the quality to be achieved, right in the first attempts, but also involves the reduction of rework;
- Value: addresses quality as a luxury, through the integration of a greater number of attributes to products and services, in addition to the use of rare materials, which cost more. The main problem in this concept is the fact that the value is relative to people, depending on the perception that each one has, in addition to that, the ability to pay and acquire the people at their disposal to spend on a given item directly impacts this definition;
- Specifications: the definition of quality, based on specifications, is something analyzed by engineers, characterized as a set of characteristics of products or services. These characteristics are understood as specifications, describing products and services based on their usefulness, attributes and performance;
- Compliance with specifications: one of the concepts most associated with quality determines the degree of identity between the specifications, the products and services provided. This is determined as the actual quality, the one the customer receives. Here, the comparison between planning and the reality of what is developed is highlighted;
- Regularity: deals with uniformity, that is, products and services that are identical to each other, that is, it discusses the need to reduce existing variations between items elaborated in the production process, being a synonym of reliability and regularity;

- Suitability for use: this definition of quality involves the customer perspective, such as fitness for use, encompassing design quality and the absence of deficiencies (or defects).

2.3.1 Main Approaches to Quality Management

The approaches that will be portrayed below are related to the main contributions of the so-called quality gurus such as Deming, Juran, Feigenbaum and Ishikawa, as follows.

2.3.1.1 Deming

The main contribution of W. Edwargs Deming are the 14 points that are focused on quality management. As SILVA and LOBO (2009) point out that for the implementation of Quality Management, it establishes a 14-point program:

- create a purpose of constant improvement of products and services;
- adopt a new philosophy of not accepting material and human errors;
- stop relying on mass inspection;
- don't buy for the price alone;
- constantly improve production and service systems;
- institute training and retraining;
- instituting leadership – leading and the manager's task;
- eliminate fear of employees;
- break down barriers between the various air and hierarchical levels;
- eliminate slogans, exhortations and goals – they only serve if accompanied by a script and method of execution;
- eliminate numerical dimensions, because those who think about numbers forget about quality;
- remove barriers to pride in the work done;
- institute a strong education program; and
- create a structure in top management to implement the first 13 points.

CARPINETTO (2012a) states that another fundamental contribution of Deming, together with Walter Sherwhart, was the Deming-Shewhart cycle, or PDCA cycle, as it became better known. For SILVA and LOBO (2009) in Deming's theory, the improvement of processes takes place through continuous improvement, whose main instrument is the PDCA cycle

CARPINETTO (2012a) emphasizes that the basic method of quality management is the PDCA cycle (Plan - Do - check - Act) for analyzing the current situation, planning actions, action, reviewing progress and replanning actions. Figure 4 represents the PDCA Cycle and how the separation of the 4 stages for continuous improvement occurs. This method suggests a continuous cycle executed in four steps: planning, doing, verifying and correcting action [Souza – 50 tools]. In the first step (Planning – Plan), we identify the problem in the process, analyze its causes and develop antidotes for non-compliance, and then we rotate the PDCA. In the next stage (Execution – Do), the action plans previously planned in the planning stage (Plan) are put into practice. From this perspective, corrective actions for the problem are taken. Then, another spin occurs. In step three (Control – Check), we control to know the effectiveness of the action

plans executed by comparing two scenarios: performed vs. planned. That done, we rotated the PDCA again. In the last stage, of the first cycle, (Corrective Action - Act) it is time to act, correctively, if we verify such need. Let's say that there was an action that was not very effective in solving the problem, we will have to improve that action or replace it with another one. There is no need to establish standards, if the result is positive, however, we will take corrective action whenever necessary. of the first cycle, (Corrective Action - Act) and time to act, correctively, if we verify such need. Let's say that there was an action that was not very effective in solving the problem, we will have to improve that action or replace it with another one. There is no need to establish standards, if the result is positive, however, we will take corrective action whenever necessary. of the first cycle, (Corrective Action - Act) and time to act, correctively, if we verify such need. Let's say that there was an action that was not very effective in solving the problem, we will have to improve that action or replace it with another one. There is no need to establish standards, if the result is positive, however, we will take corrective action whenever necessary.

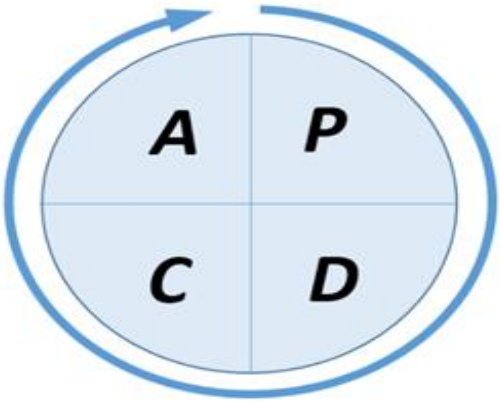


Figure 4 Continuous Improvement Cycle.
Source: BASSAN, (2018).

BASSAN (2018) emphasizes that the PDCA can be seen as a management method that guides actions and helps the industry to implement a culture of continuous improvement.

2.3.1.2 Juran

According to SILVA E LOBO (2009) for Juran, Quality is achieved through the following activities:

- Planning: establishment of objectives and means to achieve both Quality goals and the development of process control;
- Control: definition of what should be controlled, means to assess performance, comparison of performance with targets and corrective actions, and;
- Improvement: search for a high level of performance.

According to CARPINETTI (2012a) Juran argued that, in order to adapt the product for use, all processes, directly or indirectly related to the production cycle, must be directed towards meeting customer expectations. In other words, the concept of quality should be incorporated into all the organization's

processes, from product planning, through design and development, acquisition, production, commercialization and after-sales.

SILVA and LOBO (2009) highlight that regarding aspects related to the organization and management of Quality, in 1994, in one of their most recent works, Juran proposes the following actions:

- ➢ create a Quality Committee;
- ➢ establish the Quality policy;
- ➢ establish Quality objectives; and
- ➢ provide the resources, motivation and training to:
- ✓ diagnose the causes;
- ✓ encourage the establishment of corrective actions;
- ✓ establish controls to maintain the improvements achieved;
- ✓ provide problem-solving oriented training;
- ✓ establish an information system that keeps everyone updated on the progress of Quality;
- ✓ define a Quality Coordinator;
- ✓ qualify or hire personnel to advise and support the Quality program;
- ✓ make use of audits to verify system results.

2.3.1.3 Feigenbaum

Feigenbaum's contribution, as explained by CARPINETTI (2012a) comes in his book, Total Quality Control, defined quality control activities as:

- project control;
- control of incoming material;
- product control;
- study of special processes.

Figure 5 emphasizes quality control activities in companies, transcending what kind of actions occur at each level of the structure, allowing organizations to conduct their operations at a high level, resulting in full customer satisfaction.

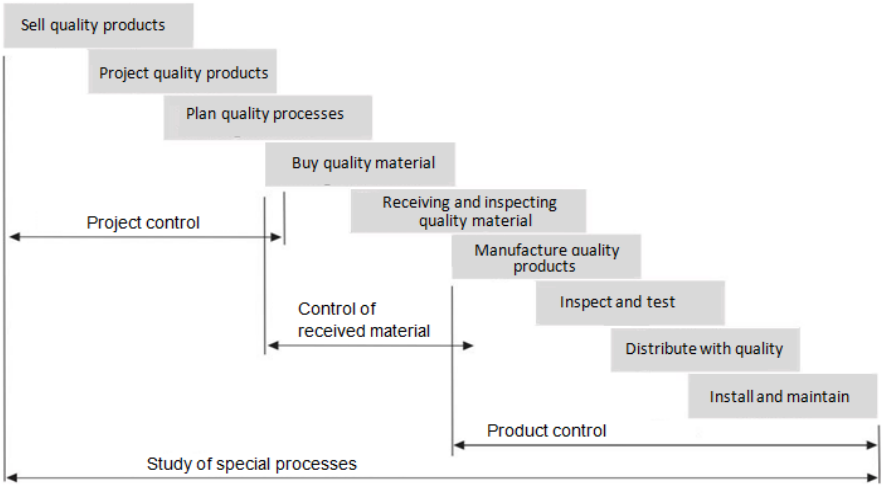


Figure 5 Quality Control Activities according to Feigenbaum.
Source: CARPINETTI, (2012a).

2.3.1.4 Ishikawa

Ishikawa's theoretical contributions are influenced by Deming and Juran. His contribution and the development of the broad vision of quality, the emphasis on the human side, the development and use of quality tools (CARPINETTI, 2012a). For CARPINETTI (2012a) it shows that Ishikawa classified statistical control techniques into three groups of increasing complexity. The first group is formed by the seven tools. They are: Pareto Analysis, Cause and Effect Diagram (Ishikawa Diagram), Histogram, Control Charts, Check Sheet, Scatter Chart and Flowchart. Intermediate statistical methods form the second group and are for use by quality specialists and some managers responsible for quality in their section. The last group is formed by advanced statistical methods:

1. Pareto Analysis;
2. Cause and Effect Diagram (Ishikawa Diagram);
3. Histogram;
4. Control Charts;
5. Verification Sheet;
6. Scatter Chart;
7. Flowchart.

2.4 Third Sector

In recent years, the role of the third sector has been relevant for the development of the regions where they are located, as IBGE points out that the northern region is responsible for employing approximately 71,016 people. This demonstrates how third-sector entities are an important part of generating income and employment.

