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Multicriteria decision model for employee performance evaluation

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Abstract

The aim of the present study is to develop a multicriteria model of employee performance based on the methods AHP (used to define the weight of criteria) and TOPSIS (applied to rank alternatives). This study is characterized as applied and descriptive research and has a qualitative and quantitative approach. The result after applying the model showed that employee A1 had the best performance in the period evaluated. Dispersion analysis among alternatives also showed the need for team training. After the survey is applied, the sector manager can regularly evaluate performance and promote training to level up the team.

Keywords

Performance evaluation; Personnel management; MCDA

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Modelo de decisão multicritério para avaliação de desempenho de funcionários

Resumo

Este estudo objetiva desenvolver um modelo multicritério de avaliação de desempenho de colaboradores baseado nos métodos AHP (utilizado para definir o peso dos critérios) e TOPSIS (aplicado para ordenar as alternativas). Este trabalho se caracteriza como uma pesquisa aplicada e descritiva, com uma abordagem quali-quantitativa. O resultado após a aplicação do modelo mostrou que o colaborador A1 teve o melhor desempenho no período avaliado. Através da análise da dispersão entre as alternativas, também foi observada a necessidade de um treinamento do time. A partir da aplicação da pesquisa, o gestor do setor poderá avaliar regularmente o desempenho e promover treinamentos para nivelamento da equipe.

Palavras-Chave

Avaliação de desempenho; Gestão de pessoas; MCDA

Modelo de decisión multicriterios para la evaluación del desempeño de los empleados

Resumen

Este estudio pretende desarrollar un modelo multicriterio para la evaluación del rendimiento de los empleados basado en los métodos AHP (utilizado para definir el peso de los criterios) y TOPSIS (aplicado para ordenar las alternativas). Este trabajo se caracteriza por ser una investigación aplicada y descriptiva, con un enfoque cualitativo y cuantitativo. El resultado tras la aplicación del modelo mostró que el colaborador A1 tuvo el mejor rendimiento en el periodo evaluado. Mediante el análisis de la dispersión entre las alternativas, también se observó la necesidad de una formación en equipo. A partir de la aplicación de la investigación, el responsable del sector puede evaluar periódicamente el rendimiento y promover la formación para la nivelación del equipo.

Palabras clave

Evaluación del rendimiento; Gestión de personas; MCDA

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Introduction

The growing competitiveness of the market requires that organizations effectively analyze their processes and operations. Employee performance is an essential part of this analysis, considering that employees affect or participate in all the activities performed in companies (Souza, 2014; Araújo & Mendes, 2018). Performance evaluation is central to personnel management within organizations, and the objectives of these evaluations may range from finding points of improvement up to employee evaluation. These evaluations are paramount in decision making regarding bonuses, dismissals, or development of skills (Dijk & Schold, 2015).

One of the difficulties in decision-making processes involving human resources of the company is the amount of information generated from performance evaluation. Evaluation is carried out using varied criteria, and it might not provide a clear result. For that reason, the Multicriteria Decision Analysis (MCDA) methods become effective in assisting decision makers in evaluating employee performance (Souza, 2014).

The MCDA is a set of methods that supports decision making, encompassing different areas, such as mathematics, administration, informatics, and others, and it should be used in resolving problems that have at least two alternatives to be analyzed that need to take the preferences of the decision maker into consideration. The obstacle of the decision maker is to evaluate various alternatives in an aggregate manner, considering diverse criteria with different metrics (Almeida, 2013; Watrobski ***et al***., 2019; Cinelli ***et al***., 2020).

The use of MCDA methods provides tools able to support the decision-making process through recommendation of actions to the one responsible for making decisions (Gomes & Gomes, 2014). When applied to performance evaluation, these methods prove to be significant in identifying points of improvement, enabling development of skills in personnel in the organizations (Zamcopé ***et al***., 2010). Other studies applied to performance evaluation can be found in Souza (2014); Morte, Pereira and Fontes (2015); Gavazini and Dutra (2016); Ishizaka and Pereira (2016); Fehrenbacher, Schulz and Rotaru (2018); Samanlioglu ***et al.*** (2018); Haq and Ahmed (2019); and Wang ***et al.*** (2020).

Other studies can be found in the context of performance evaluation; for example, Bai, Dhavale and Sarkis (2014) analyzed organizational performance through integration of the Fuzzy C-Means and TOPSIS methods. Calazans, Rocha, Araújo and Ferreira (2016) used the ELECTRE II to evaluate the performance of suppliers of the collective food service sector, while Gómez, Tabares-Urrea and Ramírez-Flórez (2020) used the AHP and TOPSIS to select and evaluate outsourced suppliers in the logistics sector. Barbosa and Löbler (2020) created a device to be able to select projects in a strategic manner in the university environment, using balanced scorecard, the AHP, and scoring techniques.

In the company that is the object of this study, a beverage retailer distributor, the current evaluation of employees is an important managerial process. Nevertheless, under the current manner of evaluation, there are failures in identification of the true points of improvement of the employees aiming to promote the development of skills in these professionals. The aim of the present study is to develop a multicriteria model of employee performance based on the AHP and TOPSIS methods.

