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Keywords: *quality management system; educational institution; FMEA; PROMETHEE II.*

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Quality Management System in Educational Institutions: Integration of FMEA and PROMETHEE II

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& Luciano Pereira da Silva Santos ^ω

Abstract- Competitiveness is increasingly rooted in organizations. Therefore, the pursuit of excellence in the provision of services has been a challenge for those wishing to occupy prominent positions. This reality is usual in public schools that make decisive decisions in the face of constraints, as resources are limited and need to be well managed. Quality management has been a strategy adopted by many educational institutions in the pursuit of process improvement and has inspired many organizations in this regard. This work intends to be an opportunity for schools experiencing difficulties in implementing and maintaining a Quality Management System (QMS) based on ISO 21001:2018. For this, we propose a model, which aimed to integrate the *Failure Mode Effects Analysis* (FMEA) of the process and the PROMETHEE II method and the adoption of two new criteria (Difficulty for failure mode resolution and Time required for fault mode to be “solved”). The model was composed of alternatives that represent the potential failure modes of Traditional FMEA, which were raised in the literature and through a semi-structured interview with the decision-maker. The differential of this work is in the adoption of two new criteria that differ from those addressed on traditional FMEA: Difficulty in failing mode resolution and Time required for the failure mode to be “cleared.” The application happened in an institution of the integral public education system, located in the State of Pernambuco (Brazil), supported by the Visual PROMETHEE software. In the end, the ordering among the barriers considered most critical to the QMS implementation process was obtained and, there was the development of guidelines to solve them.

Keywords: *quality management system; educational institution; FMEA; PROMETHEE II.*

I. INTRODUCTION

In general, consumers have changed their way of thinking and acting, being more demanding in terms of the search for the added value that products and services can provide them. This change is no different in the educational field, since defining quality in education is not trivial because it involves several functions and activities that directly or indirectly influence the concept.

The growth in the number of public education institutions in Brazil, in recent decades, has driven

studies and research on the dynamics of what has led to this evolution and its influence on the educational development of the country. From this, several opportunities arise on how to improve the management process to guarantee quality in education.

Even with so many different definitions, there is a common understanding that quality in education is not measured only by the performance of students. It is above all, according to Coutinho & Borges (2018), a consequence of well-conducted processes that lead to the expected learning, which offers an adequate for the acquisition of knowledge and well-prepared and instrumentalized teachers for the conduct of students.

According to Cassol *et al.* (2012), the quality of Brazilian education has low-performance rates when compared to other countries in the world. Among the major causes related to this, the same authors mention some: lack of investment efficiency, ill-prepared professionals, lack of adequate school management, etc. Achieving excellence in teaching is today a huge challenge and, schools need to develop different strategies than what has been offered today to achieve this goal.

Santos & Melo (2019) define that quality management is an essential perspective for the development of efficient management, and, increasingly, managers of organizations are complementing their strategic quality planning with the support of the other tools to achieve competitive advantage. In this context, having an effective quality management system (QMS) is essential to maintain a regular supply of high-quality products and services to customers (Zu & Kaynak, 2012).

Therefore, according to Cassol *et al.* (2012), the adoption of a quality management system in education seeks to ensure that planning, organization, control, and leadership are conducted, ensuring assertiveness and continuous improvement of its performance and, especially quality of education, that is the development of student's skills.

Organizations regularly need to make decisions under varying criteria that conflict with each other. Based on this scenario, developing a multi criteria analysis that assists in this process will be of great help

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in minimizing the negative consequences that decision-based on only one criterion can cause.

Consequently, this work seeks to develop a multi criteria analysis to order the most critical failure modes in the process of implementing and maintaining a QMS in a public-school institution. For this, there was the integration between the FMEA of the process and PROMETHEE II.

II. QUALITY MANAGEMENT IN EDUCATIONAL INSTITUTIONS

For the institutions to function correctly, according to Rodríguez-mantilla, Fernández-cruz & Fernández-díaz (2019), they must have enough teachers and resources to carry out their activities. However, such an action does not always happen.

