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Improvement alternatives for monitoring the efficiency of industrial operations from the perspective of strategic indicators: a case study in a metal-mechanic industry in western Santa Catarina

Alternativas de melhorias para o monitoramento da eficiência de operações industriais sob a ótica de indicadores estratégicos: estudo de caso em uma indústria do setor metalmecânico do oeste catarinense

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Abstract

This paper aims to demonstrate the applicability of multicriteria methods in managerial decision-making in the industrial sector, more precisely in a metalworking company. The multicriteria method adopted was the Analytic Hierarchy Process (AHP) by first seeking observations from the manager's perspective regarding the efficiency of industrial operations in their production processes to evaluate alternatives for improving the efficiency of operations with emphasis on strategic indicators. Meetings were held with the manager to build the criteria and identify alternatives to validate the generated model to carry out the study. The application of the AHP method allowed for prioritizing the most efficient strategic indicators, presenting the training indicator criterion, followed by the criterion represented by the rework indicator, considered by the manager as extremely important. During the interview, the manager emphasized the direct and positive connection of employee training with production performance and, consequently, quality. The data was collected in the field, and the results obtained were validated in dialogue with the manager of the industry analyzed.

Keywords: operations management; strategic indicators; case study; multicriteria decision support (AHP).

Resumo

O presente trabalho tem como objetivo demonstrar a aplicabilidade dos métodos de multicritério em tomadas de decisões gerenciais no setor industrial, mais precisamente em uma empresa do setor metal mecânico. O método de multicritério adotado foi o AHP (Analytic Hierarchy Process), buscando primeiramente através de observações um olhar sob a perspectiva do gestor quanto a eficiência das operações industriais em seus processos produtivos com o intuito de avaliar as alternativas de melhoria na eficiência das operações com ênfase em indicadores estratégicos. Para a consecução do estudo, houve a condução de reuniões junto ao gestor para a construção dos critérios e identificação das alternativas buscando validar o modelo gerado. A aplicação do método AHP permitiu priorizar os indicadores estratégicos mais eficientes, apresentando o critério indicador de treinamento, seguido pelo critério representado pelo indicador retrabalho considerados pelo gestor de extrema importância, sendo que ao decorrer da entrevista foi salientado pelo gestor a ligação direta e positiva do treinamento dos colaboradores com o desempenho da produção e consequentemente da qualidade. Os dados foram coletados em campo e os resultados obtidos foram validados em diálogo com o gestor da indústria em análise.

Palavras-chave: gestão de operações; indicadores estratégicos; decisão multicritério (AHP).

1. INTRODUCTION

The process of decision-making has become increasingly complex in the face of current transformations where the demands have been changing day after day, thus highlighting the need for optimization of costs, expenses, and profits in search of optimization of the processes of organizations (GOMES, 2014; ANDRADE, 2015).

According to Andrade (2015), methods and mathematical models can determine and allocate resources optimally. From this perspective, evaluating strategic indicators for monitoring the efficiency of an industry's operations can assist managers' decision-making process. Hence, various authors corroborate that understanding the prioritization of criteria and alternatives is essential for more assertive decision-making (ANDRADE, 2015; SOUZA, 2016). This study uses the Analytic Hierarchy Process (AHP) method to assist in multicriteria decision-making in search of monitoring the efficiency of operations, aiming at continuous improvement through the indicators of training, rework, quality, and production in a company in the metal-mechanic sector in western Santa Catarina State.

The results are based on real data from the industry analyzed obtained through meetings with the decision maker, where the criteria and alternatives analyzed were defined. Therefore, the theme of this study is the proposal of an evaluation model of performance indicators for the metal-mechanic sector through a decision support instrument to monitor the efficiency of industrial operations.

It is also added that to solve a problem or a demand, it is necessary to structure the problem by separating the goals and objectives, the criteria and subcriteria, ending with the judgment made by the decision maker or decision makers, and lastly, the priorities (OLIVEIRA & MARTINS, 2015). In this context, we seek to answer the following question: Which indicator can be considered more strategic for monitoring the efficiency of industrial operations of a company in the metal-mechanic sector in western Santa Catarina?