This study is structured in five sections, beginning with the Introduction, which presents the problem and the aim of the study. In the Review of the Literature (section 2), the applied MCDA methods and the concepts of performance evaluation will be discussed. In section 3, the Methodological Procedures will be described. Finally, section 4 is devoted to Results and Discussion of the method and section 5 to Conclusions of the Study.

1. Review of the literature

1.1. Performance evaluation

Personnel management can be understood as the area responsible for policies and practices that conciliate the expectations of organizations and of personnel so that they are fulfilled over time (Dutra, 2009). This area manages a relationship of interdependence between these groups. While organizations have people as their driving force, personnel use the corporation as a means of development, such that the objectives of each group would not be achieved without the activity of the other (Chiavenato, 2010).

To maintain the relationship of interdependence between the organization and employees, strategies are used to manage human capital. Among them, certain pillars are worked with: motivation, communication, teamwork, knowledge, and training. This effective management of human resources aims not only to bring motivation and satisfaction to employees, but also to guide them to exercise their potential so that they become a competitive differential for companies (Araújo & Mendes, 2018; Chiavenato, 2010).

An essential policy for development of human capital in organizations is performance evaluation, the basis for processes of rewarding, developing, and maintaining people (Chiavenato, 2010; Dutra, 2009). Performance can be understood as the return provided to an entity compared to a previously established standard; it is a set of expected actions and behaviors for each function within the organization (Silva ***et al.***, 2018; Souza, 2014).

Performance evaluation is characterized by analysis of the holder of a certain position and of his/her respective performance. It plays a guiding role for administration because it allows various disruptions to be identified, including problems in carrying out and supervising activities, non-compliance in adaptation of people to the positions they occupy, lack of motivation of employees, and failure to take advantage of skills. Thus, this practice is of fundamental importance for advancement of sectors and of the company as a whole (Gil, 2014). To provide these various benefits, performance evaluation must be correctly applied, and the use of efficient techniques and tools for each scenario is important.

1.2. Multicriteria decision analysis methods

Decision making is present in human daily life. People are moved to make a decision whenever they are confronted with a problem that can have more than one solution, and each one of these alternatives will carry consequences. The more alternatives and criteria to be considered in the decision, the more complex it becomes, complicating the process for the decision maker that has the authority of deliberation (Almeida, 2013; Gomes & Gomes, 2014).

The MCDA methods are clearly essential when the problem in question is complex, using varied criteria that have different metrics. The MCDA methods clarify the subjectivity that is present in any decision process. The objectives are combined through the subjective evaluation of the decision maker, who thus inserts his/her preferences in the model.

The classification proposed by Ishizaka and Nemery (2013) considers three groups of MCDA methods. The first is the Full Aggregation Approach – similar to the single criterion synthesis. This approach has methods that arose from the American School, and in them, each criterion has a score and these are then synthesized into a global score, thus assuming compensation among them. The second is the Outranking Approach and arose from the French School. In outranking, there is no compensation, but there may be incomparability among the criteria. In this approach, "two options may have the same score, but their behavior may be different and therefore incomparable". The last group is the Goal, aspiration, or reference level approach. Methods of the American and French Schools are present, which identify the alternatives based on their closeness to a defined reference.

The AHP and TOPSIS methods are both applied to problems of classification and choice, and they are very popular in the MCDA (Ishizaka & Nemery, 2013; Salih ***et al.***, 2019; Silva & Almeida, 2020; Watrobski ***et al***., 2019; Cinelli ***et al***., 2020). The TOPSIS method has a goal, aspiration, or reference level approach, in which the alternatives are compared to the solution understood to be ideal. In contrast, the AHP has a full aggregation approach, generating a score from pair-by-pair comparisons among the alternatives.

Lemos, Freitas and Tenório (2019) indicate that one of the advantages of the AHP is admitting subjectivity as an intrinsic part of the decision-making process. According to Lima and Carpinetti (2015), TOPSIS stands out through its adjustment to problems with a large number of criteria and alternatives, especially with quantitative criteria. Hybrid models of the AHP and TOPSIS methods are also used, as seen in the studies of Gómez, Tabares-Urrea and Ramírez-Flórez (2020); Wang ***et al.*** (2020); Samanlioglu ***et al.*** (2018); and Hernandez-Diaz and Neves-Dos Santos (2020).

In this study, we developed a hybrid model constituted by the AHP and TOPSIS methods through their applicability and accuracy. Through the AHP method, the inconsistencies in prioritizing criteria by the decision maker are reduced, considering that it provides for pair-by-pair comparison and provides consistent analysis of them, favoring the accuracy of the data inserted in the TOPSIS for ranking the alternatives.

1.2.1. AHP Method

The Analytic Hierarchy Process (AHP) is widely used among the MCDA methods, as it is suitable for both qualitative and quantitative indexes (WANG ***et al.***, 2020). The AHP was developed in 1977 by Thomas L. Saaty and reduces multidimensional problems, with diverse criteria and factors, into one-dimensional problems, resulting in the ranking of alternatives (Hernandez-Diaz & Neves-Dos Santos, 2020). In this method, the decision maker does not attribute numerical judgments to the alternatives but rather subjective judgments, more familiar to his/her daily life. Comparisons are made pair-by-pair, considering a preference scale of each criterion in relation to the other (Ishisaka & Nemery, 2013; Wang ***et al.***, 2020).