RUGGERI (2011) points out that this field of society has existed since its beginnings, however, it assumes nowadays a greater development caused by the conjunctural issues that emerged from the very development of capitalism. In other words, the ST spectrum grew due to the incapacity of the State and the market to supply the population with the social protection needed, forcing segments of civil society to organize themselves around issues related to the public good. Social organizations emerged with the objective of undertaking businesses with a view to benefiting society in general, seeking to develop activities that support the demands of public interest, since there is a relationship with the Government. Law N 13.204/2015 in its art. 2, item I, letter a, conceptualizes that the Third Sector (BRASIL, 2015).

According to OLIVEIRA (2016), the third sector is the designation adopted for legal entities incorporated with no economic purpose, that is, that do not distribute profit among the partners, but apply it fully in the company for the achievement of its purpose, which should always be a public purpose or objective. For OLIVEIRA (2020), the Third Sector represents a sustainable society, through alliances between the State, the private sector and Civil Society Organizations, in order to fight social exclusion.

2.5 Fuzzy Theory

Fuzzy, in English, means uncertain, doubtful, nebulous. It expresses exactly the values it deals with, allowing it to express degrees of certainty, associations or membership values, intermediate between the

extreme values of true and false of the classical (bivalent) calculus. Fuzzy logic arises from the idea of mapping variables that do not have a defined mathematical equivalence (WEBER, 2003).

The theory was developed by Lofti A. Zadeh of the University of California at Berkley in the 1960s and combines multivalued logic, probabilistic theory, artificial intelligence and neural networks to represent human thought, that is, link linguistics and human intelligence , as many concepts are better defined by words than by mathematics (FREITAS, 2020). Thus, the Fuzzy Theory emerges as a method that includes subjective information and through it allows insertion and data with results that can be understood and analyzed. In this sense, fuzzy logic provides a method of translating vague, imprecise and qualitative verbal expressions, common in human communication, into numerical values (SIMOES, 2007).

Fuzzy Logic or Fuzzy Logic as it is also known, does not treat variables as having only one state, but rather n states; each with a certain degree of association, that is, a house is not large but 0.8 large, 0.2 medium and 0.0 small. This generates the creation of sets into which data can be entered. These characteristics allow a better treatment of problems where there are imprecise or well-defined borders (CASTRO, 2018).

We can also discuss fuzzy logic as a tool capable of capturing vague information, usually described in a pseudo-natural language, and converting them to a numeric format, easy to be manipulated by today's computers (SOUSA, 2014). For SIMOES (2007), Fuzzy Logic has the following characteristics:

- Logica Fuzzy is based on words and not on numbers, that is, true values are linguistically expressed. For example: hot, very cold, true, far, close, fast, slow, medium...;

- It has several predicate modifiers such as: a lot, more or less, a little, a lot, medium ...etc;

- It also has a wide range of quantifiers, such as: few, many, around, usually;

- Makes use of linguistic probabilities, such as: probable, improbable, which are interpreted as fuzzy numbers and manipulated by their arithmetic;

- Handles all values between 0 and 1, taking these as a limit only.

When using fuzzy logic, it is necessary to create controls to accurately handle linguistic information. Thus, BARROS (2006) points out that in fuzzy controllers the tasks are commanded through terms of the usual language, related to some variable of interest and, in this aspect, linguistic variables play a fundamental role. These terms, translated as fuzzy sets, are used to transcribe the knowledge base through a collection of fuzzy rules, called fuzzy rules base. From this rule base, the fuzzy relation is obtained, which will produce the output (response, action) for each input (state, condition).

In this sense, FREITAS (2020) indicates that fuzzy logic can be used to implement fuzzy controls, applied to the most varied types of processes. For any fuzzy system, each fuzzy input corresponds to a Fuzzy output (BARROS, 2006).

Figure 6, below, configures the view of how Fuzzy Logic works with the fuzzification module, rule base, inference and defuzzification module process.

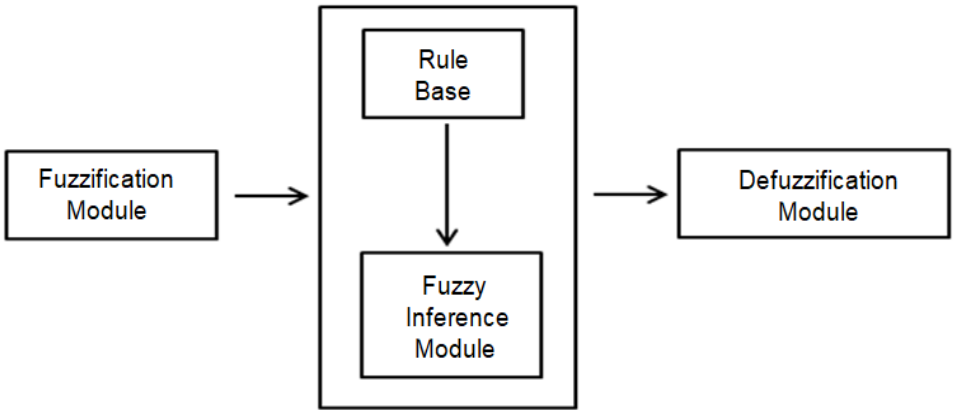


Figure 6: General schematic of a fuzzy controller.
Source: BARROS and BASSANEZI, (2006).

According to FREITAS (2020), these elements are called fuzzifier and defuzzifier, and are positioned at the input and output of the control system, respectively.

2.5.1 Fuzzy Sets

In classical set theory, an element of a universe belongs to the set or does not belong to the set. Entertendo in the real world presents situations in which classical sets are not able to adequately define certain classes of elements because they do not have enough flexibility and force an abrupt transition between absolute membership and absolute non- membership (PIMENTA, 2009).

PIMENTA (2009) fuzzy sets, considered a generalization of classical sets, enable a gradual transition, allowing each element to partially belong to one or more sets.

In figure 7, it represents the differences between classical sets and fuzzy sets, and how there is a smooth transition in (a) different from (b) which has a well-defined division.

Figure 7 – Classical Sets versus Cloudy Sets.
Source: SOUSA, (2016).

A fuzzy set is a generalization of the classical notion of sets and is well defined by its membership function, which assigns a value in the range from 0 to 1 to each element of the universe set and, in this way, the degree of relevance of the element to the set in question. The degree of relevance of an element of the universe set to a fuzzy set expresses the degree of compatibility of the element with the concept represented by the fuzzy set (NICOLLETI, 2009).

SOUSA (2016) presents that in the classical theory of sets, sets are, so to speak, "crisp", in such a way that a given element of the universe in discourse (domain) belongs or does not belong to that set. In the theory of fuzzy sets there is a degree of membership of each element to a given set. A direct consequence of this fact is that, unlike classical sets, the boundary separating fuzzy sets is not well defined.

2.5.2 Basic Operations between Fuzzy Sets

The basic operations between fuzzy sets proposed by Zadeh are complement, union and intersection (NOGUEIRA, SEARCH).

- Complement: the complement of a fuzzy set A has a membership function given by equation (1.x):

$$\mu_A = 1 - \mu_A(x) \quad (1)$$

The complement operator corresponds to the "NO" connector.

- Union: the union of two fuzzy sets A and B can be represented by BA or by A + B. The union between these fuzzy sets has a membership function defined by equation (1.x):

$$\mu_{A \cup B} = max\,[\mu_A(x_i), \mu_B(x_i)] \quad (two)$$

The union operator corresponds to the "OR" connective.

- Intersection: the intersection between fuzzy sets A and B can be represented by B∩A or by AB This operation results in the membership function given by equation (1. X):

$$\mu_{A \cap B} = min\,[\mu_A(x_i), \mu_B(x_i)] \quad (3)$$

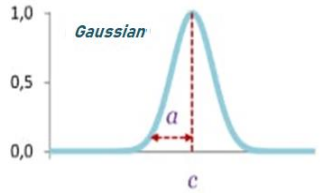
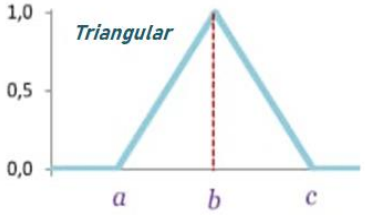
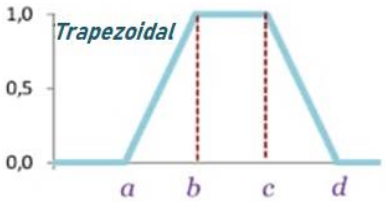
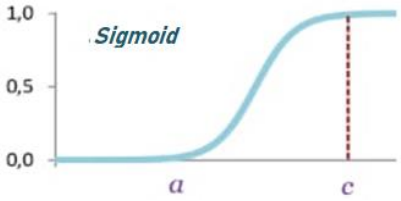
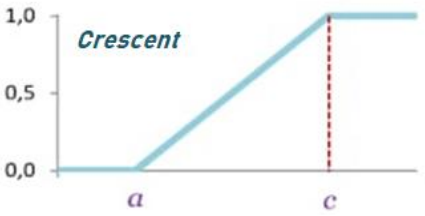
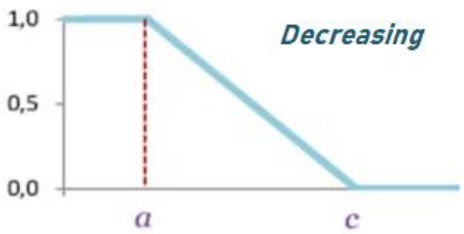
The intersection corresponds to the "E" connective.

The definitions presented for the union and intersection of fuzzy sets are particular and were proposed by Zadeh.

2.5.3 Relevance Functions

The membership functions demonstrate different formats depending on the reality in which the application of information takes place. According to CASTRO (2018) in most practical applications, membership functions are of the Gaussian, triangular, trapezoidal, increasing or decreasing type. Membership functions can take different forms associated with each input and output response. The most used are the triangular ones, and the others (trapezoidal, Gaussian and exponential) are used depending on the preference and experience of the designer (BARROS, Ana).