2. THEORETICAL FRAMEWORK

2.1 Decision support methodology

The decision can be defined as the process of analysis and choice among several available alternatives that the decision-maker must follow. In this context, the decision support method is listed as priorities, multicriteria, analytical models, and mathematical models in search of the choice to make decisions (OLIVEIRA AND MARTINS, 2015).

The method for building the Multicriteria Decision Model was chosen, where the AHP method was used by utilizing an excel spreadsheet to evaluate the weights of the criteria and alternatives. This is because it is possible to develop a spreadsheet through Microsoft Excel using formulas to solve the matrices created, including to obtain the consistency index and the eigenvector, when the decision-making is individual for a single manager, as in the case of this study, since it is difficult to make a sensitivity analysis and group decision making through Microsoft Excel.

In the classical AHP method, the problem or demand is divided into three steps where logical analysis will be applied: structuring the decision hierarchy. The problem is divided into hierarchical levels, which are the objective, criteria, and alternatives. In this step, the main elements for decision-making are identified. The second step consists of the definition of priorities and logical consistency, that is, the ability to establish a logic capable of relating its level of consistency.

The proposed approach of the study prescribes the aggregation of criteria in a non-compensatory manner. This way, we try to avoid that negative evaluations in some criteria are compensated by very positive evaluations in others (or vice-versa), which can happen in the original model of the Situational theory, which is compensatory and where evaluations are aggregated employing a weighted sum. Hence, among the different MCDA methods, the AHP was chosen since its characteristics apply to the problem's structure and the decision maker's context.

2.2 Metal-mechanic sector

The metal-mechanic sector in Brazil is of great importance and relevance due to the increasing expansion of commodities exports corroborating the Brazilian trade balance surplus at the same time that the loss of competitiveness has been the agenda of debates and great concern due to the significant increase in imports of Chinese products in the domestic consumption directly affecting the performance of the metal-mechanic chain (SOUZA et al., 2013). Moreover, the representativeness of the metal-mechanic sector in the Brazilian economy is also due to the number of investments made by the sector and jobs generated.

Thus, meeting one of the work's specific objectives, the company's current performance profile under analysis was evidenced, given its status quo evaluated its production process through a technical visit, where operational processes were managed. The industry analyzed is located in the far west of Santa Catarina State in a city with 5,000 inhabitants due to logistical issues for being far from ports and airports, suffers from the lack of suppliers of raw materials and service providers.

Notably, the industry uses a German technology, which is being improved in Brazil through the productive systems, leveraging this way and in full expansion and producing about 100 implements per year with values that vary from BRL 400,000.00 to BRL 780,000.00. As for its production process, we highlight laser cutting, bending, boilerworks, machining, pre-assembly, painting, and final assembly. The flagship product is a frontal-hydraulic head, where the transmission of power from the tractor to the forage harvester is performed for the processing of green forage. The implementation increases the efficiency in harvesting and grinding corn for silage processing, thus increasing the productivity of the rural producer's fieldwork.

The industry's main concern under analysis is the shortage of specialized labor. The company has to develop professionals internally, which generates a high cost with hours of training and significant losses with unproductivity and rework, thus hindering the sustainable growth of the business.

From the perspective of the performance indicators analyzed, it was possible to see that the lack of professional development significantly impacts the expansion of operations.

3. METHODOLOGY

In this paper, the classic AHP method was used, which presents a structured way to establish the objectives and criteria hierarchically, analyzing all criteria and alternatives and then proposing the best result to monitor the efficiency of the industry's operations through the indicator with the best result.

Among the various methods, the AHP method was chosen for operational decision-making because of the search for greater efficiency in industrial operations since the AHP is one of the most used methodologies for decision-making with multicriteria. This method was selected for its ability to evaluate alternatives qualitatively and quantitatively, where the different criteria are the different impacts capable of identifying the causes and their various consequences.

According to Oliveira and Martins (2015), the classical AHP method developed by Thomas Lorie Saaty around the 1970s ranks alternatives using pairwise comparison, where alternatives and criteria are analyzed to find the best outcome for the organization's demand.

The methodology used to apply the AHP multicriteria decision-making method to choose was the most appropriate indicator to monitor the efficiency of operations. To assist in this decision-making, the study presented by this article will demonstrate four indicators: training, rework, quality, and production. The approach of this article is quali-quantitive since it transforms qualitative judgments into numbers, that is, into a numerical scale.