In the last decades, there has been a development and massification of education, which has not always corresponded to the transfer of public funds for education in the same proportions (Parker, 2002). This situation has led educational institutions, in the sense of guaranteeing quality, to seek to do more and better with fewer resources (in relative terms) and has raised issues of management effectiveness and responsibility. For Sahney, Banwet, and Karunes (2004), quality starts with the client and at the same time is conceptualized by the client, so it is up to them to identify and provide the best performance with the resources that the organization has.

In this context, the educational institution that intends to achieve excellence in its services through a quality management system must present specific characteristics (Figueiredo Neto & Rodrigues, 2000): focus centered on its main client, the student; managers' commitment, vision, documented and optimized processes, trained employees to perform tasks, information with quick and correct circulation, concern with innovation and change and strong team spirit.

In the face of all of this discussion, a term widely applied in the practice of quality management in education and which is fundamental to the pursuit of excellence is Total Quality Management (TQM), in other words, it is a management approach used by an organization centered on quality, where the participation of all members is extremely critical and fundamental for the achievement of successful objectives. Wahid (2019) records this fundamental aspect of everyone's involvement to obtain good results at the university, for example.

In this way, TQM can be considered as the basis for the implementation of other improvement approaches. In education, a difficulty pointed out by Xavier (1991) is that the raw material of the processes, the student, is heterogeneous. Each one brings a wealth

of knowledge, customs, cultures, etc., making the exit process a very unpredictable process.

The same author also points out are five points that managers must consider in education in the search for total quality, namely:

- Compliance: the service provided by the institution must be by the previously defined specifications;
- Prevention: involves the measures used by the institution to avoid mistakes made in the process;
- Excellence: refers to meeting quality requirements at all stages of a process, turning a product or service free from defects;
- Mediation: it is the source for decision making since it is necessary to measure actions and results to find opportunities for improvement;
- Responsibility: the need for everyone involved in the institution to understand their responsibility for the functioning of the process.

On the other hand, some difficulties may arise in this attempt to get closer to the characteristics of TQM, requiring strong attention from the manager on the following points: passivity of management, change of objectives, search for immediate results, changes in administration, among others.

a) NBR ISO 15419 AND ISO 21001

The ISO 9001 Standard contains the requirements for an organization to have its QMS certified. The scope and generality of this standard do not take into account particular and peculiar aspects of the different types of organizations and, therefore, the terminologies are generic

Thus, one of the prime difficulties in applying the ISO 9001 standard in the educational area was terminology. Hence the decision to develop a document that would offer the guidelines and enable establishments to improve management, and consequently, education.

From this, the ABNT (Brazilian Association of Technical Standards) standard NBR ISO 15419 came to be, which aims to facilitate the comprehension and interpretation of the requirements of ISO 9001 under the understanding of the organizations involved as an educational sector, using the specific terminologies of this sector.

However, in May 2018, ISO 21001:2018 was launched, which was the first edition of the international standard for management systems for educational organizations (EOMS). The Portuguese version of the norm was due to be launched in 2019. The main goal of this standard is to be a management tool, prevalent to educational organizations, to respond to the expectations of interested parties. All requirements of ISO 21001:2018 are generic and any educational organization can apply it.

While educational organizations and students are the main stakeholders and beneficiaries of this

document, all other stakeholders will also gain from standardized management systems in educational organizations.

Among the potential benefits that an organization can obtain with the implementation of an EOMS, we can mention, according to Nogueira (2018): better alignment of objectives and activities with police, greater social responsibility, more personalized learning and effective response to all students, consistent processes and assessment tools to demonstrate and increase effectiveness and efficiency, greater organization credibility, culture for organizational improvement, etc.

III. FMEA IN THE CONTEXT OF QUALITY MANAGEMENT

Santos & Melo (2017) define that FMEA is a valuable team activity that can help in the creation or restructuring of a quality assurance program with to improve safety, quality, and efficiency.

FMEA is a tool widely used to obtain good results both in the product and in the process. For Rabelo, Silva & Peres (2014), the FMEA methodology is put in place to define and prioritize the corrective methods in a project, thus becoming aware of the critical, significant characteristics and, finally, developing a checklist of prevention for failures. According to Kibria, Kabir & Boby (2014), the successful activities by FMEA facilitate the identification of failure mode according to experiences, reducing cost and development time.

According to Ford *et al.* (2014), despite being valuable, the FMEA also has some crucial limitations that must be appreciated, one of which is the inability to identify all possible failure modes. Therefore, it is possible to see FMEA as complementary to other improvement methods and tools.