Figures 8; 9; 10; 11; 12 and 13 presented in Table 1 - Basic Types of Membership Functions.

Figure 8 represents the bell-shaped Gaussian function, corresponding to the result of the variables.	 Figure 8 – Gaussian.
Figure 9, represents the triangular function, corresponding to the informed variables, being one of the standard membership functions.	 Figure 9 – Triangular.
Figure 10, represents the trapezoidal function, also represents one of the standard membership functions.	 Figure: 10 – Trapezoidal.
Figure 11 represents the sigmoidal membership function, which, depending on the displacement of the curve to the right or left, indicates whether the function is increasing or decreasing.	 Figure 11 – Sigmoid.
Figure 12 represents increasing function, according to data results.	 Figure: 12 – Crescent.
Figure 13 represents a decreasing function, as a result of the data.	 Figure: 13 – Decreasing.

Source: Sousa, (2016).

TANSCHEIT (2004) emphasizes that membership functions can be defined from the user's experience and perspective, but it is common to use standard membership, such as triangular, trapezoidal and Gaussian shapes. For CASTRO (2018) he emphasizes that the triangular, trapezoidal, increasing and decreasing pseudolinear functions can easily be implemented by using the max ( ) and min ( ) functions. These representations are very useful when using a scripting language such as matlab or scilab to model a fuzzy set.

2.5.4 Fuzzy Rules

BARROS AND BASSANEZI (2006) the rule base fulfills the role of mathematically "translating" the information that form the knowledge base of the fuzzy system. KOVACIC et al (2005) point out that fuzzy rules are a central part of fuzzy controller representing the "intelligence" of fuzzy control algorithms. CICHINNI (2009) in fuzzy theory, the input parameters of the system are mapped on linguistic variables that are used in the definition of rules for the processing of output variables, also represented by linguistic variables.

In fuzzy rule-based systems each fuzzy proposition has the form If "state" Then "answer" where each "state" and each "answer" are values assumed by linguistic variables, and these in turn are modeled by fuzzy sets. The fuzzy sets that make up the "state" are called antecedents. On the other hand, the sets that make up the "response" are called consequents. The particularity of fuzzy controllers, as already noted, is that each rule has the form If "condition" Then "action" (BARROS and BASSANEZI, 2006).

The terms called antecedents describe the conditions necessary for there to be a certain result, and the terms called consequent represent the very results or actions that can be performed when the antecedents are checked. Differently from the rules in Classical Theory, a fuzzy rule can be evaluated even if the antecedents are not completely satisfied (GIBILINI, 2006).

III. MATERIALS AND METHODS

The research developed aims to use the data obtained and, consequently, the development of a fuzzy inference model. The procedures for surveying the input linguistic variables are displayed, as well as the details of the application of the study. The approach used the case study method, focused on a third sector organization, representing an investigation.

3.1 - Description of the company

Organization Y is a non-profit institution, operating for over 21 years in the field of services to meet the demands of the education sector, more specifically focused on the administrative and financial management of teaching, research and extension projects. Its main clients throughout its existence were educational segments in the State of Amazonas, more precisely in the capital Manaus, considering the concentration of public universities that eventually seek partnerships to develop activities aimed at the scientific field. Currently, it has a series of partnerships with the public sectors at the state and federal levels, as well as with the private sector, which has been seeking to develop projects aimed at research, innovation and administrative R&D activities, with a view to benefiting the society of Amazonas.

Organization Y is managed by an executive board, is registered with the Ombudsman of Foundations of the Public Ministry of the State of Amazonas, has 32 employees and its headquarters are located in an easy access point in the city of Manaus. As of 2006, it created the Competitive Intelligence Nucleus – NIC, with the purpose of attracting new partners by supporting the development of new management proposals.

3.2 Materials

The gathering of bibliographical references regarding the themes: processes, project management, quality management, third sector and fuzzy theory. As for the acquisition of data, Origin of the financial resources of the projects, submitted to the analysis of the computer system. The use of Matlab R2016a software, in the implementation of the Fuzzy inference model to assess the quality of the project management process. As well as Microsoft Windows 7, for development work.

3.3 Data Relation and Fuzzy Theory and Experimental Methodology

The 4 (four) linguistic variables determined in the previous step were integrated into the modeling of the Fuzzy Theory, using to make a quality measurement evaluation model in the project management process of organization Y. For the development of the research, the indicated system collected data based on the project management process of organization Y, in order to present the main variables that are part of the process and how these points are a significant part of the progress and fulfillment of the objectives of the projects managed by that organization.

3.4 - Identification and description of linguistic variables

Organization Y is composed of several sectors in which there are numerous processes in progress, including the one developed by the project management sector, where the structural series of how the processes of that sector unfolds was listed, with collection of input variables and subsequent evaluation of the most important ones. Thus, the evaluation of actions and practices delimited 4 (four) linguistic variables with potential to build the proposed method, namely: Documentation, System Service Capacity, Process Structure (flow) and Origin of Project Financial Resources. The aspects indicated by the 4 (four) variables are essential to the progress of orders generated in the project management sector,

The description of the chosen linguistic variables follows:

*3.4.1 - Documentation:*It is relevant because it has a degree of information about the document received.

If the document presents all the information necessary to meet the demand, the service is faster. For good practice of the activities, it was pointed out that the Document element is very relevant for the fulfillment of the main demands received in organization Y.

It is very important that, when analyzing the format of the documents that are presented to organization Y, those responsible verify the authenticity of what is being received, since the document will remain in the company's records base.

*3.4.2 - System Service Capacity:*The variable in question is related to the implemented system and whether it meets the needs of organization Y regarding the execution of projects.

In this sense, the system's service capacity is allied to performance during the execution of activities aimed at achieving what was planned and planned in the project in progress. Organization Y is concerned with providing equipment with appropriate capabilities to support the load of information necessary to meet the needs of analyzing the processes in progress.

3.4.3 - Process Structure (flow): Selected for presenting the procedures adopted by organization Y, they efficiently serve the execution of projects.

The structure element of the processes is concerned with the flows adopted by the organization when it comes to meeting the planning of projects, if each activity is flowing according to the procedures for which it was designated so as not to result in rework, as this would delay the progress of orders that are in the production chain.

3.4.4 - Source of Project Financing Resources:The variable in question is important because it deals with the source of capital to be used. Being divided into two segments:Very bureaucratic – public resource and the organization acting as a support foundation (locks in meeting demands) and Little bureaucratic – private resource (meeting demands flows faster).

In this case, if the resource is public, it will be specified by law, that is, the use by organization Y acting as a support foundation, follows the procedures provided for in the legal system and are more bureaucratic, which makes it difficult, delays the execution of projects . Thus, the main means of partnerships are through administrative contracts, agreements, cooperation agreements, among others.

Therefore, third sector organizations that seek partnership opportunities for the development of projects with public bodies must meet the criteria provided for in Law No. 8666/1993 of June 21, 1993 - Public Administration Tenders and Contracts.In this sense, for sources of financial resources in the public sector, the third sector organization is required to agree, according to law 8666/93, pointing out the existence of a lot of bureaucracy. In the case of resources from the private sphere, the capital arrives at the Foundation's management with little bureaucracy, as it follows cooperation paths with greater flexibility in the use of resources.

IV. RESULTS AND DISCUSSIONS

4.1 Application of the Fuzzy Method

The above variables were used as input data (Fuzzification) for a Fuzzy System in order to assess the quality of processes in project management in organization Y, showing through functions the structural format it gains after entering the data in the matlab software . To obtain the membership functions, the parameter was the 4 variables and the numerical range was established [0-100]. The membership functions resulting from the proposed variables, after entering the data, were of the triangular, trapezoidal and sigmoid types.

4.1.1 Fuzzification function for variable "Documentation"

For the project to take place, a relationship between the project coordinators and the analysts responsible for meeting the demands within the organization is necessary, as the coordinators are aware of the needs of the projects, such as which services will be contracted, which are the materials will be purchased, the billing schedule, financial schedule, among other information that will be demonstrated in the Basic Project. Based on this information, the coordinator forwards their demands to the organization, which is responsible for executing the requested request. Thus, the coordinators forward to the institution documents (forms, official letters, processes, etc.) containing information necessary to fully meet the demand. Therefore, the more complete the document, faster and more efficient will be the fulfillment of the coordinator's request. If the project coordination sends a document requesting a certain activity, such as payment from a supplier and the document does not contain the supplier's bank account, for example, the institution will be unable to meet said demand, needing to contact the supplier for the collection of pending information, causing delay in the demanded execution. The same happens if the institution receives a demand to purchase material, for example. If the document does not present the necessary material specifications, a product may be purchased that does not meet the project's needs, which may lead to greater delays in the delivery of the product, since the purchased equipment must be exchanged or even cause a financial loss to the project. The linguistic variable “Documentation” constitutes three membership functions, with trapezoidal and triangular shapes. Figure 14 shows the trapezoidal and triangular structures, taking into account linguistic values: low, medium, high.