In order to achieve the proposed objective, this study was separated into three stages, the definition of the company to be analyzed, the weighting of criteria, and the ranking of alternatives; with previous analysis of the industry, the researcher verified vital points that demanded improvement. Using the theoretical basis, it was possible to propose alternatives that can help the industry analysis to monitor its industrial operations' efficiency. Next, the distinct indicators to be analyzed in the industry were listed: training, rework, quality, and production indicators.

Thus, data collection and analysis occurred as follows: the first step occurred with the industry through the criterion of convenience, where a preliminary company assessment occurred. In the second step, the company's production process was evaluated. Then, the alternatives and criteria for monitoring the efficiency of the company's operations from the standpoint of the strategic indicators for monitoring the efficiency of the company's operations were defined. From this, the decision maker was defined, thereby adding the criteria and alternatives and conducting the interview with the decision maker.

The interview was conducted with the decision maker, who has the youngest profile (37 years old and occupies the position of manager and director of the organization). The company analyzed in this study has around 30 years of existence and an organizational chart, where the manager is assigned the responsibility and authority of the decision-making process.

The judgments were built through an interview with the industry manager, thus building a decision tree for selecting the most appropriate indicator to achieve industrial operations' efficiency. The next step was to identify the multiple objectives of the decision problem. In this step, the identification, structuring, analysis, and understanding of the relevant objectives (strategic, fundamental, and middle objectives) was performed in such a way as to guarantee the quality of the decision-making process.

The solution found through the decision-making process aims to achieve the main objective of the industry studied, which is to evaluate the strategic indicators for monitoring the efficiency of its industrial operations. In order to achieve the main objective, the middle objectives are outlined, which are:

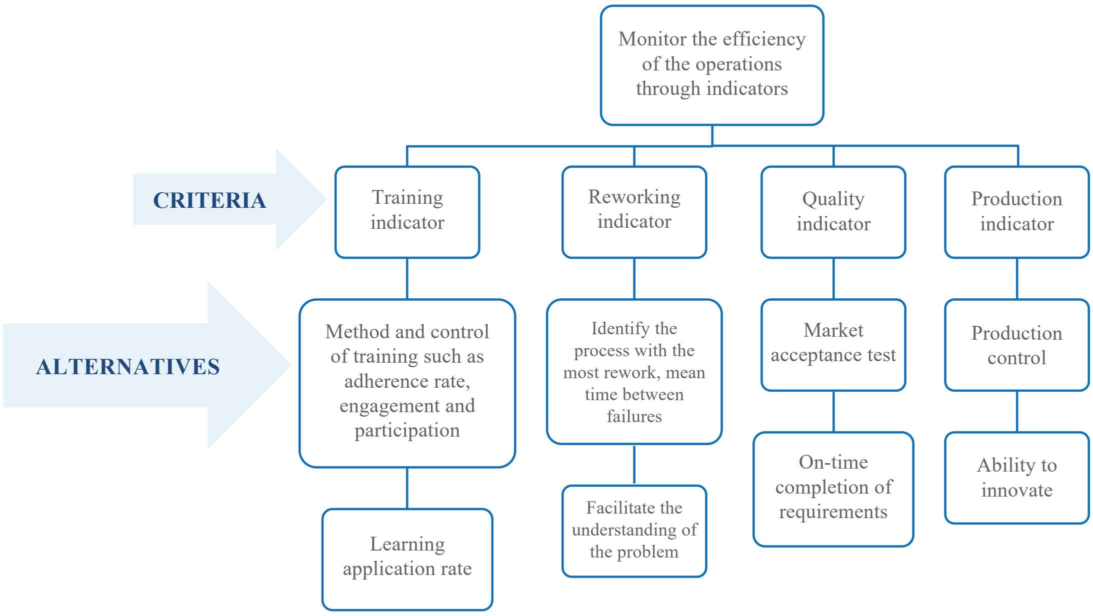
- Identify the performance indicators used by the industry;
- Evidence of the current performance profile (status quo) of the industry analyzed;
- Diagnose the impact of training, rework, quality, and productivity indicators in the industry;
- Analyze the existing relationships between the indicators and the efficiency of the industrial operation.