This tool takes into account the use of import elements: type of potential failure, the effect of possible fail, cause of the failure, current controls, indexes, recommended actions, implemented measures, preventive actions, containment actions, etc.

Santos & Melo (2019) point out that the faults considered most critical will be the first in the ranking, thus being a priority for the application of improvements. The determination of the risk priority index (Risk Priority Number – RPN) is performed based on the product between three indices defined by Liao & Ho (2011):

- Severity (S): indicates the degree of impact caused by the failure of an individual component or procedure;
- Occurrence (O): indicates the degree of the frequency with which a defeat can occur;
- Detection (D): indicates the degree of impact caused by the fail that cannot be detected.

In this specific work, where the process of implementing a QMS in an institution of the public

education system was analyzed, the process FMEA was used, which after collecting the main flaws/difficulties found in the literature and through a semi-structured interview with the institution's manager, it analyses their criticality about the process of implementing a QMS based on ISO 21001:2018 standard.

Due to the complexity of the QMS implementation process, the study of the main failure modes requires a multicriteria analysis, since it is difficult to make a decision based only on one criterion and, in most cases, these criteria are in conflict with each other.

IV. MULTICRITERIA DECISION METHODS

The purchase of consumer goods, personal items, household appliances, and even the choice of an educational institution are problems faced daily by people. The solution to many of these types of difficulties is, in most cases, based on a single decision parameter, cost. Nevertheless, not all decisions are summarized just in this, which leads the decision-maker to seek the best decision support methods that satisfy his application needs.

The first methods of decision support started to emerge, in estimation, around the 70s, which for Olson (2001) the development of comparative research about the methodology of support for the multicriteria decision, has been showing that there is not one that stands out from the other, involving the entire context of the decision. Thus, it is up to the decision-maker to use the best method for that specific situation.

For Cavalcanti & Almeida (2005), we can see multicriteria decision support as a set of methods that lend themselves to clarify a problem, in which multiple criteria evaluates the alternatives, which are normally conflicting.

Gomes Júnior *et al.* (2011) put out that the main factors analyzed in choosing a multicriteria decision support method are analysis of the context, actors, and preference structure associated with the problem.

a) PROMETHEE II

The family of PROMETHEE methods aims to build a relationship of Outranking; this family adds information between the alternatives and the criteria and uses this relationship to support the decision. In PROMETHEE, the decision maker's preference in favor of one option over another option b increases with a bigger difference $[f_i(a) - f_i(b)]$ between the performance of the choices for each criterion j and $f_i(a)$ and $f_i(b)$, respectively, are the values of the performance of the options a and b in criterion j.

Brans and Vincke (1985) presented six different ways to determine such a preference, which have values between 0 and 1 from the definition of the general functions, or preferably. Type I – Usual Criterion, Type II- U-Shape Criterion, Type III- U-shape Criterion, Type IV- Level Criterion, Type V- Linear Criterion, and Type VI –

Gaussian Criterion are the classifications of these functions.

The PROMETHEE II, the focus of the work, took the non-compensatory hypothesis, which tends to favor more balanced alternatives (alternatives that have reasonably good ratings in all criteria) and provides a cardinal score for each proxy that is possible to use to develop a pre - complete order.

This method ranks the alternatives, establishing an order of $\Phi(a) = \Phi^+(a) - \Phi^-(a)$ (liquid flow); establishes a complete pre-order among the alternatives. (BRANS & VINCKE, 1985; BRANS & MARESCHAL, 1992; TALEB & MARESCHAL, 1995):

V. PROPOSAL AND APPLICATION OF THE MODEL

The proposed model aims to integrate FMEA and PROMETHEE II, wanting to order the difficulties (from the most critical to the least critical) encountered in the process of implementing and maintaining a QMS, based on ISO 21001:2008, in an institution of the public comprehensive education network in the city of Bezerros, in the rough Pernambuco state.

For the construction of the model, it was necessary to identify the alternatives and the criteria that will go under evaluation, as well as their particularities, to then be applied with the aid of the Visual PROMETHEE software, and thus, obtain what is expected of it more effectively.

a) Description of the Education Institution of the Case to be Applied

The studied school has been operating since 2012. High school has integrated technical courses in

the areas of Administration and Maintenance and Computer Support.

