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Utilizing SVNL OWA Distance Measure and Neutrosophic TOPSIS in the Assessment of Management Leadership Styles

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Abstract. In the complex field of evaluating leadership styles, the integration and aggregation of data has become crucial. This article delves into the use of OWA-TOPSIS, a hybrid methodology that combines the Ordered Weighted Averages (OWA) Operator and the Method for Ordering Preferences by Similarity with the Ideal Solution (TOPSIS), to achieve an accurate and holistic assessment of leadership executive. By unifying diverse data and aggregating information from multiple sources, you achieve a more complete and nuanced view of management capabilities and styles. This approach not only improves the objectivity of the analysis, but also provides a powerful tool for decision-making in complex corporate environments, where leadership skills are critical to organizational success. The OWA-TOPSIS methodology stands out for its ability to handle ambiguous and subjective information, transforming it into a quantifiable and easily interpretable result. By applying this method, you can discern more clearly which leadership styles are most effective in different contexts and specific situations. Furthermore, the flexibility of this technique allows it to be adapted to various industries and sectors, making OWA-TOPSIS a versatile solution for leadership analysis. The research detailed in this article offers an innovative and insightful perspective on how to optimize management evaluation, thereby providing essential guidance for improving organizational effectiveness through informed leadership strategically aligned with corporate objectives.

Keywords: OWA; TOPSIS; SVNLOWAD Decision Making; Management Styles.

1 Introduction

The evaluation of leadership styles has been a central concern in the field of management and business administration for decades. Understanding how different leadership styles impact organizational performance, employee satisfaction, and decision-making effectiveness is critical for any organization seeking to improve its processes and achieve its strategic objectives [1]. In this sense, the precise and objective assessment of these leadership styles becomes a crucial tool for managers and human resources managers. Historically, various methodologies have been used to assess leadership, from qualitative surveys and interviews to more sophisticated quantitative techniques [2]. However, one of the persistent challenges has been the integration and aggregation of data from multiple sources and the interpretation of information that is often subjective and ambiguous. This is where hybrid methods such as OWA-TOPSIS emerge as innovative and effective solutions to address these challenges [3]. The Operator of Ordered Weighted Averages (OWA) is a technique that allows the aggregation of data taking into account the degree of importance of each criterion, while the Method for Ordering Preferences by Similarity with the Ideal Solution (TOPSIS) facilitates the comparison of alternatives depending on its proximity to an ideal solution [4]. The combination of these two methodologies offers a robust tool for the assessment of leadership styles, providing results that are both accurate and interpretable [5].

The use of OWA-TOPSIS in the evaluation of leadership styles allows us to overcome some of the limitations associated with traditional methods. For example, the ability to handle ambiguous and subjective information is particularly useful in contexts where employee perceptions and opinions play a crucial role in assessing leadership [6]. Furthermore, this methodology offers the necessary flexibility to adapt to different industries and organizational contexts, making it a versatile and widely applicable solution [7].

A key aspect in the implementation of OWA-TOPSIS is the correct determination of the weights assigned to each criterion. This requires a deep understanding of organizational priorities and close collaboration with relevant stakeholders [8]. Precision in the assignment of these weights ensures that the results adequately reflect the realities and needs of the organization, providing a solid basis for strategic decision making.

This article aims to explore in detail the application of OWA-TOPSIS in the assessment of management leadership styles. Through an exhaustive analysis of case studies and practical examples, it will be demonstrated

how this methodology can be used to obtain valuable elements and improve organizational effectiveness [9]. Furthermore, the advantages and limitations of this approach will be discussed, providing clear and practical guidance for its implementation in different contexts. The importance of effective leadership cannot be underestimated in the contemporary business environment. Leaders not only guide their teams toward achieving organizational goals, but also set the cultural tone and work climate within the company [10]. Therefore, having accurate and reliable tools to evaluate and improve leadership styles is essential for any organization that aspires to maintain its competitiveness and relevance in the market [11].

The OWA-TOPSIS methodology represents a significant advance in the evaluation of management leadership styles. By providing a systematic and objective way to analyze complex, multifaceted data, this technique offers organizations a powerful tool to optimize their leadership and, ultimately, their overall performance. As companies continue to face increasing challenges in an increasingly dynamic and competitive business environment, the ability to evaluate and adjust leadership styles effectively will be more crucial than ever [12].