Thus, the criteria associated with each objective were established, as well as the structuring in hierarchical levels and definition of weights and priorities. As described by Keeney and Raiffa (1993), the criteria representing the objectives in the modeling process are established from each objective defined in the previous step. For each defined objective, a variable is established to measure the level of performance with which the objectives should be achieved. In the same context, clarifying the decision criteria allows for later identification of the set of potential alternatives (DE ALMEIDA, 2013).

3.1 Possible alternatives

The criteria and alternatives can be seen in Figure 1.

Figure 1 - Criteria associated with the alternatives listed to the general objective of the study



Source: The author (2022)

According to Saaty and Shih (2009), the hierarchy is first created to describe the problem, starting with the global objective at the top and then decomposing it into parts, similar to the structure of a tree, with the global objective as the root. Comparisons are expressed in linguistic/verbal terms converted into numerical values using the Saaty Scale for comparative judgments.

The values of this scale are given in 9 points, and the comparisons express verbal terms converted into numerical values through the Saaty Scale for comparative judgments that measure the degree of importance of the elements listed in the study, as shown in Table 1.

Table 1 - Saaty Scale

ESCALA	AVALIAÇÃO	RECÍPROCO
extremamente preferido	9	1/9
muito forte a extremo	8	1/8
muito fortemente preferido	7	1/7
forte a muito forte	6	1/6
fortemente preferido	5	1/5
moderado a forte	4	1/4
moderadamente preferido	3	1/3
igual a moderado	2	1/2
igualmente preferido	1	1

Source: Saaty (2008)

After establishing the criteria for judgments and using this information to calculate the weights, it will be possible to analyze the consistency of the information. Consistency is when all other data can be logically deduced from an amount of raw data from a given base. Sometimes the values can turn out to be inconsistent. Given this, Saaty develops procedures that allow judgments to be evaluated for consistency.

4. DISCUSSION OF THE RESULTS

Through an evaluation performed by the industry manager, it was possible to find the best alternative, given the other options of indicators, that will contribute to a better performance of the industry by monitoring the efficiency of operations. Table 2 shows the results of the criteria matrix.

Table 2 - Calculation of the consequence matrix - pairwise comparison ranked by criteria

Monitor the efficiency of operations through of indicators	Training indicator	Rework indicator	Quality indicator	Production indicator	Priorities
Training indicator	1	3	1	5	**0.480**
Rework indicator	1/5	1	3	5	**0.337**
Quality indicator	1/5	1/3	1	1	**0.182**
Production indicator	1/7	1/5	1/5	1	**0.049**
	1.543	4.533	5.200	12.000	

Source: The author (2022)

This stage evaluates which preference structure is the most appropriate for representing the decision maker's preferences concerning the set of consequences and adequate rationality. For this problem, the decision maker can express preference relations under a strict preference (P) and indifference (I) structure (ROY, 1996), there being no incomparability, confirming that such preferences among alternatives follow the properties of orderliness and transitivity (VINCKE, 1992; ROY, 1996).

Compensatory rationality of the decision maker in the problem was also identified since it is necessary to balance the set of required needs in terms of a trade-off between criteria, being acceptable the compensation of lower performance of an alternative in one criterion by a better performance in the other criteria.

This need to make trade-offs between conflicting factors to find the best option becomes relevant when suppliers' offers present contradictions between criteria. For instance, the supplier with the lowest price may not simultaneously have the best quality, or the supplier with the best quality may not be able to deliver within a short time interval (AISSAOUI, HAOUARI, & HASSINI, 2007).

To make the intracriteria evaluation, the functions used values that vary on a scale from 0 to 1. The criteria to which weight 1 was assigned are the most relevant for a given indicator, and so each one is evaluated successively. This normalization procedure is widely used for multicriteria evaluation.

To evaluate the order of relevance of the criteria, the additive deterministic model was used. It was considered that all indicators have the same weight from 1 to 9 each. The criterion that presents the highest global value will be the most relevant to the solution; thus, we have the order of importance of the criteria.