According to Ishizaka and Nemery (2013), Hernandez-Diaz and Neves-Dos Santos (2020), Wang ***et al.*** (2020), and Henao ***et al.*** (2020), the AHP application phases are the following:

Phase 1: Identification of the objective, criteria, and alternatives through decomposition of the problem, which is structured according to hierarchy. The first level contains the objective of the decision; the second represents the criteria; and the last level represents the alternatives. In more complex decision-making processes, more levels may be added.

Phase 2: Attribution of weight to the criteria. In this step, the decision maker evaluates each criterion as opposed to another based on the fundamental scale proposed by Saaty (2000), presented in Table 1. The fundamental scale is formed of 9 levels – the odd-numbered levels describe the main dominances of a criterion over the others and the even-numbered levels are intermediate to these.

The evaluation is made by the decision maker who, through pair-by-pair comparison, indicates the degree of preference of an criterion in relation to a criterion. At the end of the comparisons, a matrix is presented like the one in Equation 1.

Table 1: Fundamental scale of Saaty

Fundamental scale of Saaty

Intensity of the importance	Definition	Explanation
1	**Equal importance**	Two criteria contribute equally to the objective
2	Weak	
3	**Moderate importance**	One criterion is slightly more important for the objective than the other
4	Moderate plus	
5	**Strong importance**	One criterion is strongly more important for the objective than the other
6	Strong plus	
7	**Very strong importance**	One criterion is very strongly more important than the other; it has dominance shown through practice.
8	Very, very strong	
9	**Extreme importance**	The dominance of one criterion over the other is as great as possible, considering the objective.

Source: Saaty, T. L. (2000). *Fundamentals of decision making and priority theory with the analytic hierarchy process.*

$$A = \begin{pmatrix} 1 & a_{12} & \cdots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & 1 & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \cdots & 1 \end{pmatrix} \quad (1)$$

Phase 3: Normalization of the matrix. The elements of the normalized matrix are obtained through division of each element of the comparison matrix by the sum of all the elements of its respective column, according to Equation 2.

$$n_{ij} = \frac{a_{ij}}{\sum a_i}$$

(2)

Phase 5: Definition of vector weight. The priority vector represents the contribution of each criterion to the overall objective and is obtained from the mean of each row of the normalized matrix; each row represents a criterion. The sum of all the weights results in 1, indicating the participation of 100% of the criteria to achieve the objective. Equation 3 shows this calculation.

$$p_i = \frac{\sum a_{1n}}{n}$$

(3)

Phase 6: Analysis of the consistency of the comparisons. In order to validate the data obtained, analysis of the consistency of the evaluations of the matrix of the criteria is carried out. This validation relates the maximum eigenvalue and the number of criteria evaluated () and is performed based on the consistency ratio. The calculation of the eigenvalue is through Equation 4, and the consistency index (CI) is calculated through Equation 5.

$$\lambda_{max} = \frac{\sum Av_i}{p_i} \times \frac{1}{n}$$

(4)

$$CI = \frac{\lambda_{max} - n}{n-1}$$

(5)

With the CI known, the consistency ratio (CR) is found through division of the consistency index by the random consistency index (RI), which varies according to the order of the matrix, as shown in Table 2. The matrix is considered consistent when the CR is less than 0.10, according to Equation 6.

$$CR = \frac{CI}{RI} < 0.1$$

(6)

Table 2: Random consistency indexes

Random consistency indexes

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	0	0.52	0.89	1.11	1.25	1.35	1.40	1.45	1.49	1.51	1.54	1.56	1.57	1.58

Source: Saaty, T. L. (2000). *Fundamentals of decision making and priority theory with the analytic hierarchy process*.

1.2.2. TOPSIS method

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) is a classification method that acts in ordering alternatives based on their closeness to a solution held to be ideal (Zhongyou, 2012).

According to Lima Júnior and Carpinetti (2015, p.22), the "basic principle of TOPSIS consists in choosing an alternative that is as near as possible to the positive ideal solution and as distant as possible from the negative ideal solution". For this comparison to be made, reference parameters are defined for the ideal and least ideal solutions, and they are named as "positive ideal solution" and "negative ideal solution". Each alternative of the problem is compared to the parameters, and the results obtained from this allow the ranking (Zhongyou, 2012).