This study aims to contribute to the field of business management and administration, providing a theoretical and practical framework for the application of OWA-TOPSIS in the assessment of leadership styles. The findings presented in this article are expected to serve as a valuable guide for practitioners and academics interested in improving leadership practices and strategic decision making in their organizations [13].

2 Related Words.

2. 1 Leadership styles.

Leadership styles, a topic widely discussed in management and organizational psychology literature, represent a crucial aspect for the functioning and success of any organization. From autocratic styles to more democratic and transformational ones, each approach has its own characteristics and effects on employee behavior and performance. The essential question is how to determine which of these styles is most appropriate in different contexts and how leaders can adapt to meet the changing needs of their teams and organizations. First, autocratic leadership, characterized by centralized decision-making and absolute control by the leader, has traditionally been valued in crisis situations or when clear and rapid direction is needed. However, this style can result in low morale and a lack of creativity among employees, who may feel that their opinions and contributions are not valued. Despite these disadvantages, there are times when strong and decisive leadership is essential to overcome significant obstacles [10].

On the other hand, democratic leadership, which encourages participation and collaboration among team members, can create a more inclusive and motivating work environment. This style promotes creativity and innovation, as employees feel empowered to share their ideas and solutions. However, in situations where rapid action is required, the consultation and consensus process can slow down decision-making, which could be detrimental. Transformational leadership, which focuses on inspiring and motivating employees to reach their full potential, has gained popularity in recent years [14]. Transformational leaders are visionaries who foster a strong sense of purpose and commitment among their followers. However, this style also requires a high level of charisma and interpersonal skills, which can be a challenge for some leaders. Additionally, overreliance on a transformational figure can be risky if that figure retires or moves to another organization. It is important to note that there is no single, perfect leadership style that fits all situations. The best leaders are those who can assess circumstances and adapt their approach to the needs of the moment. Flexibility and the ability to learn and evolve are essential characteristics of effective leadership. In this sense, leadership development programs should focus on strengthening these adaptive skills instead of promoting a single style as the ideal.

The organizational context also plays a crucial role in the effectiveness of leadership styles. In organizations with rigid hierarchical structures, an autocratic style may be more accepted and effective, while in organizations with flatter, more collaborative structures, a democratic or transformational approach may be more appropriate. Therefore, leaders must be aware of organizational culture and adjust their style accordingly. Diversity in leadership is also a factor that should not be underestimated. The inclusion of different perspectives and experiences can enrich the decision-making process and foster a more innovative and resilient environment. Leaders should strive to create diverse teams and be open to different leadership approaches and styles within their teams. In terms of leadership assessment, it is essential to use a combination of qualitative and quantitative metrics. 360-degree evaluations, which include feedback from subordinates, colleagues, and superiors, can provide a complete view of a leader's performance. Likewise, organizational performance indicators, such as productivity, employee satisfaction, and talent retention, should also be considered. Finally, ongoing training and professional development are essential for leadership growth and effectiveness. Leaders must be committed to their own development and seek opportunities to improve their skills and knowledge. This includes not only formal training, but also self-reflection and learning from past experiences [10].

Leadership styles are multifaceted and must be tailored to the specific needs of the organization and team. There is no single approach that guarantees success in all situations. The ability to continually evaluate, adapt, and evolve

is what distinguishes truly effective leaders. As organizations face increasingly complex and dynamic challenges, the importance of adaptive and diversified leadership becomes even more evident.

2.2 OWA-TOPSIS.

The OWA-TOPSIS Neutrosophic method combines the techniques of the Operator of Ordered Weighted Averages (OWA) and the Method for Ordering Preferences by Similarity with the Ideal Solution (TOPSIS) with the principles of neutrosophic logic, providing a robust approach for making decisions. decisions in complex and ambiguous environments [15]. Below is a detailed and argued analysis of this method, highlighting its components, benefits and applications. Firstly, it is essential to understand the fundamentals of each technique involved. The OWA is an aggregation operator that allows multiple decision criteria to be combined, weighting each one according to their relative importance. This operator is especially useful when subjective and objective judgments must be integrated, offering a flexible way to handle ambiguous and diverse information. On the other hand, TOPSIS is a multi-criteria decision method that orders the alternatives according to their proximity to an ideal solution, considering both the distance to the ideal solution and the worst possible solution. The integration of these two methods provides a powerful tool for the evaluation and comparison of alternatives in a complex decision space [16,17].