The intracriteria evaluation stage is directly related to the criteria established at the start of the decision-making process since it is the attribute that will direct the evaluation scale. The intracriteria evaluation is the stage where the scales for criteria evaluation are determined since the method must be standard to assist in the decision in an egalitarian manner (ALMEIDA, 2013). Thus, criteria were calculated as judgment weights of the established alternatives.

Table 3 - Criteria matrix

Monitor the efficiency of the operations through indicators	Training indicator	Rework indicator	Quality indicator	Production indicator
Training indicator	1	3	1	5
Rework indicator	0.200	1.000	3.000	5.000
Quality indicator	0.200	0.333	1.000	1.000
Production indicator	0.143	0.200	0.200	1.000
Weight	**0.480**	**0.337**	**0.182**	**0.049**
			Consistency ratio	0.02343
			Consistency index	0.021086535

Source: The author (2022)

The first judgment made with the manager was inconsistent, so a new round was made since his first judgment was inconsistent about his decisions. Then in this new round, the consistency of the judgments was verified after performing pairwise comparisons. The AHP method used in this study calculates the CR (consistency ratio) compared to the CI (consistency index) of the matrix of proposed judgments through the RI (consistency index of a random matrix). According to Saaty (2012), the values are calculated according to the size of the different matrices, as shown in Table 1.

Consistency ratio (CR): is the calculation that allows one to evaluate the inconsistency in the function of the performed judgments through the equation: CR = CI IR, where: CI is the consistency index and RI is the random index. The Random Index is the consistency index obtained for a reciprocal random matrix, presenting non-negative elements for several N matrix sizes.

Table 4 - Random consistency index

MATRIX DIMENSION	1	2	3	4	5	6	7	8	9	10
RANDOM INCONSISTENCY	0	0	0.58	0.9	1.12	1.24	1.32	1.14	1.45	1.49

Source: Adapted from Saaty (2008)

The analysis indicated a CR index of 25%; this represents that there is consistency since it is less than 10%. In Table 5, it is possible to see the matrix of the quality criteria regarding the alternatives.

Table 5 - Normalized matrix

NORMALIZED MATRIX	TRAINING INDICATOR	REWORK INDICATOR	QUALITY INDICATOR	PRODUCTION INDICATOR
	65%	66%	19%	42%
	13%	22%	58%	42%
	13%	7%	19%	8%
	9%	4%	4%	8%

Source: The author (2022)

With the ranking of the criteria, we know that the training indicator criterion is the most important, with 0.480, or 48% of the total importance, followed by the indicator rework, with 0.337, or 33.7 % of the total importance. In third place, the quality indicator with 0.182, or 18.2 % and the production indicator is the least important in this analysis with 0.049 or 4.9 % of the total importance.

Regarding this study, the researcher noted that the company conducts its work efficiently but highlights that the increase in productivity desired by the industry is linked to the lack of training of employees, observed that the training used so far by the industry is not enough to address all the needs of employees generating rework and consequently the low productivity of the industry, impacting directly on business growth. Thus, the implementation of a training program in the industry analyzed, as in any other industry, contributes to developing organizations, as shown in the literature (CHIAVENATO, 2014; MEIRELES, 2017; SOUZA et al., 2013). The authors corroborate that the training of employees qualifies the workforce and increases their technical level, thus improving productivity.

Thus, the most important criterion in this judgment is the training indicator. It is also noteworthy that our decision is consistent since the analysis showed a CR index of 2% and a consistency index of 0.02. This represents consistency since it is less than 10%.

0.021086535	IC
2%	RC

Given the normalized matrix, we arrive at the normalized value. We obtain the priority vector of the criteria. Next, the evaluation of the judgment matrix of the alternatives was performed, and the priority vectors were aggregated into a single vector. In Table 6, it is possible to visualize the criteria matrix in relation to the alternatives.