The installed capacity of the school follows the standard of state technical schools in the state of Pernambuco, Brazil, and has twelve classrooms, six laboratories, two specific laboratories, for craft courses, an auditorium, a library, a multisport court (covered and with a changing room), a coffee shop, canteen, and a living area.

The school is not certified by ISO 21001:2018, but it is concerned with developing its activities with a focus on quality so that it can effectively serve interested parties. The manager has excellence as a priority and works with the expectation of making the school recognized by society as a reference for professional education.

b) Alternatives

Some results, gathered from the literature, were presented to the decision-maker regarding the biggest obstacles in the process of implementing and maintaining a QMS in organizations as a whole. Also, the authors conducted a semi-structured interview with the institution's manager, who addressed the five fundamental points that must be considered in education in the search for total quality, in addition to taking into account elements such as infrastructure, information exchange process, the role of the state, involvement of families, etc. From this, it was possible to identify new failure modes for the multicriteria analysis.

At the end of this stage, the authors raised the eleven main difficulties that the manager has encountered, as shown in Table 1.

Table 1: Model alternatives

Label	Alternatives	Source
A1	State bureaucratic requirements	Educational Institution Manager and MokhtarSanyet <i>et al.</i> (2013)
A2	Lack of resources	Biasini (2012); Tanabe & Souza (2006);
A3	Failure to communicate with teachers	Educational Institution Manager and Beer (2003) and Klein & Sorra (1996)
A4	Staff demotivation	Biasini (2012); Tanabe & Souza (2006); Beer (2003); Taylor & Wright (2003); Klein & Sorra (1996)
A5	Change in school culture	McLean & Antony (2014); Beer (2003); Klein & Sorra (1996); Biasini (2012); Tanabe & Souza (2006); Fleury(1993).
A6	No internship requirement for technical courses offered by the school	Educational Institution Manager, Taylor & Wright (2003) and MokhtarSanyet <i>et al.</i> (2013)
A7	Low family participation in monitoring children at school	
A8	Insufficient full-time staff	
A9	Lack of a team of psychology professionals	
A10	Resistance by the outsourced team of general services	
A11	Not knowing the demands of students regarding the technical courses offered by the school	

Source: The authors (2020)

c) *Criteria*

According to Roy (1996), we can understand a criterion as being a tool that allows the comparison between alternatives according to the point of view or from the perspective of significance.

Given that there are many sceneries that may require different levels of importance, the decision model must consider the subjectivity of the decision-maker for decision making. This approach is not common to traditional FMEA.

So, through the semi-structured interview, the decision-maker understood the definition of the criteria and considered the following criteria for this model:

- The occurrence of failure mode (O);
- Possibility of the failure not being detected (D);
- The severity of disaster (S);

- Difficulty in resolving failure mode (DIF);
- The time required for the failure mode to be “eliminated” (T).

Given the chosen criteria, it is indispensable to clarify that the first three (occurrence, detection, and severity) refer to the traditional FMEA and that the choice for the last two (difficulty and time) was so that there would be a substantial contribution to the analysis, further refining the assessment made through the FMEA and making the study more robust and refined.

For each of these criteria, the objective (minimizing and maximizing), weight (importance), and the preference function were established by the decision-maker, as shown in Table 2.

Table 2: Details of the criteria

Criteria	Objective	Weight	Preference Function
Occurrence	Maximizing	0,2	Usual
Detection	Maximizing	0,1	Usual
Severity	Maximizing	0,3	Usual
Difficulty	Maximizing	0,2	Usual
Time	Maximizing	0,2	Usual

Source: The authors (2020)

The evaluation of the weights attributed by the decision-maker occurred in a direct (interactive) way. The authors based the objective chosen for each criterion on the Likert scale used to assist in the identification of its criticality regarding the alternatives (Tables 3, 4, 5, and 6). To find the most critical flaws, the authors established to maximize the resolution time in months. For the criteria of occurrence, detection,

difficulty, and severity, the objective chosen was also the maximize, as the values of the nominal scales of the software are different comparing to those of the model (Table 3, 4, 5 and 6), in which very bad =1 and very good=5. Then, as you maximize the best outcome from the software, you also maximize the most critical result from the model.