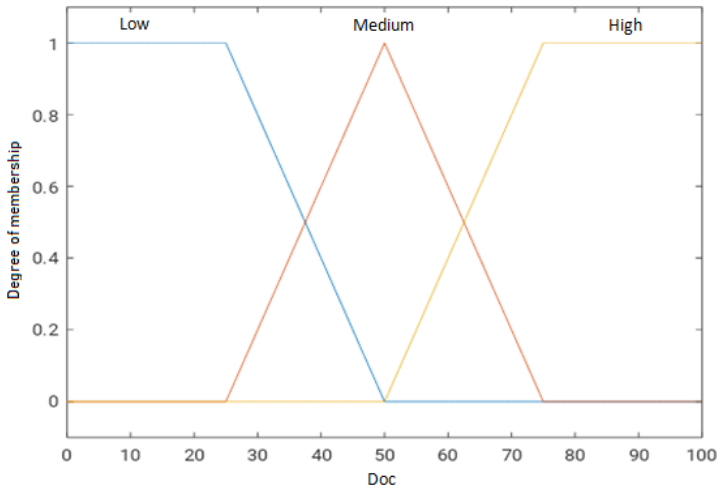


Figure 14 – Membership functions of the “Documentation” input variable.
Source: Authors, (2021).

Table 2 presents the values obtained in the fuzzification of the membership function of the “Documentation” variable.

Table 2. Numeric Values of the "Documentation" Variable.

Documentation	
linguistic value	Numerical Value
Low	[0 0 25 50]
Medium	[25 50 75]
Great	[50 75 100 100]

Source: Authors, (2021).

4.1.2 Fuzzification function for variable "System Service Capacity"

For better project management, Institution Y has an integrated system for controlling and monitoring project demands. A company was hired to customize a system to meet the Institution's needs in terms of project control. The system is integrated, that is, the information is made available to all sectors involved, in the various areas of activity, whether HR, finance, accounting, purchasing, billing, protocol and other sectors, making the analyst responsible for controlling the projects, hold the information necessary to monitor the demands, as well as monitor the budget balance, financial and other information necessary for the proper management of projects and provide the coordinator with information for any decision-making process.

In the linguistic variable “service capacity of the system” resulted in three membership functions, having formed trapezoidal and triangular. Figure 15 demonstrates the compositions of the trapezoidal and triangular types.

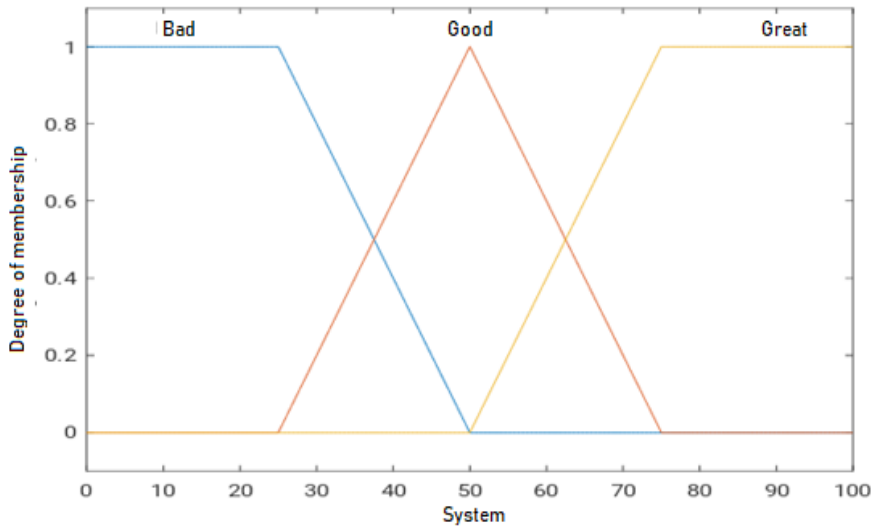


Figure 15 – Membership functions of the “System Service Capacity” input variable.
Source: Authors, (2021).

Table 3 explains the values corresponding to the membership function of that variable.

Table 3 - Numerical values of the variable "System Service Capacity"

System Service Capacity	
linguistic value	Numerical Value
Bad	[0 0 25 50]
Good	[25 50 75]
Great	[50 75 100 100]

Source: Authors, (2021).

4.1.3 - Fuzzification function for variable "Process Structure" (flow)

In order for the projects to be carried out, the demand goes through several sectors in the institution. Each sector has specific procedures for a good and efficient operation. For each type of demand, there is a flow to be followed within the institution. For example, a demand for payment of personnel, after the document is received and filed, goes to the project sector, where the analyst evaluates the information contained in the demand, as well as the documents sent. If everything is fine, it will inform the HR department where this expense should be allocated in the project. The HR analyst will include the expense in the system, according to the item previously informed and will forward it to the financial sector for payment. After this process, the entire banking movement and the original supporting documents, will be forwarded to the accounting sector and put an end to the file, for archiving the documents. In the case of a request to purchase equipment or contract services from a legal entity, the demand will be forwarded to the purchasing sector, presenting a new flow. The linguistic variable “Process Structure” derived three membership functions, presenting trapezoidal and triangular shapes.

Figure 16 depicts the trapezoidal and triangular type structures.

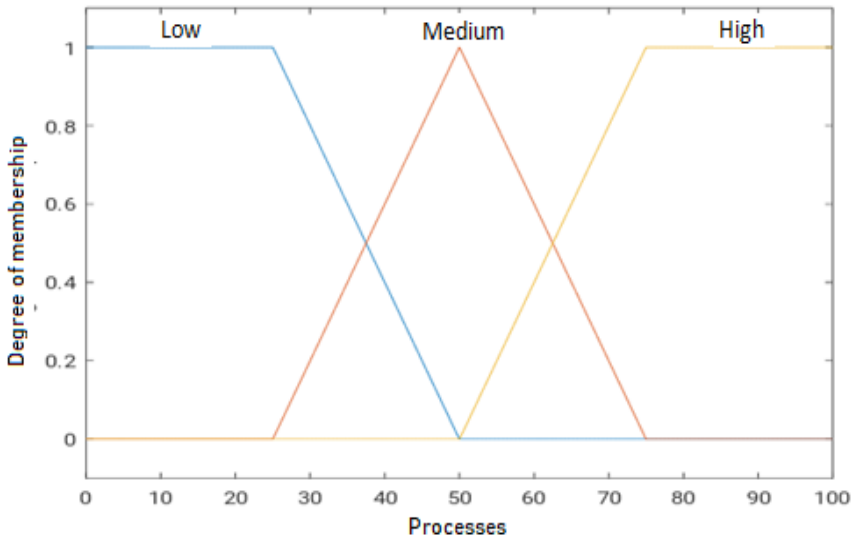


Figure 16 – Membership functions of the “Process Structure” input variable.

Source: Authors, (2021).

Table 4 shows the values obtained in the fuzzification of the variable membership function “Process Structure”.

Table 4. Numerical values of the variable "Process structure"

Process Structure	
linguistic value	Numerical Range
Low	[0 0 25 50]
Medium	[25 50 75]
High	[50 75 100 100]

Source: Authors, (2021).

4.1.4 - Fuzzification function for variable "Origin of Project Financial Resources"

The projects managed by organization Y are financed by public or private institutions, which will define the source of the resource. In case the resource comes from a private institution, the execution of the project will happen in a less bureaucratic way. The requirements for using the resource do not comply with any law, but with the procedures required by the financing institution, which often suffices for a report with statements of expenditure in accordance with the Basic Project. Therefore, the cases of private capital the third sector organization receives the transfer usually through donation, featuring little bureaucracy. In the case of projects financed by public institutions, where the reaction is specified by law, where the organization acts as a supporting foundation, the bidding law, 8.666/93, where all acquisition and/or contracting of services must be obeyed above R$ 17,600.00, must be bid. And in the case of demands below this value, a minimum of 3 quotations are required for proof of purchase with a company that offers the lowest value product or service. The linguistic variable “origin of the financial resources of the projects” resulted in two pertinence functions, represented by the sigmoid formats.

Figure 4.4 depicts the membership functions of the sigmoid type.

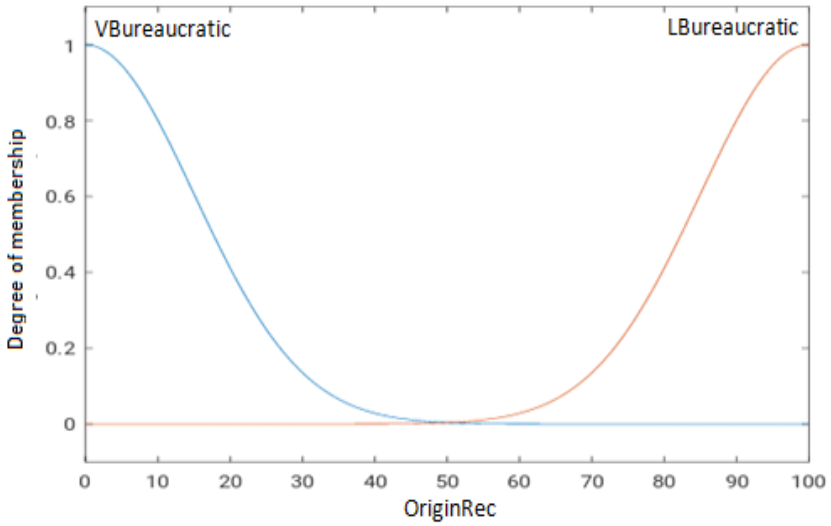


Figure 17 - Membership functions of the input variable “Origin of Project Financial Resources”.

Source: Authors, (2021).

Table 5 depicts the numerical values obtained in the fuzzification process of the variable source of Project Financial Resources and the corresponding intervals according to the dynamics of the function.

Table 5. Numerical values of the variable “origin of the Project's Financial Resources”.

Origin of Project Financial Resources	
linguistic value	Numerical Range
very bureaucratic	[15 0]
Little bureaucratic	[15 100]

Source: Authors, (2021).