Table 6 - Matrix of indicator criteria in relation to the alternatives

PRIORIDADES FINAIS DAS ALTERNATIVAS					
Alternativa	Indicador treinamento	Indicador retrabalho	Indicador qualidade	Indicador produção	Prioridade Final
Peso dos critérios	**0,480**	**0,337**	**0,182**	**0,049**	
Método controle treinamento	0,400	0,281	0,152	0,041	0,873
Taxa aplicação do aprendizado	0,080	0,056	0,030	0,008	0,175
Tempo médio entre falhas	0,360	0,253	0,137	0,037	0, 786
Facilitar entendimento problema	0,120	0,084	0,046	0,012	0,262
Teste aceitação mercado	0,432	0,303	0,164	0,044	**0,943**
Conclusão requisitos no prazo	0,048	0,034	0,018	0,005	0,105
Controle de produção	0,420	0,295	0,159	0,043	0,917
Capacidade de inovar	0,060	0,042	0,023	0,006	0,131
Soma	1,920	1,348	0, 728	0,196	

Source: The author (2022)

Through the analysis of the general priorities, it is possible to observe that in the training indicator criterion, the alternative that stood out the best was the market acceptance test, followed by the production control alternative. As of the manager's judgment for the quality indicator criterion, the alternative that stood out was the market acceptance test, followed by the production control alternative.

When analyzing the judgments for the production criterion, the most relevant alternatives were "market acceptance tests" and "mean time between failures." Still, low scores are highlighted in all alternatives when analyzing the production criterion.

The manager considered the training indicator criterion of extreme importance, followed by the criterion represented by the rework indicator. During the interview, the manager stressed that the training of employees has a direct and positive link with the performance of production and consequently quality, and also added that the training adds important information which facilitates the understanding of problems that may arise or even sometimes being able to mitigate failures or even increase the time between them.

It is also highlighted that the company's greatest pain is the difficulty in hiring qualified labor and thus being unable to increase productivity due to the labor's low schooling. The closest study center is 50 km away, which hinders professional development. With this view, Araújo (2006) mentioned the application of training to reduce rework and waste and improves the organization's climate, leading to gains and differentials in competitiveness.

4.1 Sensitivity analysis

With the sensitivity analysis performed, it is possible to verify the behavior of the variables, indicating through simulations the possible alternative scenarios that could demonstrate the existing sensitivity in decision-making.

Based on the analyses performed using the AHP method, the alternative to be prioritized by the industry manager was verified. The sensitivity analysis is extremely important, as it allows us to understand the robustness of the manager's decision and which criteria influenced the original results. In addition, various authors have warned that no final decision should be made without first performing a sensitivity analysis. In this step, the robustness of the final result obtained in the previous step is verified when variations in the input data in the consequence matrix are considered. To perform this analysis in a first scenario, the same weight must be given to all criteria (indicators), according to Table 7.

Table 7 - Sensitivity Analysis (Scenario 1). All criteria with the same weight.

Alternativa	Indicador treinamento	Indicador retrabalho	Indicador qualidade	Indicador produção	Prioridade Final
Peso dos critérios	0,333	0,333	0,333	0,333	
Método controle treinamento	0,291	0,291	0,291	0,291	**1,166**
Taxa aplicação do aprendizado	0,042	0,042	0,042	0,042	0,167
Tempo médio entre falhas	0,000	0,000	0,000	0,000	0,000
Facilitar entendimento problema	0,000	0,000	0,000	0,000	0,000
Teste aceitação mercado	0,000	0,000	0,000	0,000	0,000
Conclusão requisitos no prazo	0,291	0,291	0,291	0,291	1,163
Controle de produção	0,087	0,087	0,087	0,087	0,349
Capacidade de inovar	0,314	0,314	0,314	0,314	1,256
Soma	1,025	1,025	1,025	1,025	

Source: The author (2022)

With all criteria having the same weight, the alternative, method, and training control become the best alternative, emphasizing that in the previous decision, the training indicator criterion had the highest weight (0.480), followed by the second highest weight (0.337) represented by the rework indicator criterion. This would be the first scenario. In a second scenario, we try to determine which weight would be necessary for the training indicator criterion to tie the alternatives' overall priorities. For this to be done, we should change the weights of the criteria and see how they change with the priorities of the alternatives according to Table 8.