According to Lima and Carpinetti (2015), Pedro (2019), and Gómez, Tabares-Urrea and Ramírez-Flórez (2020), the TOPSIS algorithm follows these steps:

Step 1: Define decision matrix , composed of the performance of the alternatives in each criterion () and the vector weight , composed by the weights of each criterion (), and presented in Equation 7. In Equation 8, represents the alternatives, while represents the criteria.

$$W = [W_1, W_2, \ldots, W_m] \qquad (7)$$

$$D = \begin{matrix} & C_1 & C_2 & \cdots & C_j & \cdots & C_m \\ A_1 & d_{11} & d_{12} & \cdots & d_{1j} & \cdots & d_{1m} \\ A_2 & d_{21} & d_{22} & \cdots & d_{2j} & \cdots & d_{2m} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ A_i & d_{i1} & d_{i2} & \cdots & d_{ij} & \cdots & d_{im} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ A_n & d_{n1} & d_{n2} & \cdots & d_{nj} & \cdots & d_{nm} \end{matrix}$$

Step 2: Normalize the decision matrix , represented in Equation 8. The elements of the normalized matrix are represented by and defined using Equation 9.

$$n_{ij} = \frac{d_{ij}}{\sqrt{\sum d_{ij}^2}} \quad (9)$$

Step 3: Weight the normalized decision matrix using Equation 10. The elements of the weighted matrix are represented by .

$$p_{ij} = w_j n_{ij}, i = 1, 2, \cdots, n; \ j = 1, 2, \cdots, m. \quad (10)$$

Step 4: Determine the positive ideal solution () and negative ideal solution () from Equations 11 and 12. The expressions and represent the best and the worst score achieved by the alternatives, respectively, considering criterion . If the criterion is a disadvantage, the positive ideal solution will be the minimum value among the criteria of the alternatives. If the criterion is a benefit, the positive ideal solution will be the maximum value.

$$A^+ = \{MAX_{jp_{ij}} | j = 1, 2, \cdots, m\} = \{n_1^+, \cdots, n_j^+, \cdots, n_m^+\} \quad (11)$$

$$A^- = \{MIN_{jp_{ij}} | j = 1, 2, \cdots, m\} = \{n_1^-, \cdots, n_j^-, \cdots, n_m^-\} \quad (12)$$

Step 5: Using Equation 13, calculate the Euclidean distance () between the positive ideal solution and the elements of the weighted matrix. In a similar manner, using Equation 14, calculate the Euclidean distance () between the negative ideal solution and the elements of the weighted matrix.

$$D_i^+ = \sqrt{\sum_{i=1}^{n}\left(p_{ij} - n_j^+\right)^2} \tag{13}$$

$$D_i^- = \sqrt{\sum_{i=1}^{n}\left(p_{ij} - n_j^-\right)^2} \tag{14}$$

Step 6: Calculate the closeness coefficient () of each alternative to the ideal solution using Equation 15. This coefficient represents the overall performance of the alternative.

$$CC_i = \frac{D_i^-}{D_i^+ + D_i^-} \tag{15}$$

Step 7: Finally, rank the alternatives in a decreasing manner from the values of the closeness coefficient. The nearer to 1, the better the performance of the alternative.

2. Methodological procedures

2.1. Characterization of the study

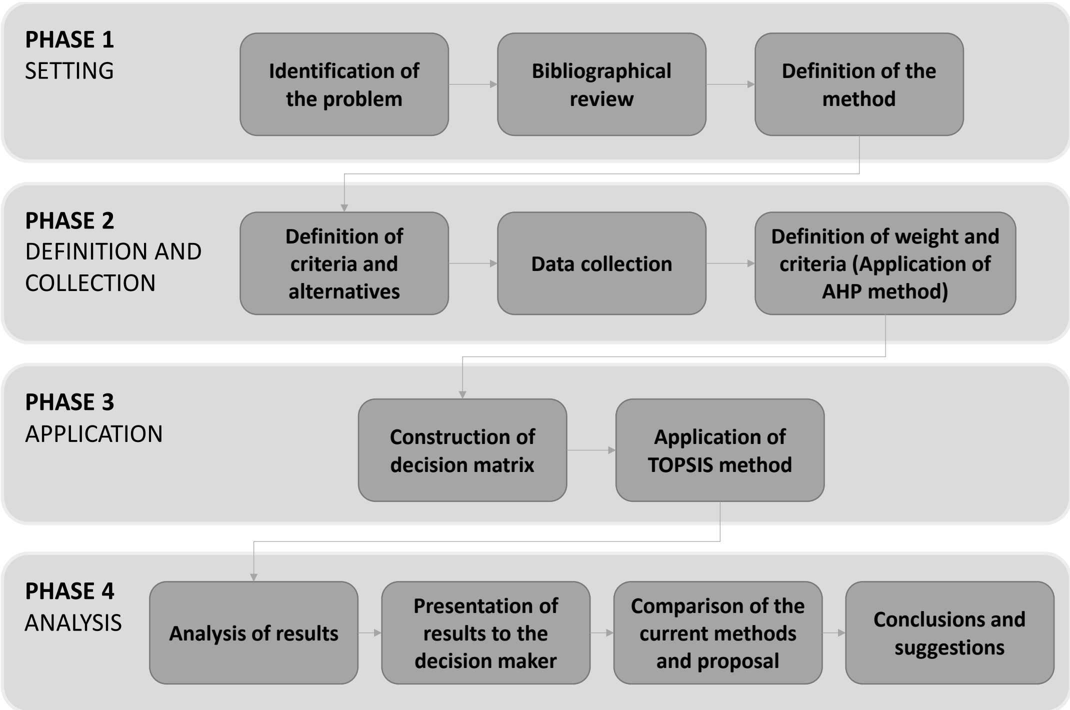
A study of an applied nature is defined by the search for solutions to specific problems (Bairagi & Munot, 2019). A descriptive study, commonly used in social and business environments, represents or analyzes facts through observations of the phenomenon of interest (Bairagi & Munot, 2019; Nayak & Singh, 2015). Considering the procedures, a case study has a character of depth regarding an objective for solution of a specific problem (Vergara, 2016).