4.2 Levels of Inference

For the development of the rule bases conclusions, it will be used to relate the IF-THEN type. According to LIMA (2013), the IF part defines whether the rule is valid for the present case or not and in the composition, each rule defines the evaluation result for the THEN part. In the THEN part, the evaluation result for the rule is defined, generating a linguistic value for the output parameter of the respective inference block represented in the architecture.

According to Silva et al (2019) the set of rules define the procedures of input variables, its format is of the type: If (IF) = antecedent; So (THEN) = consequent.

4.3 Range

In this first moment, the range obtained from the four linguistic variables at the input will be presented, according to the data in figures 1; 2; 3 and 4. Table 6 will demonstrate the range of the four linguistic variables.

Table 6 – Range of the four variables.

Linguistic Variable	range
Document	[0 100]
System Service Capacity	
Process Structure	
Origin of Project Financial Resources	

Source: Authors, (2021).

To continue the research, defuzzyfication rules will be defined, as well as the application of the model in the case study company and the evaluation of the results.

4.4 rule base

The rule base was developed from the variables and their limits and resulted in 54 rules for the referred problem.

Table 7 represents the basis of rules found during the relation of linguistic values.

Table 7 – Rules Base.

Documentation		System Service Capacity	Process Structure	Origin of Financial Resources	Quality (Great, Good, Fair, Bad, Insufficient)
1	Low	Bad	Low	VBurocratic	Insufficient
2	Low	Bad	Medium	VBurocratic	Insufficient
3	Low	Bad	High	VBurocratic	Insufficient
4	Low	Good	Low	VBurocratic	Insufficient
5	Low	Good	Medium	VBurocratic	Insufficient
6	Low	Good	High	VBurocratic	Regular
7	Low	Great	Low	VBurocratic	Insufficient
8	Low	Great	Medium	VBurocratic	Insufficient
9	Low	Great	High	VBurocratic	Regular
10	Medium	Bad	Low	VBurocratic	Bad
11	Medium	Bad	Medium	VBurocratic	Bad
12	Medium	Bad	High	VBurocratic	Regular
13	Medium	Good	Low	VBurocratic	Bad
14	Medium	Good	Medium	VBurocratic	Regular
15	Medium	Good	High	VBurocratic	Regular
16	Medium	Great	Low	VBurocratic	Bad
17	Medium	Great	Medium	VBurocratic	Regular
18	Medium	Great	High	VBurocratic	Regular
19	High	Bad	Low	VBurocratic	Bad
20	High	Bad	Medium	VBurocratic	Bad
21	High	Bad	High	VBurocratic	Regular
22	High	Good	Low	VBurocratic	Bad
23	High	Good	Medium	VBurocratic	Good
24	High	Good	High	VBurocratic	Good
25	High	Great	Low	VBurocratic	Regular
26	High	Great	Medium	VBurocratic	Good
27	High	Great	High	VBurocratic	Good
28	Low	Bad	Low	Lbureaucratic	Insufficient
29	Low	Bad	Medium	Lbureaucratic	Bad
30	Low	Bad	High	Lbureaucratic	Bad

31	Low	Good	Low	Lbureaucratic	Bad
32	Low	Good	Medium	Lbureaucratic	Regular
33	Low	Good	High	Lbureaucratic	Regular
34	Low	Great	Low	Lbureaucratic	Regular
35	Low	Great	Medium	Lbureaucratic	Regular
36	Low	Great	High	Lbureaucratic	Good
37	Medium	Bad	Low	Lbureaucratic	Regular
38	Medium	Bad	Medium	Lbureaucratic	Good
39	Medium	Bad	High	Lbureaucratic	Regular
40	Medium	Good	Low	Lbureaucratic	Regular
41	Medium	Good	Medium	Lbureaucratic	Good
42	Medium	Good	High	Lbureaucratic	Good
43	Medium	Great	Low	Lbureaucratic	Good
44	Medium	Great	Medium	Lbureaucratic	Good
45	Medium	Great	High	Lbureaucratic	Good
46	High	Bad	Low	Lbureaucratic	Good
47	High	Bad	Medium	Lbureaucratic	Good
48	High	Bad	High	Lbureaucratic	Good
49	High	Good	Low	Lbureaucratic	Good
50	High	Good	Medium	Lbureaucratic	Great
51	High	Good	High	Lbureaucratic	Great
52	High	Great	Low	Lbureaucratic	Good
53	High	Great	Medium	Lbureaucratic	Great
54	High	Great	High	Lbureaucratic	Great

Source: Authors, (2021).

4.5 Defuzzification

In defuzzification, the controller contains a control variable (output), which will correspond to the linguistic variables great, good, regular, bad, insufficient.

Table 8 shows the ranges of the output sets.

Table 8 - Linguistic Values of defuzzification.

Quality	
linguistic value	Numerical Range
- Great	[70 90 100 100]
Good	[50 70 90]
Regular	[30 50 70]
Bad	[10 30 50]
Insufficient	[0 0 10 30]

Source: Authors, (2021).

This variable had five membership functions, being trapezoidal and triangular, covering an interval [0-100], as shown in Figure 18.

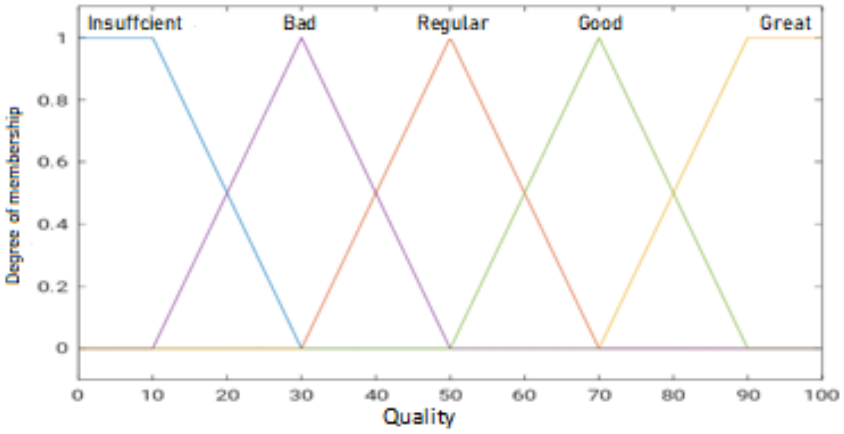


Figure 18 - Membership function of the quality variable.

Source: Authors, (2021).

Defuzzification enabled the mapping of the quality membership function, as shown in figure 4.5, showing precise information regarding quality and translating the sets to fuzzy logic format.

4.6 Fuzzy Controller

Figure 19 shows the fuzzy controller to obtain quality, where the diagram shows the interactions that occur in the controller, with the first blocks corresponding to the 4 linguistic input variables (fuzzification): Document, System Service Capacity, Structure of processes, Origin of financial resources, which reflect their pertinent functions. The middle block shows the resulting 54 rule bases. In the third block, the output membership function (defuzzification) regarding the quality measurement is presented.

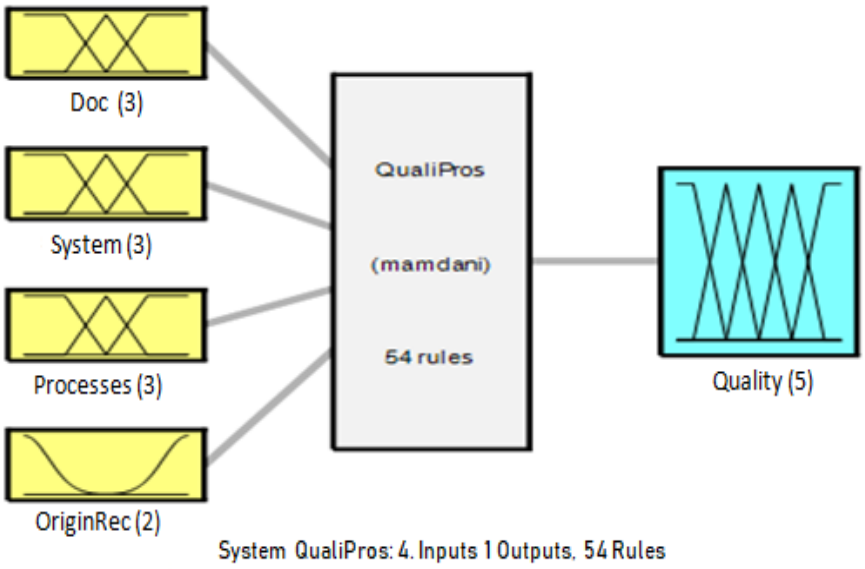


Figure 19 - Fuzzy Controller Representation for Quality
Source: Authors, (2021).

The above structure was determined based on the set of rules that were applied to them mathematically, and they are connected through the linguistic rules based on the expert's knowledge.

4.7 Results and discussions

Using Fuzzy Logic, it was possible to develop an inference system to assess the quality of processes aimed at a Third Sector organization, in this case company Y.

Distributions were defined for each input variable, essential to guide the degree of relevance of the functions, to elaborate a base of rules that allowed to make the prediction of the quality. Thus, each qualitative variable (Documentation, System Service Capacity, Process Structure and Origin of Financial Resources) demonstrated trapezoidal, triangular and Gaussian functions in accordance with the information entered in the Matlab system.

The "documentation" variable refers to the level of information present in the documents that arrive at Institution Y for the execution of the projects. The more information, better and faster is the fulfillment of demand.