Table 8 - The weight required for the training indicator criterion to lead to a tie in the overall priorities of the alternatives

Alternativa	Indicador treinamento	Indicador retrabalho	Indicador qualidade	Indicador produção	Prioridade Final
Peso dos critérios	**0,240**	**0,120**	**0,060**	**0,060**	
Método controle treinamento	0,063	0,031	0,016	0,016	0,126
Taxa aplicação do aprendizado	0,226	0,113	0,057	0,057	**0,453**
Tempo médio entre falhas	0,031	0,016	0,008	0,008	0,063
Facilitar entendimento problema	0,000	0,000	0,000	0,000	0,000
Teste aceitação mercado	0,000	0,000	0,000	0,000	0,000

Alternativa	Indicador treinamento	Indicador retrabalho	Indicador qualidade	Indicador produção	Prioridade Final
Conclusão requisitos no prazo	0,280	0,140	0,070	0,070	**0,559**
Controle de produção	0,000	0,000	0,000	0,000	0,000
Capacidade de inovar	0,000	0,000	0,000	0,000	0,000
Soma	0,600	0,300	0,150	0,150	

Source: The author (2022)

With the indicator training criterion with half the total weight, the most relevant alternative is the on-time completion of requirements, followed by the rate of learning application, the alternative training control method and mean time between failures appear with low priority, and the other alternatives have zero priority.

At this stage, the results must be evaluated, and recommendations must be elaborated at a detailed level concerning the decision-making process, contemplating the confidence level the decision-maker must have regarding the built decision model. The recommendation is shown to the decision maker through an analysis and recommendations report, along with the solution found in each scenario, emphasizing the reliability of the decision support model built. Likewise, highlighting the role of the DSS, in terms of interactivity with the decision maker and ease of performing preference elicitation, identify inconsistencies between answers and evaluate that they coincide with the initial choices.

In this sense, it is important to highlight that the decision-maker may have cognitive difficulties in identifying the indifference relations in the weight elicitation procedure, which may explain the behavior of the values of the scale constant k concerning the large value for some criteria and the near zero value for others.

It is also important to emphasize that the decision-maker should evaluate all criteria, considering the weights of the criteria not only as the degree of importance but taking into account the space of consequences, identifying preferences and trade-offs between criteria.

5. FINAL CONSIDERATIONS

From a previous analysis conducted by the researcher in the metal-mechanic sector, it was possible to verify points that require improvement. Through the theoretical foundation, it was possible to propose alternatives to the industry manager regarding quality and issues related to production and rework. Using the experience of the industry manager, one can denote that the priority alternative that would make it possible to monitor the efficiency of operations is directly related to personnel training. It is emphasized that, with the sensitivity analysis performed, it is possible to verify the behavior of the variables, thus being able to indicate through simulations and different scenarios capable of demonstrating the existing sensitivity in decision-making.

The implementation of the action or the adoption of procedures on the set of indicated actions, according to the defined problem, is what the decision-making support aims to achieve.

After all the tests, we conclude and reach a final decision; from the sensitivity analysis, we can express the final recommendation, stressing that the greatest weight is the training indicator, where the final priority highlighted is market acceptance when we give the same weight to all criteria the alternative that stands out is the method of control of training and finally when we use half the weight in the indicator training criterion the final priority highlighted is the completion of requirements on time followed by the final priority application rate of learning.

Following the recommendations indicated in the report, the company should evaluate implementing the model as the interconnection of the training given to its employees in all its operational sectors since, in the two scenarios used to perform the sensitivity analysis, the alternatives with the highest final priority are related to the training indicator criterion.

Considering that employee training is directly and positively linked to reworking, quality, and production, for Bilanakos et al. (2018), well-trained employees have a greater ability to produce standardized goods, with less rework and a longer mean time between failures. Therefore, the organization must know its processes in order to improve its quality, thus increasing the ability to monitor the efficiency of its industrial operations.

The study contributes to greater knowledge and understanding of the metalworking company's production process, demands, and pains. This way, it is possible to suggest proposals for improvement in this process based on plausible resources for the industry. It is worth mentioning the low educational level of the workforce since the closest study center is 50 km away from the municipality where the industry is located, hindering professional development, thus highlighting the importance of internal training aligned with the increase of efficiency in industrial operations. It was also possible to identify how the lack of training can negatively impact the production processes, reducing productivity and increasing the chances of error.

From this perspective, it is possible to identify improvement points and propose an action plan so that the company can improve its professional development process by implementing an annual training plan and elaborating a competency matrix for each function.

In this way, the performance indicators will be monitored monthly, and it will be possible to evaluate the improvement of the processes' control through management tools.

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