The present study is classified as a case study and is characterized as applied and descriptive research; the objective is the solution of a real problem in a company in Brazil. This study uses a qualitative-quantitative approach to the problem, because its steps require numerical and subjective analyses from the perspective of those involved. Thus, subjective data were used regarding employee performance evaluation that will be translated into quantitative values, resulting in a ranking.

2.2. Research steps

The present study was developed in four phases, namely, setting, definition and collection, application, and analysis. Each one of the phases has steps, as can be observed in Figure 1.

Figure 1: Phases and steps of the development of the study



Source: Research data.

3. Results and discussion

This study was carried out in a beverage distribution retailer company, and one of the problems faced by the organization was evaluation of employees through a form filled out by the leader of each sector as the starting point. The topics addressed encompass behavior and productivity; however, most of them are generalist, not allowing the points of individual improvement or improvement of the entire sector to be identified.

The general process of performance evaluation of the company, called "people cycle", occurred annually, which does not allow continual evaluation and effective monitoring of the evolution of the employee. In addition, this time interval makes it more difficult to carry out specific evaluations for dismissal or promotion of employees. The current method restricted the process by limiting analysis of skills. This leads to biased and superficial performance evaluation since the criteria – arising from the competence form – cannot be changed and adapted to each sector. The study was carried out in one of the sectors of the company, responsible for monitoring the deliveries made. The decision maker of the performance evaluation process was responsible for the sector, and five employees were evaluated.

The presentation and discussion of the results of this study begins with analysis of the current method of performance evaluation. It is important to note that the "people cycle" is a standardized process from the company supplier, and it is responsible for defining the time frame for application of the phases in the partner distributors. The competence form, used at the beginning of the cycle, can be applied at any time by managers, though that is not a common practice in the sector participating in the study.

For the present study, the form was applied in reference to the performance of the employees in the same period considered for calculation of the model developed. The form consists of topics related to the performance and skills of the employee, and evaluation of each one of these points occurs through a four-degree scale: very positive, positive, negative, and very negative. The result is seen in Table 3, which presented the behavioral compliance index of each employee.

Table 3: Employee performance within the current evaluation method

Employee	Behavioral compliance index
A1	98%
A2	98%
A3	72%
A4	68%
A5	57%

Source: Research data.

From the results obtained, there is a tie between employees A1 and A2, who were most highly ranked, both with 98% on the behavioral compliance index. Analyzing the results of the other employees, it can be seen that all are above average, by exhibiting indexes greater than 50%.

An unfavorable aspect of the use of the evaluation form is the lack of prioritization of the criteria. Sixteen behaviors are evaluated, all judged with the same scale and weight. That implies greater standardization of the result by not considering the subjectivity of each criterion. Productivity analysis especially loses out through being evaluated using the scale present on the form, being based solely on the perception of the manager of the area and not on the results achieved by each employee.

The decision-making model in this study relied on two MCDA methods: AHP was used for definition of the weights of the criteria, and TOPSIS was used in ranking of the alternatives. The first step in the execution and collection phase was definition of the criteria and alternatives. The criteria were recommended by the decision maker and selected with the objective of encompassing the productivity and skill dimensions so as to meet the needs of the decision-making process. The twelve criteria selected along with their descriptions, units of measure, and polarity (the objective of maximizing or minimizing) are shown in Table 4.

For application of the model in other sectors and companies, adaptation of the criteria used is necessary. Criteria related to behavior can be widely utilized by other decision makers; however, in the case of criteria related to productivity, such as criteria C1, C2, C3, and C4, that would not be possible. The criteria of this model can be added or modified according to the preferences and needs of the decision maker.

Table 4: Criteria matrix

INDICATOR	CODE	DESCRIPTION	UNIT OF MEASURE	POLARITY
Reversal of returns	C1	Ratio between the number of returns resolved and the total number of returns indicated.	Percentage	Maximize
Handling unscheduled downtime	C2	Number of unscheduled downtimes resolved in the period.	Unit	Maximize
Geographic location of the points of sale	C3	Number of confirmations of geographic locations of points of sale in the period.	Unit	Maximize
Reaction time	C4	Mean time to begin to deal with the problem or memorandum.	Minute	Minimize
Interpersonal relationship	C5	Ease of social interaction and harmonious interaction with other people.	Likert Scale	Maximize
Adaptability	C6	Ability to adapt to changes.	Likert Scale	Maximize
Ownership	C7	Disposition and general level of interest in the functions, activities carried out, and area of operation.	Likert Scale	Maximize
Communication	C8	Ability to communicate, and clear and objective verbal fluency.	Likert Scale	Maximize
Technical and practical knowledge	C9	Mastery in carrying out the functions characteristic of the activity performed.	Likert Scale	Maximize
Proactiveness	C10	Ability to resolve questions in advance; initiative in foreseeing situations and resolving them.	Likert Scale	Maximize
Emotional Balance	C11	Skill in dealing with situations of conflict and pressure.	Likert Scale	Maximize
Absenteeism	C12	Percentage of absences during the month.	Percentage	Minimize

Source: Research data.