Neutrosophic logic, developed by Florentin Smarandache, adds an additional dimension to this approach, allowing uncertainty, imprecision and inconsistency in data to be handled more effectively than traditional techniques [18]. Instead of working with exact and precise values, neutrosophic logic allows for the inclusion of degrees of truth, falsehood, and indeterminacy, which is crucial in situations where information is incomplete or contradictory. By incorporating neutrosophic logic into OWA-TOPSIS, the method's ability to handle the complexity and ambiguity inherent in many decision problems is significantly improved. The OWA-TOPSIS Neutrosophic method implementation process follows several steps. First, the decision criteria are defined and weights are assigned using the OWA operator, considering the relative importance of each criterion. Alternatives are then evaluated based on these criteria, using neutrosophic logic to represent information in a richer and more flexible way [19]. Next, the TOPSIS method is applied to order the alternatives according to their proximity to the ideal neutrosophic solution, taking into account both the truth, falsity and indeterminacy of the data. One of the main advantages of this approach is its ability to integrate multiple sources of information and manage uncertainty effectively. This is particularly useful in contexts where data is incomplete or contradictory, such as in risk assessment, strategic planning, and decision making in dynamic environments. Additionally, the OWA-TOPSIS Neutrosophic method is highly adaptable, allowing its application in a wide variety of fields, from business management to engineering and social sciences [20].

In terms of practical applications, the OWA-TOPSIS Neutrosophic method has proven to be useful in the evaluation of investment projects, supplier selection, prioritization of strategic initiatives and quality management, among others [17]. For example, in the selection of investment projects, this method allows decision-makers to evaluate multiple projects based on a series of financial, technical and strategic criteria, integrating both objective data and subjective judgments and managing the uncertainty inherent in future projections. Despite its advantages, the OWA-TOPSIS Neutrosophic method also presents some challenges. Determining appropriate weights for criteria and accurately representing neutrosophic information requires a high level of expertise and a deep understanding of neutrosophic logic. Furthermore, the implementation of this method can be computationally intensive, especially when dealing with large volumes of data or considering numerous alternatives [18].

The OWA-TOPSIS Neutrosophic method represents a significant contribution to the theory and practice of multi-criteria decision making. By combining the strengths of OWA and TOPSIS with the flexibility of neutrosophic logic, this approach provides a robust and adaptable tool to meet the challenges of decision making in complex and ambiguous environments. As organizations and decision makers face increasingly complicated problems, the adoption of methods such as OWA-TOPSIS Neutrosophic becomes increasingly relevant, offering an effective way to integrate multiple perspectives and manage uncertainty systematically [19].

This section provides a brief overview of the fundamental principles related to SVNS and SVNLS, covering definitions, operating principles, and metrics for measuring distances.

Definition 1 [21]. Let x be an element in a finite set,

$$P = \{ x, T_P(x), I_P(x), F_P(x) | x \in X \}, \quad (1)$$

where the membership function for truth, $T_P(x)$,the membership function for indeterminacy $I_P(x)$, and the membership function for falsehood $F_P(x)$clearly adhere to condition (2):

$$0 \leq T_P(x), I_P(x), F_P(x) \leq 1; \ 0 \leq T_P(x) + I_P(x) + F_P(x) \leq 3 \quad (2)$$

For an SVNS, P in X, we call the triplet $\left(T_P(x), I_P(x), F_P(x) \right)$its single-valued neutrosophic value (SVNV), denoted simply $x = (T_x, I_x, F_x)$for computational convenience.

Definition 2 [22]. Let $x = (T_x, I_x, F_x)$and and $= (T_y, I_y, F_y)$there are two SVNVs. So

1) $x \oplus y = (T_x + T_y - T_x * T_y, I_x * T_y, F_x * F_y)$;
2) $\lambda * x = (1 - (1 - T_x)\lambda, (I_x)\lambda, (F_x)\lambda), \lambda > 0$;
3) $x^{\lambda} = ((T_x)\lambda, 1 - (1 - I_x)\lambda, 1 - (1 - F_x)\lambda), \lambda > 0$

2.3 The linguistic set

Let be $S = \{s_\alpha | \alpha = 1, \dots, l\}$a finite and fully ordered discrete term set with the odd value, l, wheres_α denotes a possible value for a linguistic variable. For example, if $l = 7$, then a set of linguistic terms S could be described as follows [23]:

$$S = \{s_1, s_2, s_3, s_4, s_5, s_6, s_7\} = \{extremely\ poor, very\ poor, poor, fair, good, very\ good, extremely\ good\}. \quad (3)$$

Any linguistic variable, s_iy s_j, in S must satisfy the following rules:

1) $Neg(s_i) = s_{-i}$;
2) $s_i \leq s_j \Leftrightarrow i \leq j$;
3) $\max(s_i, s_j) = s_j,\ if\ i \leq j$;
4) $\min(s_i, s_j) = s_i,\ if\ i \leq j$.