Table 3: Scales used to determine the occurrence of failures

Occurrence		Likert Scale
Unlikely	It rarely occurs in the process	1
Too Small	Failure occur, but not too often	2
Moderate	Sometimes the cause of failure during the process occurs	3
High	Failure occurs quite frequently during the process	4
Alarming	It occurs routinely during the process	5

Source: Santos & Melo (2019)

Table 4: Scale used to determine failure detection

Detection		Likert Scale
High	The failure is immediately identified in the process as a decisive factor for the good functioning of the QMS	1
Moderate	The failure is easily identified in the QMS implementation process	2
Small	The failure is commonly found, but not in most areas	3
Too Small	The failure is is only visible in some areas	4
Unlikely	The presence of a failure is in the QMS implementation process is rarely noticed.	5

Source: Santos & Melo (2019)

Table 5: Scales used to determine the severity of failures

Severity		Likert Scale
Just Noticeable	The failure is not important, becoming irrelevant to the QMS implementation process	1
Little Importance	The failure exists, but it does not hinder the the operation of the QMS implementation process	2
Moderate	The failure exists and even though it is not so alarming, it contributes together with other flaws so that at least 50% of the functioning of the QMS implementation process is compromised	3
Serious	The failure exists and is already seen as an alarming factor that contributes together with other flaws, so that at least 80% of the functioning of the QMS implementation process is compromised	4
Very Serious	The failure exists and prevents the QMS implementation process from working	5

Source: Santos & Melo (2019)

Table 6: Scales used to determine the difficulty in solving failure modes

Difficulty	Likert Scale
Too Small	1
Small	2
Moderate	3
High	4
Very High	5

Source: Theauthors (2020)

The time necessary criterion for the failure mode to be “eliminated” was the only one not to use a five-point Likert scale since it was attributed to it the expected number of months that each alternative would take to be solved.

d) Application of the Model on Visual Promethee

The authors used Visual PROMETHEE software. To apply the model to the software, the traditional FMEA table (considering the criteria chosen for the model) was elaborated together with the decision-maker through an

interactive process, to collect information about the controls that the institution has currently to detect and prevent failure modes. Also, there was the discussion about possible preventive actions to solve these failures. Then, the manager assigned the score for each alternative based on the scales established for each criterion and settled the number of months that would be needed to solve the potential failure modes for the time criterion. Tables 7, 8, and 9 present the result of the FMEA application.

Table 7: Application of FMEA part 1

POTENTIAL FAILURE MODE	EFFECT (S) OF POTENTIAL FAILURE	SEV. (S)	POTENTIAL CAUSE (S) OF FAILURE	OCCUR. (O)	CURRENT PREVENTION CONTROL	DETEC. (D)	CURRENT DETECTION CONTROL	DIFFIC. (DIF)	TIME (T)	RECOMMENDED PREVENTIVE ACTION
Government bureaucratic requirements	Spends more time with the bureaucratic and less with the pedagogical	3	Business management applied in education	4	Demand distribution with the management team	2	There is not	4	12	Higher number of servers in the administrative part
Lack of resources	Lack of educational support material and maintenance	4	Delays in transfers and insufficient amounts	4	There is not	1	There is not	5	6	Regularize onlending and correct amounts
Failure to communicate with teachers	Lack of alignment in actions	2	Lack of standardization of the communication process	3	Confirmation of receipt of information by the messaging application	4	In stock valuations	3	2	Establish unified communication mechanisms
Staff demotivation	Low profit	2	Overwork and low pay	2	Ongoing training and pedagogical meetings	4	Bimonthly monitoring	3	6	Optimization of workload and career enhancement

Source: The authors (2020)