Definition of the weight of each criterion, determined through intermediation of the AHP, began with construction of the pair-by-pair comparison matrix of the criteria. Following the method, preferences of the decision maker were attributed in relation to each criterion, based on the fundamental scale. From these preferences, the comparison matrix was constructed, shown in Table 5. The matrix was normalized and weighted, and the weights were calculated. The weight vector resulting from application of the AHP method is shown in Table 6. The employee absenteeism criterion had the highest degree of importance, with a weight of 38.89%, and the geographic location of the points of sale and reaction time had the lowest priorities.

Table 5: Pair-by-pair comparison matrix of criteria

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
C1	1.00	5.00	9.00	3.00	5.00	3.00	1.00	3.00	3.00	1.00	1.00	0.11
C2	0.20	1.00	2.00	3.00	0.33	0.33	0.20	0.20	0.33	0.14	0.14	0.11
C3	0.11	0.50	1.00	0.33	0.20	0.33	0.14	0.14	0.20	0.11	0.11	0.11
C4	0.33	0.33	3.00	1.00	0.33	0.33	0.20	0.14	0.20	0.14	0.14	0.11
C5	0.20	3.00	5.00	3.00	1.00	3.00	0.33	0.33	1.00	0.20	0.33	0.11
C6	0.33	3.00	3.00	3.00	0.33	1.00	0.33	1.00	1.00	0.20	0.33	0.11
C7	1.00	5.00	7.00	5.00	3.00	3.00	1.00	0.33	1.00	1.00	1.00	0.11
C8	0.33	5.00	7.00	7.00	3.00	1.00	3.00	1.00	3.00	1.00	1.00	0.11
C9	0.33	3.00	5.00	5.00	1.00	1.00	1.00	0.33	1.00	0.33	0.33	0.11
C10	1.00	7.00	9.00	7.00	5.00	5.00	1.00	1.00	3.00	1.00	1.00	0.11
C11	3.00	7.00	9.00	7.00	3.00	3.00	3.00	1.00	3.00	1.00	1.00	0.11
C12	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00	1.00

Source: Research data.

Table 6: Weight of the criteria

	C1	*C2*	*C3*	*C4*	*C5*	*C6*
WEIGHT	0.0951	0.0204	0.0120	0.0174	0.0414	0.0356
	C7	*C8*	*C9*	*C10*	*C11*	*C12*
WEIGHT	0.0712	0.0839	0.0435	0.1008	0.0889	0.3889

Source: Research data.

After delimitation of the weights, matrix consistency was analyzed. To do so, first the was calculated, in order to define the value of the consistency index. As seen in Table 7, the consistency index obtained was 0.1329. Having obtained this value, the consistency ratio (CR) was calculated. The random consistency index used was 1.54, since the comparison order matrix is 12. For a matrix to be held to be consistent, it is necessary for the CR to be below 0.10. As observed, still in Table 7, the CR obtained was 0.0863, thus attesting to the consistency of the results obtained.

Table 7: Results obtained from consistency analysis

λ máx	CI	CR
13,4617	0,1329	0,0863

Source: Research data.

With definition of the weight of each criterion, it was possible to proceed to the ranking phase through the TOPSIS method. The first step of this phase consisted in construction of the decision matrix, presented in Table 8, formed by the performance of the alternatives in the criteria used in the period of one month. To provide continuation in application of TOPSIS for ranking the alternatives, the decision matrix was normalized. As can be seen in the matrix of criteria, they were expressed in different units and, through normalization, it was possible to obtain a non-dimensional matrix with the possibility of

comparison between criteria, as shown in Table 9, by the normalized matrix. After that, the weighted matrix was calculated through multiplication of the normalized matrix and the weight vector.

Table 8: Decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
A1	72.73%	484	132	25.63	5	5	5	5	5	5	5	0.03%
A2	66.94%	343	150	28.15	5	5	5	5	5	5	4	0.03%
A3	45.56%	91	17	28.58	3	3	3	3	5	3	3	0.03%
A4	89.47%	40	1	25.40	5	4	2	5	2	3	2	0.03%
A5	61.18%	89	3	22.75	3	3	2	4	3	3	3	0.03%

Source: Research data.

Table 9: Normalized decision matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
A1	0.473	0.796	0.658	0.438	0.5185	0.545	0.611	0.500	0.533	0.570	0.630	0.447
A2	0.436	0.564	0.748	0.481	0.5185	0.545	0.611	0.500	0.533	0.570	0.504	0.447
A3	0.297	0.150	0.085	0.488	0.3111	0.327	0.366	0.300	0.533	0.342	0.378	0.447
A4	0.582	0.066	0.005	0.434	0.5185	0.436	0.244	0.500	0.213	0.342	0.252	0.447
A5	0.398	0.146	0.015	0.388	0.3111	0.327	0.244	0.400	0.320	0.342	0.378	0.447

Source: Research data.