To avoid loss of information during an aggregation process, the discrete term set S will be extended to a continuous term set. $S = \{s_\alpha | \alpha \in R\}$.Any two linguistic variables $s_\alpha, s_\beta \in S$satisfy the following operating laws [13,22] :

1) $s_\alpha \oplus s_\beta = s_\alpha + \beta$;
2) $\mu s_\alpha = s_{\mu\alpha}, \mu \geq 0$;
3) $\frac{s_\alpha}{s_\beta} = s_{\frac{\alpha}{\beta}}$

Definition 5 [22] . Let there be $x_i = \langle s_{\theta(xi)}, (T_{xi}, I_{xi}, F_{xi})\rangle$ $(i = 1, 2)$two SVNLN. Its distance measure is defined as in (6):

$$d(x_1, x_2 v) = \left[|s_{\theta(x1)} T_{x1} - s_{\theta(x2)} T_{x2}|^{\mu} + |s_{\theta(x1)} I_{x1} - s_{\theta(x2)} I_{x2}|^{\mu} + |s_{\theta(x1)} F_{x1} - s_{\theta(x2)} F_{x2}|^{\mu}\right]^{\frac{1}{\mu}} \quad (4)$$

In particular, equation (6) reduces the Hamming distance [23] of SVNLS and the Euclidean distance of SVNLS when $\mu = 1$and $\mu = 2$, respectively.

2.4 MADM Based on the SVNLOWAD-TOPSIS Method

For a given multi-attribute decision-making problem in SNVL environments, $A = \{A_1, \dots, A_m\}$denotes a set of discrete feasible alternatives, $C = \{C_1, \dots, C_n\}$represents a set of attributes, and $E = \{e_1, \dots, e_k\}$is a set of experts (or DM) with the weight vector $\omega = \{\omega_1, \dots, \omega_k\}$T, such that $\sum_{i=1}^{n} w_i = 1$ and $0 \leq \omega_i \leq 1$. Suppose the attribute weight vector $s\,v = (v_1, \dots, v_n)^T$, which satisfies $\sum_{i=1}^{n} v_i = 1$ and $v_i \in [0, 1]$. The evaluation, $\alpha_{ij}^{(k)}$given by the expert, $e_{t(t = 1,\dots,k)}$on the alternative, $A_{i(i = 1,\dots,m)}$,relative to the attribute, $C_{j(j = 1,\dots,n)}$forms the individual decision matrix as shown in equation [24] (7):

$$D^k = \begin{array}{c} \\ A_1 \\ \vdots \\ A_n \end{array} \begin{array}{c} \begin{array}{ccc} C_1 & \cdots & C_n \end{array} \\ \begin{pmatrix} \alpha_{11}^{(k)} & \cdots & \alpha_{1n}^{(k)} \\ \vdots & \ddots & \vdots \\ \alpha_{m1}^{(k)} & \cdots & \alpha_{mn}^{(k)} \end{pmatrix} \end{array} \quad (5)$$

where $\alpha_{ij}^k = \langle s_{\theta(\alpha_{ij})}^k, (T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k)\rangle$is represented by an SVNLN, which satisfies$s_{\theta(\alpha ij)}^k \in \bar{S}, T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k \in [0,1] and\ 0 \leq T_{\alpha_{ij}}^k + I_{\alpha_{ij}}^k + F_{\alpha_{ij}}^k \leq 3$.

Geng et al.[25] extended the TOPSIS method to adapt it to the SVNLS scenario, and the procedures of the extended model can be summarized as follows.