Table 8: Application of FMEA part 2

POTENTIAL FAILURE MODE	EFFECT (S) OF POTENTIAL FAILURE	SEV. (S)	POTENTIAL CAUSE (S) OF FAILURE	OCCUR. (O)	CURRENT PREVENTION CONTROL	DETEC. (D)	CURRENT DETECTION CONTROL	DIFFIC. (DIF)	TIME (T)	RECOMMENDED PREVENTIVE ACTION
Change in School Culture	Low acceptance	2	Lack of co-responsibility of school actors	3	Family meeting at school and parent and teacher meeting	4	Evaluation of family and parent and teacher meetings	3	12	Systematic planning to raise awareness among school actors
No internship requirement for technical courses offered by the school	More theoretical and less practical training	2	Change in legislation	3	Provide opportunity for contact with practice	5	Monitoring the professional life of graduates	5	12	Establish elective courses that enable professional practice
Low family participation in monitoring children at school	Lack of follow-up in students' academic life	3	Culture of non-responsibility	4	Family meeting at school and parent and teacher meeting	2	Evaluation of family and parent and teacher meetings	2	12	Planning attractive and differentiated actions for parents and guardians
Insufficient full-time staff	Non-availability of full-time professional	3	Existence of hired professionals	3	Request for full-time professionals	3	Elaboration of bimonthly plans	3	6	Location of full-time teachers to attend 100% of the workload

Source: The authors (2020)

Table 9: Application of FMEA part 3

POTENTIAL FAILURE MODE	EFFECT (S) OF POTENTIAL FAILURE	SEV. (S)	POTENTIAL CAUSE (S) OF FAILURE	OCCUR. (O)	CURRENT PREVENTION CONTROL	DETEC. (D)	CURRENT DETECTION CONTROL	DIFFIC. (DIF)	TIME (T)	RECOMMENDED PREVENTIVE ACTION
Lack of a team of psychology professionals	Large number of students with psychological problems	4	No function in schools	5	Monitoring of students and family orientation	3	Pedagogical support	5	12	Establish partnerships with entities and / or professionals in the field
Resistance by the outsourced team of general services	Lack of professional performance	4	Political interference in nominations	4	There is not	1	There is not	4	6	Selection of professionals by curriculum and experience
Not knowing the demands of students regarding the technical courses offered by the school	Offer of courses that do not meet local interest	2	Criteria for choosing courses	3	There is not	5	There is not	2	12	Optimization of the criteria for choosing the courses offered

Source: The authors (2020)

From this assessment, the Visual PROMETHEE software used pertinent information from the FMEA (Tables 7, 8, and 9) and Table 2. Following the procedures of the PROMETHEE II method, the table 10

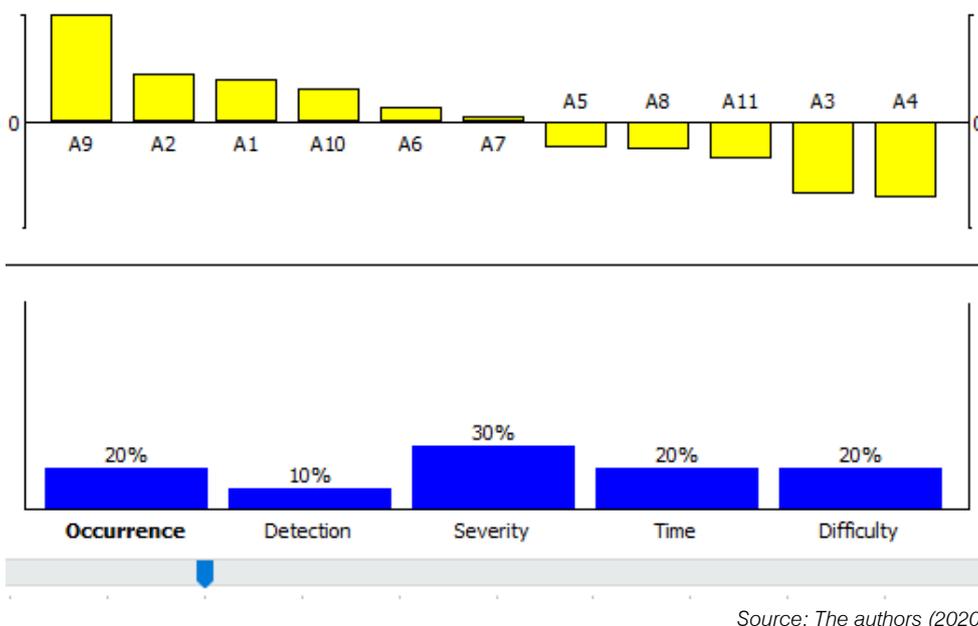
presents positive, negative, and net flows. And, from that, the general ranking was obtained. Table 10 shows these results.