Considering the polarity of each criterion, the positive ideal and negative ideal solutions were found. As determined by the method algorithm, the positive ideal solution is formed by the best values achieved of each criterion, whereas the negative ideal solution is composed of the worst values achieved in each criterion. The results are presented in Table 10.

Table 10: Positive and negative ideal solutions

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
A+	0.055	0.016	0.009	0.007	0.021	0.019	0.043	0.042	0.023	0.057	0.057	0.174
A-	0.028	0.001	0.000	0.008	0.013	0.012	0.017	0.025	0.009	0.034	0.023	0.174

Source: Research data.

After definition of the ideal solutions, the Euclidean distance of each alternative to the ideal solution was calculated. After that, the closeness coefficient () was obtained. The results can be seen in Table 11.

Once the closeness coefficients were obtained, the alternatives were ranked, as shown in Table 11. As seen in Equation 15, the indicates how much the distance to the negative ideal solution () represents the sum of the distances. The case of being 1 indicates that the alternative considered is at the same point as the positive ideal solution, being as distant as possible from the negative ideal solution. For that reason, the nearer the to 1, the better the alternative.

Table 11: Distances, coefficient of closeness to the ideal solution, and ranking of alternatives

	D +	D -	CC	Ranking
A1	0.0105	0.0595	**0.8506**	**1st**
A2	0.0186	0.0519	**0.7356**	**2nd**
A3	0.0523	0.0200	**0.2769**	**4th**
A4	0.0536	0.0333	**0.3832**	**3rd**
A5	0.0507	0.0179	**0.2605**	**5th**

Source: Research data.

The results indicate that employee A1 had superior performance during the period evaluated, with a coefficient of 0.8506. Employee A1 is followed by employee A2, who had a coefficient of 0.7356. After concluding application of the model, the results were presented to the decision maker, who indicated their similarity to reality.

Analysis of Table 12 comparing the evaluation models applied shows significant differences between the results. Use of more criteria in the proposed model indicates the tie between employees A1 and A2 is broken, who both had 98% behavioral compliance on the form. This tie break occurred mainly through the use of quantitative productivity criteria, in contrast with the form that had only one question on this dimension, and that was of a qualitative character. The criteria considered are subject to the performance of the employee in the period and not only the perception of the manager, allowing a more assertive result.

Comparing all the employees, a change is seen in the result in the ranking order, where alternative A4 exceeds A3 in the proposed model. Analyzing the dispersion shown in Table 12, given by standard deviation, it is understood that the current form method tends to conceal the results, presenting less disparity among the alternatives.

From the results of evaluations, other steps of the total process of the "people cycle" are performed when the decision maker has the results of the questionnaire. However, the decision maker is not able to clearly identify the points of greatest divergence among the employees, which hinders strategic actions in the effort to determine the levels of performance.

According to the needs indicated by the decision maker, the hybrid AHP-TOPSIS model provides input for awarding the employee with the best performance in the period, as well as for a possible decision regarding reduction in personnel of the sector. In these cases, the necessary information is extracted from the final ranking of the alternatives. Another need of the decision maker was identification of the points of greatest divergence among the employees. This analysis proves to be possible through the decision matrix, which contains the result of the alternatives in all the criteria.

Table 12: Comparison between the results of the evaluations

Employee	Result from current method (form)	Result from proposed model (AHP-TOPSIS)
A1	98%	0.8506
A2	98%	0.7356
A3	72%	0.2769
A4	68%	0.3832
A5	57%	0.2605
STANDARD DEVIATION	0.1658	0.2446

Source: Research data.

Table 13: Standard deviation of the criteria in the normalized matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
STANDARD DEVIATION	0.09	0.29	0.33	0.04	0.10	0.10	0.17	0.08	0.13	0.11	0.13	0.00

Source: Research data.

The standard deviations of the criteria are shown in Table 13. Greater dispersion appears in the C3, C2, and C7 criteria. The normalized matrix was used for this calculation so that the result of the deviation is non-dimensional, allowing comparison among the values obtained. Considering that the C2 and C3 criteria are of productivity, the decision maker can consider the weight of the criteria to select which of the two options needs to be worked on initially with the team. With this in mind, actions were proposed for some of the criteria of greatest dispersion, as can be seen in Table 14.

Comparison of the results obtained in this study with other studies that applied the same methodology shows that the integration of the AHP and TOPSIS is used to make the application more trustworthy and realistic. For example, the study of Ali, Mahmood and Salam (2020) used the hybrid AHP-TOPSIS analysis to evaluate practices that influence operational performance, resembling the present study in seeking a more realistic and trustworthy application. Samanlioglu *et al*. (2018) achieved their objectives of personnel selection considering thirty evaluation criteria through AHP and TOPSIS, differing from this study by using diffuse modeling and group decision methods. This shows the need for adaptation of the models when the nuances of each problem are considered.