Step 1. Normalize the individual decision matrices:

In practical scenarios, MADM problems can encompass both benefit attributes and cost attributes. Let B and S the sets of benefit attributes and cost attributes, respectively. Therefore, the conversion rules specified in (8) apply:

$$\begin{cases} r_{ij}^{(k)} = \alpha_{ij}^{(k)} = \langle s_{\theta(\alpha_{ij})}^k, (T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k)\rangle, & \text{for} \quad j \in B, \\ r_{ij}^{(k)} = \langle s_{l-\theta(\alpha_{ij})}^k, (T_{\alpha_{ij}}^k, I_{\alpha_{ij}}^k, F_{\alpha_{ij}}^k)\rangle, & \text{for} \quad j \in S. \end{cases} \quad (6)$$

Thus, the standardized decision information, $R^k = (r_{ij}^{(k)})_{m\times n}$, is set as in (9):

$$R^k = (r_{ij}^{(k)})_{m\times n} = \begin{pmatrix} r_{11}^{(k)} & \cdots & r_{1n}^{(k)} \\ \vdots & \ddots & \vdots \\ r_{m1}^{(k)} & \cdots & r_{mn}^{(k)} \end{pmatrix} \quad (7)$$

Step 2 . Build the collective matrix:

All opinions from individual DMs are aggregated into a group opinion:

$$R = (r_{ij})_{m\times n} = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \quad (8)$$

Where $r_{ij} = \sum_{k=1}^{t} \omega_k \, r_{ij}^{(k)}$.

Step 3. Set the weighted SVNL decision information:

The weighted SVNL decision matrix, , is formed as shown in (11), using the operating laws given in Definition 2 above:

$$Y = (y_{ij})_{m\times n} = \begin{pmatrix} v_1 r_{11} & \cdots & v_n r_{1n} \\ \vdots & \ddots & \vdots \\ v_1 r_{m1} & \cdots & v_n r_{mn} \end{pmatrix} \quad (9)$$

The OWA operator is fundamental in aggregation techniques, widely studied by researchers . Its main advantage lies in organizing the arguments and facilitating the integration of the experts' attitudes in decision-making. Recent research has explored OWA in distance measurement, generating variations of OWAD[26] . Taking advantage of the benefits of OWA, the text proposes an SVNL OWA distance measure (SVNLOWAD). Given the desirable properties of the OWA operator, an SVNL OWA distance measure (SVNLOWAD) is proposed in the following text.

Definition 6 [26] . *Let $x_j, x_j^{'}$ $(j = 1, \ldots, n)$the two collections of SVNLN be.*

$$SVNLOWAD((x_1, x_1'), \ldots, (x_n, x_n')) = \sum_{j=1}^{n} w_j d(x_j, x_j'), \quad (10)$$

Therefore, step 4 of this method can be considered as follows:

Step 4 [27]. For each alternative, $A_i$the SVNLOWAD is calculated for the PIS, $A^+$and the NIS A^-, using equation (12):

$$SVNLOWAD(A_i, A^+) = \sum_{j=1}^{n} w_j \, \dot{d}\left(y_{ij}, y_j^+\right), i = 1, \ldots, m \quad (11)$$

$$SVNLOWAD(A_i, A^-) = \sum_{j=1}^{n} w_j \, \dot{d}\left(y_{ij}, y_j^-\right), i = 1, \ldots, m \quad (12)$$

where $\dot{d}(y_{ij}, y_j^+)$and $\dot{d}(y_{ij}, y_j^-)$are the j -th largest values of $\dot{d}(y_{ij}, y_j^+)$and , $\dot{d}(y_{ij}, y_j^-)$respectively.

Step 5 . In the classical TOPSIS approach, the relative closeness coefficient, C , is used to rank the alternatives. However, some researchers have highlighted cases where relative closeness does not achieve the desired objective of simultaneously minimizing the distance from the PIS and maximizing the distance from the NIS. Thus, following an idea proposed in references [18] , in equations (15)–(17), we introduce a modified relative closeness coefficient, $C'(Ai)$, used to measure the degree to which the alternatives, Ai (i = 1,..., m =1,...,), are close to the PIS and also far from the NIS, congruently:

$$C'(A_i) = \frac{SVNLOWAD(A_i, A^-)}{SVNLOWAD_{\max}(A_i, A^-)} - \frac{SVNLOWAD(A_i, A^+)}{SVNLOWAD_{\min}(A_i, A^+)}, \quad (13)$$

where

$$SVNLOWAD_{\max}(A_i, A^-) = \max_{1\le i\le m} SVNLOWAD(A_i, A^-), \quad (14)$$

and

$$SVNLOWAD_{\min}(A_i, A^+) = \min_{1\le i\le m} SVNLOWAD(A_i, A^+). \quad (15)$$