Therefore, the higher the level of information present in the document, the more efficient the service, and consequently the lower, the slower it takes to meet the demand, as there is not enough data. Institution Y has an integrated system that assists in the execution of demands, as well as budgetary and financial controls. The variable "system service capacity" determines whether this system meets the needs of a good functioning of the projects. Therefore, as for the system's capacity classified as great, it defines that the integrated system efficiently meets the needs of institution Y regarding the execution of projects, that is, as the system is integrated, all sectors involved in project management have the necessary information for control, decision-making and any relevant information about the progress of the projects. A bad rating, on the other hand, refers to a system that does not help with project management.

When the variable “process structure” presents a high level, it means that the procedures of the sectors, adopted by institution Y, result in a good execution of the projects, demonstrating that the sectors complement each other. A low level defines that the procedures are inefficient, thus hindering the progress of projects, causing dissatisfaction on the part of project coordinators, as well as funders, beneficiaries and the entire team involved.

The “origin of financial resources” variable is divided into two categories, very bureaucratic and not very bureaucratic, depending on who is the project's funder and what relationship is specified by law, when the organization acts as a support foundation. In the case of public resources, institution Y is required to account for the resources received to Organs inspection bodies of the municipality, state or union. It must also adopt the bidding laws, 8,666/ for the acquisition of products/equipment or contracting of services for the execution of the projects.

In the case of resources from private lenders, they are classified as little bureaucratic, as there is no need to comply with Law 8666 and rendering of accounts, in most cases, is much simpler. In the defuzzification, 5 sets were used for output (Great, Good, Regular, Bad and Insufficient), the function presented the trapezoidal and triangular format, showing the values for the output variable, based on the quality measurement.

With the defined rules and membership functions developed previously, the results were obtained as shown in figures 20 and 21 as a solution for the fuzzy system. Two solutions were demonstrated, one with the variable “origin of project financial resources” being very bureaucratic, that is, a public resource, and a second solution with the same variable being little bureaucratic, a private resource.

Figure 20 shows the document, system and process variables together with the variable “source of financial resource” = little bureaucratic. With the defined rules and membership functions developed previously, the results were obtained as shown in figures 20 and 21 as a solution for the fuzzy system. Two solutions were demonstrated, one with the variable “origin of project financial resources” being very bureaucratic, that is, a public resource, and a second solution with the same variable being little bureaucratic, a private resource. Figure 20 shows the document, system and process variables together with the variable “source of financial resource” = little bureaucratic.

With the defined rules and membership functions developed previously, the results were obtained as shown in figures 20 and 21 as a solution for the fuzzy system. Two solutions were demonstrated, one with the variable “origin of project financial resources” being very bureaucratic, that is, a public resource, and a second solution with the same variable being little bureaucratic, a private resource.

Figure 20 shows the document, system and process variables together with the variable “source of financial resource” = little bureaucratic. one with the variable “origin of the financial resources of the projects” being very bureaucratic, that is, a resource of public origin, and a second solution with the same variable being little bureaucratic, a resource of private origin. Figure 20 shows the document, system and process variables together with the variable “source of financial resource” = little bureaucratic. one with the variable “origin of the financial resources of the projects” being very bureaucratic, that is, a resource of public origin, and a second solution with the same variable being little bureaucratic, a resource of private origin.

Figure 20 shows the document, system and process variables together with the variable “source of financial resource” = little bureaucratic.

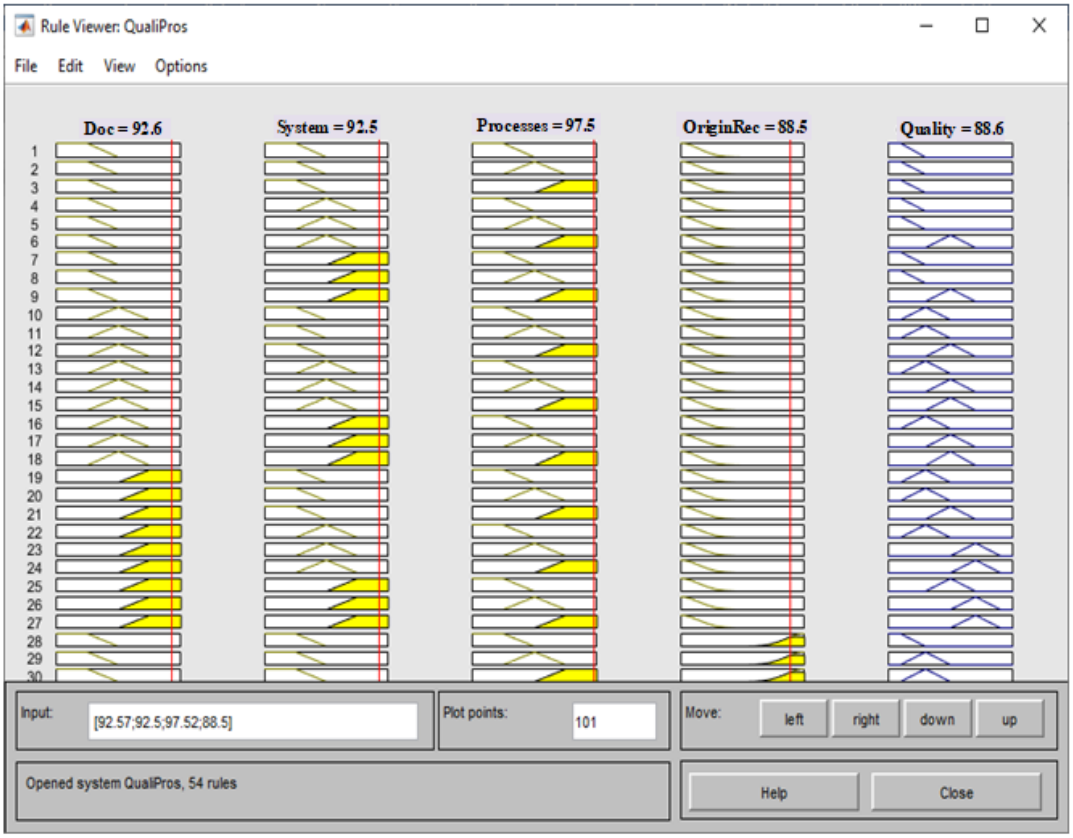


Figure 20: Good Quality Rules Graph (with variation of the little bureaucratic resource).
Source: Authors, (2021).

Figure 20 shows the quality value of 88.6, showing a good quality, showing that the linguistic variables Document, System Service Capacity, Process structure, associated with the variable Origin of financial resources with little bureaucracy, are well ordered and robust, generating a process conducive to high quality as they efficiently meet the structural needs of the processes. The linguistic variables "Document" and "Service capacity of the system" in this scenario, present a variation around 92%, "Process structure" was around 97% and "Origin of financial resources" with 88%, this was reflected in the result favorably once quality has been achieved. In this sense, company Y has a strong procedural structure.

Figure 21 shows the same situation as the previous one, but with the variable “origin of the financial resource” = very bureaucratic.

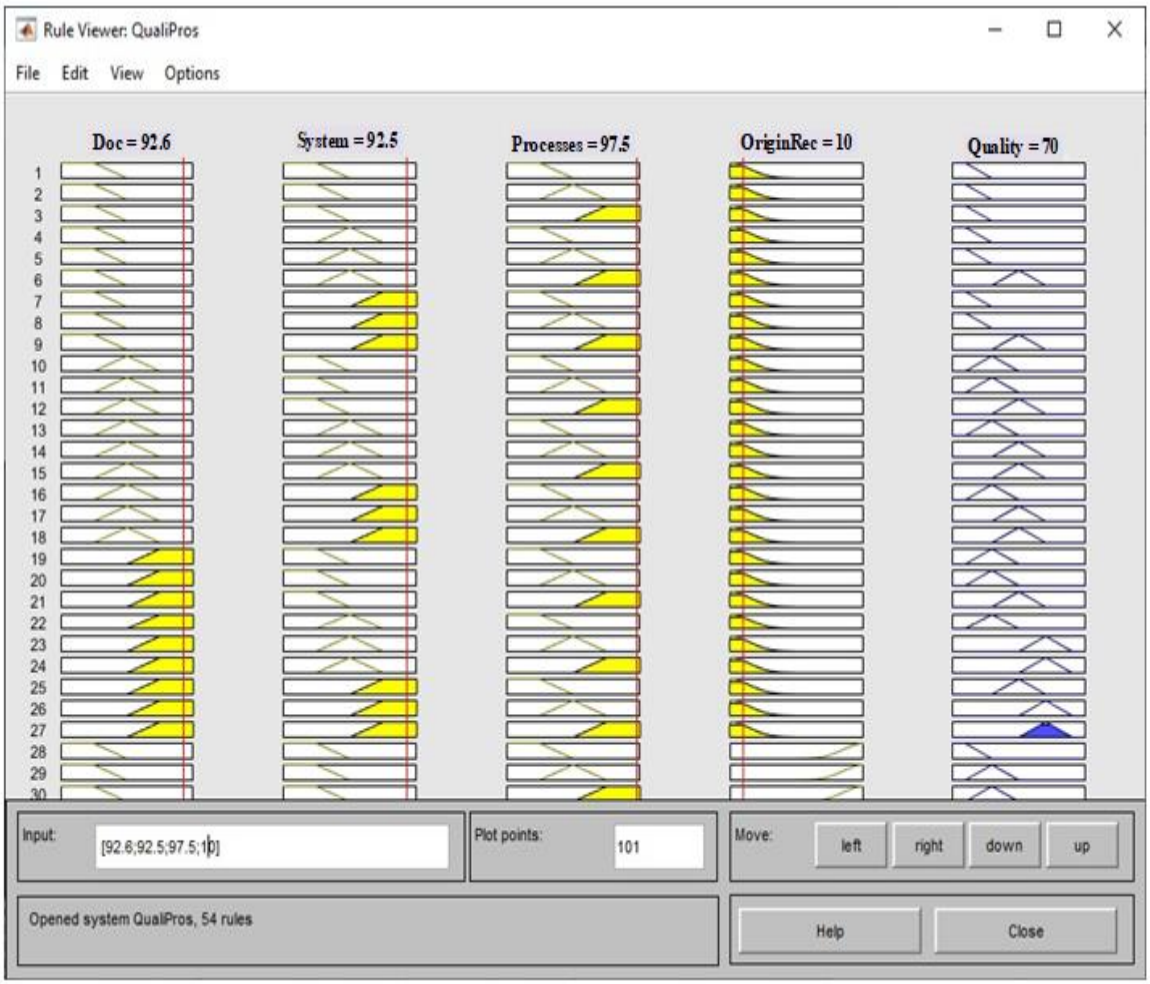


Figure 21: Good Quality Rules Graph (with very bureaucratic resource variation).
Source: Authors, (2021).