Table 14: Plan of actions for leveling up employee performance

CRITERION	ACTION	OBJECTIVE	RESPONSIBLE
Handling unscheduled downtimes	Experienced employees offering support to inexperienced employees.	Share good practices and training in the activity.	Sector leader.
Geographic location of the points of sale	Training	Show employees how to schedule appointments and how to prioritize this action.	Sector leader.
Ownership	Meeting – Knowing the impact of one's work	Make employees aware of the importance of their function in the results of the company.	Personnel and management sector.
Ownership	Presentation of goals and monthly challenge	Stimulate employees to achieve individual goals and those of the sector.	Sector leader
Emotional balance	Emotional intelligence course	Stimulate efforts toward self-knowledge in order to promote emotional intelligence.	Personnel and management sector.

Source: Research data.

Comparing the AHP and the TOPSIS to each other in separation shows the advantages and disadvantages of each one of them (Table 15). When the methods are applied alone, they have different concepts, central process, consistency, and structuring of the problem. However, the use of AHP together with TOPSIS is complementary, according to the results of this study. Although the application of TOPSIS is simple, it requires specifications from decision makers regarding the weights given (ZAPARTE, 2018). Thus, the AHP method is important for evaluating the consistency of the weights attributed to the criteria (LAFLEUR, 2011; ZAPARTE, 2018). The application of AHP and TOPSIS together provides decision makers with an important tool to assist them in their decisions, allowing more adequate understanding regarding the most interesting alternative to achieve their objective. It is important to emphasize that in the literature there is no decision model involving employee performance evaluation with AHP and TOPSIS methods. However, other examples of application can be seen in Sedghiyan ***et al.*** (2021), Bhadra, Dhar and Salam (2021), and Marzouk and Sabbah (2021). One of the disadvantages of applying the AHP and TOPSIS is the need for an analyst with knowledge of MCDA tools.

After modeling of the decision process using AHP and TOPSIS, the decision maker analyzed the results and affirmed that the tool was viable for evaluating employee performance, and that it would be adopted by the company. In addition, the decision maker provided positive feedback at the end of the study on the practical results of application of the tool, especially when compared to the traditional methods used by the personnel management sector. The results of this study confirmed the applicability of the AHP and TOPSIS method for solving problems involving performance evaluation under multiple criteria, and these methods can be extended to other types of companies.

Table 15: Comparison of the main characteristics of AHP and TOPSIS

	AHP	TOPSIS
Concept	Scoring model – scoring obtained through alternatives	Commitment Model – there is no ideal solution, but a solution with optimal values in all the attributes selected.
Central Process	Hierarchical principle of pair-by-pair comparison of criteria.	Distance principle – calculate the shortest distance of the alternative to the positive ideal solution (PIS) and the greatest distance from the negative ideal solution (NIS).
Consistency	Yes – the consistency index is calculated	No – there are no comparative indexes as indicators
Structuring of the Problem	Few criteria and alternatives – it becomes complicated as the number of criteria and alternatives increases	Many criteria and alternatives – this is facilitated through being simple mathematical calculations.
Final Results	Global, fluid ranking	Global, fluid ranking

Source: Adapted from THOR, DING, KAMARUDDIN (2013).

Conclusion

This study developed a multicriteria model to evaluate employee performance in a beverage distribution company. In this model, the AHP and TOPSIS methods were used, the first for definition of the weight of the criteria and the second for ranking the alternatives.

Comparison of the current method of performance evaluation and the proposed model showed that the result obtained from the use of the multicriteria model was more assertive, which allowed the decision maker to more easily identify the points of improvement of the employees and of the sector as a whole. Thus, training can be promoted and actions directed to improve productivity and skills.

The proposed model also proved to be more efficient in productivity analysis upon considering metrics inherent to the sector. The possibility of inserting weights on the criteria was important because that allowed the result of performance evaluation to be directed by the degree of importance of each criterion. In addition, the result of each alternative was singular, showing the improbability of obtaining ties in the final ranking. By not being limited to a specific time horizon, the model developed was considered efficient because it can be used both for periodic evaluations and specific decisions.

Considering the results presented, the Multicriteria Decision Analysis methods are effective when used for performance evaluation. It is important to consider that the decision maker needs to be prepared for the process in which the criteria must be chosen so as to address the needs linked to the decision.

A limitation of the study was its application in only one of the sectors of the company. Therefore, future studies are suggested with the use of the hybrid AHP-TOPSIS model in other areas, considering the criteria and alternatives appropriate for each one. Another possibility to explore is extending the study to apply the proposed method to annual awards of the employees, based on skills and on achieving goals.

After presentation of the results of this study to the decision maker, he decided to use the proposed multicriteria model as a relevant tool in performance evaluation, to be periodically applied in the sector. In addition to being used as a basis for judgment of the decision maker in the "people cycle" – since that process and the standard form cannot be discontinued – the model developed will serve as a basis for decision-making processes, such as recognition of employees, modifications in the workforce, and identification of gaps in team knowledge.

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