It is clear that $C'(A_i) \le 0$ $(i = 1, \ldots, m)$the higher the value of $C'(A_i)$, the better A_i the alternative. Furthermore, if an alternative A^*satisfies the conditions $SVNLOWAD(A^*, A^-) = SVNLOWAD_{\max}(A^*, A^-)$and $SVNLOWAD(A^*, A^+) = SVNLOWAD_{\min}(A^*, A^+)$, then $C'(A^*) = 0$y the alternative $A^*$is the most suitable candidate, since it has the minimum distance to the PIS and the maximum distance to the NIS.

Step 6. Rank and identify the most desirable alternatives based on the decreasing closeness coefficient $C'(A_i)$obtained using Equation (15).

3. Results and discussion.

The importance of leadership styles in organizations is a central topic in business management and organizational theory. Below, ten key aspects are explored that highlight its relevance:

1. **Influence on Organizational Culture:** Leadership styles shape the culture of an organization. A leader who promotes transparency, collaboration and innovation, for example, will establish an organizational culture that values these principles, directly influencing employee behavior and attitudes.
2. **Impact on Morale and Motivation:** Leadership style significantly affects employee morale and motivation. Transformational leaders, who inspire and motivate their teams through a shared vision, can raise employee morale and engagement, resulting in greater productivity and job satisfaction.
3. **Decision Making Effectiveness:** Different leadership styles impact decision making effectiveness. An autocratic leader can make decisions quickly in crisis situations, while a democratic leader can involve his or her team in the process, resulting in more inclusive and well-informed decisions.
4. **Talent Development:** Leaders who adopt a coaching or transformational leadership style focus on the development and growth of their employees. This not only enhances individual skills, but also prepares the organization for future leadership needs, ensuring successful succession.
5. **Adaptability and Organizational Resilience:** An adaptive leadership style can help an organization become more resilient in the face of change and challenges. Leaders who can adjust their style according to the needs of the context and the team contribute to greater flexibility and organizational responsiveness.
6. **Labor Relations:** Leadership style influences labor relations and team cohesion. A leader who practices a participatory and empathetic style fosters a positive and collaborative work environment, which can reduce conflict and improve communication.
7. **Innovation and Creativity:** Leaders who adopt styles that encourage creativity and innovation, such as transformational leadership or situational leadership, can drive the generation of new ideas and solutions. This is vital for the competitiveness and continued growth of the organization.
8. **Performance and Results:** Organizational performance is closely linked to leadership style. Effective leaders align individual goals with organizational goals, which can improve overall performance and results, from productivity to profitability.
9. **Customer Satisfaction:** A leadership style that promotes customer service and quality can have a positive impact on customer satisfaction. When employees are motivated and engaged, they are more likely to provide superior service, which improves customer loyalty and company reputation.
10. **Talent Retention:** Leadership styles influence talent retention. A positive work environment and effective leadership are key factors in retaining valuable employees, reducing turnover and costs associated with hiring and training new employees.

Leadership styles are fundamental to the success and sustainability of an organization. Leaders who can adapt and use different leadership styles depending on the needs of the context and the team have a significant advantage in creating a strong, flexible and growth-oriented organization. Understanding and developing effective leadership styles should be a priority for any organization that aspires to achieve its strategic objectives and maintain a competitive advantage in the market.

For the development of the study, three experts in the field participated, who collaborate in the selection of criteria of interest and in the evaluation of various leadership styles. In this case, three styles are considered for evaluation:

1. **Autocratic Leadership:**
   - Characteristics: The autocratic leader makes decisions unilaterally, without consulting team members. This style is characterized by centralized control and top-down communication.
   - Advantages: Allows quick decision making, which is useful in crisis situations or when immediate action is required. It can also be effective in environments where close supervision is needed.
   - Disadvantages: It can lead to low morale among employees, as their opinions and contributions are not valued. In the long term, it can result in a lack of creativity and innovation due to dependence on the leader for decision making.
2. **Democratic Leadership:**
   - Characteristics: Also known as participative leadership, this style involves the participation of employees in the decision-making process. The democratic leader encourages collaboration and two-way communication.
   - Advantages: Promotes a high level of commitment and job satisfaction among employees, as they feel valued and listened to. This style can also encourage creativity and innovation as multiple perspectives are considered.
   - Disadvantages: The decision-making process can be slower, which can be a drawback in situations

that require a quick response. Additionally, it can be difficult to reach consensus in large, diverse teams.