Table 10: Ranking of the alternatives and the PROMETHEE II flows

RANKING	ALTERNATIVE	Φ	$\Phi+$	$\Phi-$
1	A9	0,6900	0,7400	0,0500
2	A2	0,3100	0,5400	0,2300
3	A1	0,2700	0,5100	0,2400
4	A10	0,2100	0,5000	0,2900
5	A6	0,0900	0,3700	0,2800
6	A7	0,0300	0,3900	0,3600
7	A5	-0,1800	0,2200	0,4000
8	A8	-0,1900	0,2700	0,4600
9	A11	-0,2500	0,2100	0,4600
10	A3	-0,4800	0,1200	0,6000
11	A4	-0,5000	0,1200	0,6200

Source: The authors (2020)

In addition to the result shown in Table 10, the graphical form is helpful to visualize the behavior of each alternative, as shown in Figure 1.



Source: The authors (2020)

Figure 1: Behavior of each alternative

The upper part of the figure is a bar graph showing the complete ranking of PROMETHEE II, expressed as a net flow. The lower part, which is also a bar graph, shows the weights of the criteria.

attributing other weights to the criteria. In setting 1, the decision-maker is unable to express his preferences. Scene 2 is a variation of the distinct two contexts. Tables 11 and 12 show the characteristics of the situations and the comparison of the rankings obtained through them, respectively.

That done, the authors purpose an analysis of scenarios to understand the behavior of the model when

Table 11: Evaluated scenarios

Scenarios	Criteria Weights				
	O	D	S	DIF	T
Real Scenario	0,2	0,1	0,3	0,2	0,2
Scenario 1	0,2	0,2	0,2	0,2	0,2
Scenario 2	0,15	0,15	0,4	0,1	0,2

Source: The authors (2020)

Table 12: Comparison of scenario results

Ranking	Real Scenario	Scenario 1	Scenario 2
1	A9	A9	A9
2	A2	A6	A2
3	A1	A1	A1
4	A10	A2	A10
5	A6	A10	A7
6	A7	A7	A6
7	A5	A5	A8
8	A8	A11	A11
9	A11	A8	A5
10	A3	A3	A4
11	A4	A4	A3

Source: The authors (2020)

It shows that the alternative A9 remained in first place in the ranking of the three scenarios, which emphasizes the importance of developing actions to solve it. Similarly, alternatives A3 and A4 occupied the last positions in the three scenes.

VI. FINAL CONSIDERATIONS

The model consisted of performing the integration between the FMEA of the process and the PROMETHEE II method. For this, there was the adoption of two new criteria in addition to those addressed in the calculation of the RPN: Difficulty in resolving the failure mode and Time required for the failure mode to be "eliminated." This inclusion served to refine the model, further optimizing the results.

The application of the model made it possible to identify the failure modes considered most critical in the implementation and maintenance stages of the school's QMS. As a result of the real scenario, the alternative that ranked first in the ranking was A9, followed by A2 and A1, consequently.

The A9 alternative obtained a much higher net flow compared to the others, which deserves to highlight the importance of developing actions that can solve it since the lack of a team of psychology professionals directly affects the performance of students and collaborators. Therefore, the presence of this type of professional would significantly assist in carrying out a making better use of the school's activities.

In general, alternatives A2 and A1 do not depend directly on the school to be solved, occupying the first positions in the ranking. As much as there is an interest in solving them, the lack of resources and state requirements demand external and sometimes complex actions, which leaves the school in a delicate situation, needing to develop internal mechanisms to solve it or it minimizes the impacts of these failure modes.

On the other hand, the alternatives A3 and A4 occupied the last positions of the ranking, which does not make them less significant, but at the beginning, they are not a priority. As much as they deal with the failure to communicate with teachers and demotivate staff, these obstacles happen in some specific and isolated cases since, in most cases, the school strives for adequate communication and motivation of employees.

The work brought an innovative feature since the type of approach taken in is uncommon in the literature. Through it, public and private institutions can rely on developing their models, with the necessary modifications.

Wherefore, the studied school can develop action plans aimed at alternatives that hinder the process of implementing and maintaining the QMS and, with that, be certified by ISO 21001. Through this, its results will be even more considerable, and the school

will become a source of benchmarking to other educational institutions in the region and the country.

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