It can be seen from Figure 21 that, even with the origin of the resource being very bureaucratic, that is, resources from projects that have public funders and in which organization Y acts as a supporting foundation, such as state or federal universities , public institutions, the quality is still good, with the output variable quality having a value of 7.0. Therefore, as organization Y presents an excellent performance of the other variables, documentation, system and process, regardless of the source of the resource (public or private), it continues to present a good quality of service in the project management process. Next, we present two simulations, demonstrating that this model is viable for measuring the quality of project management processes. Figure 22 shows a good quality model.

Figure 22: Good Quality Rules Graph.
Source: Authors, (2021).

According to figure 22, in which the variable “document”, has greater influence on the impact of quality, perceived during the simulation of combination of variables, representing about 70%. And the variables "system service capacity", "Process Structure" have equivalent impact, as they represent 50% of influence on the quality of processes in project management, and the variable "Origin of financial resources" has low representation, having 20 % influence on quality. Therefore, the value of 67.6 referring to the result of obtaining quality, as shown in Figure 4.7, exposes the dynamics with the linguistic variables "documentation", "system service capacity", "process structure", "origin of financial resources ”, were compiled during the application of fuzzy logic.

According to the rules viewer in Figure 20, rule 23 was activated, being as follows, IF "Document" = High, "System Service Capacity" = Good, "Process Structure" = Medium and "Origin of Financial Resource” = Very bureaucratic THEN Quality = Good, with this scenario company Y would have an adequate quality with a parameter of “good” in the processes involving project management.

With respect to Figure 23, the rules chart represents quality as being poor.

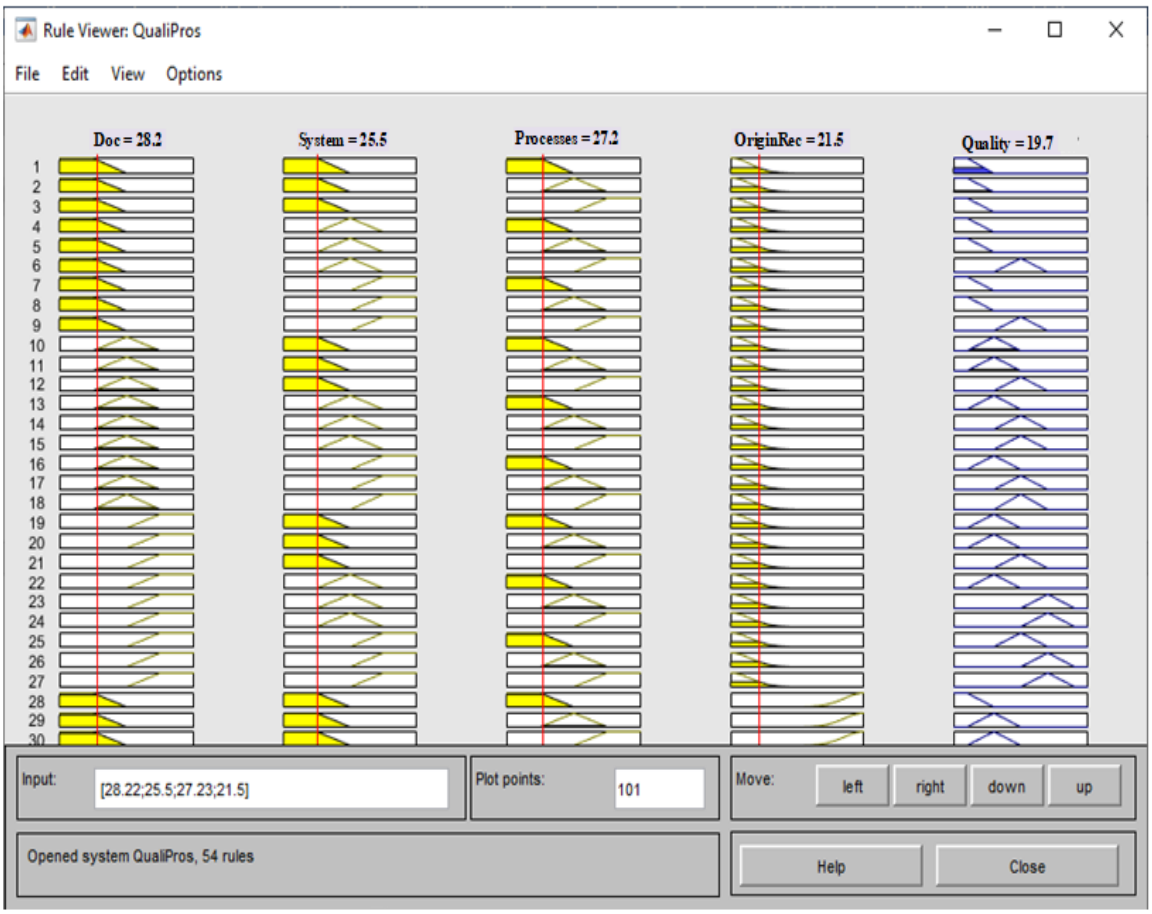


Figure 23: Bad Quality Rules Graph.
Source: Authors, (2021).

The graph above represents the output variable quality as being bad, since the index was around 19.7, representing a level with little or no quality, in this aspect the linguistic values tended to show an unfavorable scenario for achieving the quality of the process.

In this case, rule 10 shows the following form, IF "Document" = Medium, "System Service Capacity" = Poor, "Process Structure" = Low and "Source of Financial Resource" = Very Bureaucratic THEN "Quality" = Bad and the linguistic variables were as follows: "Document" 28% impact on the result, "System service capacity" around 25% of relevance in the result, "Process structure" was 27% with regard to importance in the result and the “Origin of financial resources” with an indicator of 21% in relation to the result of the existence of quality.

Based on this panorama, the quality was well below 20%, so that company Y would have to intervene to improve all 4 linguistic variables, as these significantly reflect the final result. Company Y currently does not have a structured procedure for measuring the quality of project management processes, occasionally the assessment is carried out in a non-experimental way, that is, in the organization's daily experience. However, the scenarios that resulted in good and excellent would be the most suitable for that corporation, as they are able to reflect how the linguistic variables Document, Service Capacity of the system, Structure of processes, Origin of financial resources have an impact on the achievement of quality in the project management processes.

V. CONCLUSIONS

Promoting a more efficient project management is in the interest of many professionals and organizations, as it serves to make the realization of projects safer and faster. Seeking to measure the quality of project management within organization Y, the Fuzzy methodology was used.For the development of this methodology, the project management process within organization Y was analyzed, which provided an understanding of the dynamics of how the procedural steps occur within the sector, from the receipt of the demand to its completion, allowing for the assimilation of the of execution of the steps of the process and carry out the identification of linguistic variables. In order to implement the Fuzzy Inference model used to measure the quality of the project management sector, the input linguistic variables (fuzzification) were identified: Documentation, Service Capacity, Process Structure - Flows, Origin of financial resources of the projects. The implementation of the developed fuzzy model allowed us to understand the dynamics of the functioning of the 4 (four) linguistic variables of the project management process within organization Y, pointing out the weaknesses of the process in the face of improvement in the pursuit of quality, optimizing the process flows in order to minimize errors, waste of time and labor. The evaluation of quality in project management processes through the fuzzy methodology proved to be feasible to help the desired observations, allowing to understand the impact of each linguistic variable on the research result, pointing out how organization Y can use the information obtained for improvement of the project sector structure. pointing out the weaknesses of the process in the face of improvement in the pursuit of quality, optimizing process flows in order to minimize errors, waste of time and labor. The evaluation of quality in project management processes through the fuzzy methodology proved to be viable to help the desired observations, allowing to understand the impact of each linguistic variable on the research result, pointing out how organization Y can use the information obtained for improvement of the project sector structure. pointing out the weaknesses of the process in the face of improvement in the pursuit of quality, optimizing process flows in order to minimize errors, waste of time and labor. The evaluation of quality in project management processes through the fuzzy methodology proved to be viable to help the desired observations, allowing to understand the impact of each linguistic variable on the research result, pointing out how organization Y can use the information obtained for improvement of the project sector structure.

For future work, it is recommended to develop models based on linguistic characteristics in accordance with the segment of the institution that wants to measure quality, enabling the application of the method in several new organizational segments.

VI. THANKS

To the Post-Graduate Program in Process Engineering of the Technology Institute of the Federal University of Pará (PPGEP/ITEC/UFPA), ITEGAM, Muraki Institutional Support Foundation for the financial support of PPFRH/CAPDA/SUFRAMA.

VII. REFERENCES

Araújo, Luis Cesar G. de; Garcia, Adriana Amadeu; Martines, Simone; Process Management: better results and organizational excellence; 2nd edition, São Paulo, Atlas, 2019.

Association Of Business Process Management Professionals - ABPMP. Guide to Business Process Management: Common Body of Knowledge, 2013.

Bassan, Edilberto José. Quality Management: Tools, Techniques and Methods. 1st edition, Curitiba, 2018.

Bennett, Roger; Barkensjo, Anna. Relationship quality, relationship marketing, and client perceptions of the levels of service quality of charitable organizations. International Journal of Service Industry Management, vol. 16, no. 1, p. 81-106, 2005. Available: <https://www.emerald.com/insight/publication/issn/0956-4233/vol/16/iss/1.>. Accessed on: March 18, 2021.

Barros, Laécio Carvalho De.; Bassanezi, Rodney Carlos Bassanezi. Topics in fuzzy logic and biomathematics. UNICAMP/IMECC, Campinas, São Paulo, 2006.

Ballestero-Alvarez, María Esmeralda. Quality, production and operations management. 3rd edition, São Paulo, Atlas, 2019.

Barros, Ana Claudia. Detection and Classification of High Impedance Faults in Electric Power Systems Using Fuzzy Logic. Available at:<https://repositorio.unesp.br/bitstream/handle/11449/87092/barros_ac_me_ilha.pdf?sequence=1&isAllowed=y>. Accessed: May 20, 2021.

Borges, Carlos; Rolim. Fabioan. Applied project management: concepts and practical guide. Brasport, Rio de Janeiro, 2015.

Burmester, Hiano. Hospital Quality Management. 1st edition, São Paulo, Saraiva, 2013.

BRAZIL, Law No. 13.204, of December 14, 2015.Amends Law No. 13.019, of July 31, 2014, "which establishes the legal regime for voluntary partnerships, involving or not transfers of financial resources, between the public administration and civil society organizations, in a mutual cooperation regime, for the achievement of public interest purposes; defines guidelines for the development and collaboration policy with civil society organizations. Available at: <http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2015/lei/l13204.htm>. Accessed on: April 4, 2021.

Carvalho, Marly Monteiro De; Rabechini Jr, Roque. Fundamentals in Project Management: building competencies to manage projects. 5th edition, São Paulo, Atlas 2021.

Carpinetti, Luiz Cesar Ribeiro. Quality Management: Concepts and Techniques. 2nd ed. São Paulo: Atlas, 2012a.

Carpinetti, Luis Cesar Ribeiro. Quality Management: concepts and techniques. 3rd edition, Atlas, São Paulo, 2016b.

Carpinetti, Luis Cesar Ribeiro; Gerolamo, Matthew Cecílio. Quality Management: ISO 9001:2015. 1st edition, Atlas, São Paulo, 2019.

Castro, Rodrigo Evengelista De. Artificial Intelligence: Genetic Algorithms in Practice, 2018.

Cichini, Fabio Augusto Leandrin. Application of a Fuzzy Decision Support Inference System to estimate the values of shares listed on the São Paulo Stock Exchange. 2009.<Https://Repositorio.Unesp.Br/Handle/11449/93042?Show=Full> Access on 04/18/2021.

Freitas, Marcos Airton De Sousa; Freitas, Gabriel Belmino. Artificial Intelligence and Machine Learning: theories and applications. 1 edition, 2020.

Gerreiro, Fernando Estudillo. Strategic Tools in Project Management. 2nd edition, São Paulo, Publishing, 2013.

Gibilini, Daniel. Application of artificial intelligence techniques in dynamic channel allocation in wireless networks. 2006. Dissertation (Masters in Digital Systems) - Polytechnic School, University of São Paulo, São Paulo, 2006. doi:10.11606/D.3.2006.tde-04092006-154457.Available at: <https://www.teses.usp.br/teses/disponiveis/3/3141/tde-04092006-154457/pt-br.php>. Accessed on: May 23, 2021.

Brazilian Institute of Geography and Statistics. Available at: <Ibge.gov.br>. Accessed on: March 25, 2021.

Jesus, Leander; Apple tree, Andrew. Rethinking Management through Processes. Publisher: Elogroup, 1st edition, 2015.

Keeling, Ralf; White, Renato Henrique Ferreira. Project management. 4th edition, São Paulo, Saraiva Educação, 2019.

Kerzner. Harold. Project Management: best practices. . 4th edition, Bookman. Porto Alegre. 2020.

Kovacic, Zdenko et al. Fuzzy Controller Design: Theory and Applications. Available at:<https://www.academia.edu/43854555/Fuzzy_Controller_Design_Theory_and_Applications?email_work_card=view-paper>. Accessed on: May 21, 2021.

Lima, Humberto Junior Rodrigues De et al. Fuzzy Logic Applied to Monitoring Large Equipment in the Mining Industry. Available at: <https://simpep.feb.unesp.br/anais_simpep.php?e=8>. Accessed: April 28, 2021.

Lobo, Renato Nogueirol. Quality management. 2nd edition, São Paulo, Érica, 2020.

Lobo, Renato Nogueira; Silva, Damiao Limeira Da. Quality Management: Guidelines, Tools, Methods and Standardization. Saraiva, 2009.

Souza, Jose Orlando De Lima. 50 management tools: diagnose and solve problems. Christmas, 2021.

Marchall Junior, Isnard et al. Quality and Process Management. 1st edition, Rio de Janeiro, Editora FGV, 2012.

Neto, Manoel Veras De Sousa, Project Management: Project Model Canvas (PMC), Rio de Janeiro, Abreu's System Ltda, 2014.

Nicoletti, Maria Do Carmo; Camargo, Heloisa de Arruda. Fundamentals of Fuzzy Set Theory. Series Notes. 1st edition, Edufscar São Carlos, 2009.

Nogueira, Maycon Mariano. Applying Fuzzy Logic in Mobile Robot Control using Programmable Logic Devices and VHDL Language. Available at:<https://repositorio.unesp.br/bitstream/handle/11449/87069/nogueira_mm_me_ilha.pdf;jsessionid=7B18519E24E61D17D1C291496B8000EA?sequence=1>. Accessed: May 20, 2021.
Oliveira, Clair De. The Third Sector framework: doctrine and practice. Jundiaí, Paco Editorial, 2016.

Oliveira, Maria Suzie. Ethics in the Third Sector and the New Liberalism. Maceio, 2020.

Oliveira, Otávio J. et al. Quality Management: advanced topics. Cengage, São Paulo, Learning, 2020.

Padua, Elisabete Matallo Marchesini. Research Methodology: theoretical-practical approach. Papirus Publisher, 2016.

Passarini, Guisepe Ricardo. Productive Process Management through a systemic approach. SENAI - SP. São Paulo. 2014.

Paim, Rafael. et al. Process Management: thinking, acting and learning. 1st edition, Porto Alegre, Bookman, 2009.

Saucer, Claudio. Process Management in Practice. Leanpub, 2021. Available: http://leanpub.com//gestaoporprocesso – access: March 25, 2021 at 22:00 hours and 45 minutes.

Meadow, Darci. Project Control Planning. 8th edition, New file: Falconi editora, 2014.

Pradella, Simone; Furtado, João Carlos; Kipper, Liane Mählmann. Process Management: from theory to practice. 4th reprint, São Paulo, Atlas, 2016.

Project Management Institute (PMI) A Guide to the Project Management Body of Knowledge (PMBOK Guide)/. Sixth Edition, 2017.

Pimenta, Adinovam Henriques De Macedo Pimenta. Genetic Generation of Type Interval Fuzzy Classifier – 2. Available at: <https://repositorio.ufscar.br/bitstream/handle/ufscar/444/3199.pdf?sequence=1>. Accessed: May 20, 2021.

Ruggeri, Rene G. Project Management in the third sector. Brasport, Rio de Janeiro. 2011.

Slack, Nigel; Brandon-Jones, Alistair. Johnston, Robert. Production management. 8th edition, São Paulo, Atlas, 2018.

Sanches, Arthur Caldeira. Quality management. Cube Evolve, President Prudente, 2019.

Sordi, Jose Osvaldo De; Management by Process: an approach to modern administration. 4th edition, São Paulo, Saraiva, 2014.

Simões, Marcelo Godoy; Shaw, Ian S. Fuzzy Control and Modeling. Blucher: FAPESP, São Paulo, 2007.

Silva, Luciana Maria Da et al. State of the art of the fundamentals and ideas of Fuzzy Logic applied to Science and Technology. Available at: <https://periodicos.utfpr.edu.br/rbgeo/article/view/9365>. Accessed on: April 28, 2021.

Sousa, Carlos Pimentel De. Nebulous Logic; an introduction. 3rd Edition, publisher, 2014.

Sousa. Carlos Pimentel. Fuzzy in Excel. 1st edition, Fortaleza. Federal University of Ceará, 2016.

Tanscheit, Ricardo. Fuzzy Systems. Pontifical Catholic University of Rio de Janeiro.Available at:<http://www.inf.ufsc.br/~mauro.roisenberg/ine5377/leituras/ICA-Sistemas%20Fuzzy.pdf>. Accessed on: April 16, 2021.

Usirono, Carlos Hiroshi, Office of Processes. Brasport, city, 2015.

Valle, Rogério; Oliveira, Saulo Barbara De. Analysis and modeling of business processes. São Paulo: Atlas, 2012.

Weber, Leo; Klein, Pedro Antonio Trierweiler. Application of Fuzzy Logic in Software and Hardware. Ulbra, Canoas, 2003.

Yin, Robert K. Case Study: planning and methods. 5th edition, Bookman, Porto Alegre, 2015.