3. **Transformational Leadership:**
   - Characteristics: The transformational leader inspires and motivates employees to reach their full potential by creating a shared vision and fostering a strong sense of purpose. This style focuses on change and innovation.
   - Advantages: Can result in very high levels of commitment and motivation among employees, which in turn can lead to superior organizational performance. Transformational leaders are capable of bringing about significant and positive changes within the organization.
   - Disadvantages: Requires a high level of charisma and interpersonal skills on the part of the leader, which may not be easy to find or develop. Additionally, reliance on a transformational figure can be risky if that leader retires or moves to another organization.
4. **Situational leadership:**
   1. Adaptability: Situational leaders adjust their leadership style based on the team members' level of maturity and skills, as well as the specific demands of the task.
   2. Continuous diagnosis: They constantly evaluate the situation to determine the level of direction and support each team member needs at any given time.

Advantages:

- Flexibility: Allows the leader to adapt to different contexts and challenges, thus optimizing the team's effectiveness.
- Team Development: Fosters the individual and collective development of team members by providing the appropriate level of direction and support.
- Disadvantages:
- Complexity: Requires advanced diagnostic skills and adaptability on the part of the leader, which can be difficult to master.

The evaluation criteria are fundamental to evaluate the different styles. In this study the following criteria have been selected:

1. **Decision Making Efficiency:**
   - Description: This criterion evaluates the leader's ability to make timely and effective decisions that benefit the organization.
   - Indicators: Speed in decision making, quality of decisions, impact of decisions on organizational performance.
   - Example: An autocratic leader may be very effective in crisis situations where a quick decision is needed, while a democratic leader may be more appropriate in situations where it is important to consider multiple perspectives.
2. **Employee Motivation and Engagement:**
   - Description: This criterion measures the degree to which the leader can inspire and motivate his or her employees, as well as his or her ability to foster commitment and job satisfaction.
   - Indicators: Levels of job satisfaction, staff turnover rates, commitment to the organization, enthusiasm and team morale.
   - Example: A transformational leader who inspires his team with a shared vision can significantly increase employee engagement and motivation, while an autocratic style could have the opposite effect.
3. **Innovation and Creativity Capacity:**
   - Description: This criterion evaluates how the leadership style fosters innovation and creativity within the organization.
   - Indicators: Number of new ideas generated, implementation of innovative initiatives, work environment that encourages creativity.
   - Example: Democratic leadership, which encourages participation and the exchange of ideas, can be more effective in generating innovation compared to autocratic leadership, which could restrict creativity.

Experts assign a set of weighting values to the chosen criteria to reflect their relative relevance in the evaluation process. These weight values, provided by the experts, are as follows: C1: 0.15, C2: 0.25, C3: 0.25 and C4: 0.35.

The experts participating in the study provide evaluations for each alternative with respect to the mentioned criteria. These evaluations are expressed in terms of SVNL (Semantic Linguistic Numerical Variable) decision information using the linguistic term set $(S = s_1 = \text{“}extremely\ poor\text{”}, s_2\text{“}very\ poor\text{”}, s_3 = \text{”}poor\text{”}, s_4 = \text{“}fair\text{”}, s_5 = \text{“}good\text{”}, s_6 = \text{“}very\ good\text{”}, s_7 = \text{“}extremely\ good\text{”})$.

The standardized SVNL decision matrices are set out in Table 1 to Table 4.

Table 1: Evaluation of alternatives according to Criterion 1

Alternatives	EXPERT 1	EXPERT 2	EXPERT 3
1	S5(0,4,0,2,0,3)	S5(0,4,0,3,0,4)	S6(0,5,0,2,0,3)
2	S6(0,6,0,1,0,2)	S6(0,7,0,2,0,3)	S5(0,5,0,2,0,3)
3	S5(0,4,0,3,0,4)	S6(0,4,0,2,0,4)	S6(0,5,0,1,0,3)
4	S6(0,7,0,2,0,3)	S4(0,8,0,1,0,2)	S4(0,6,0,1,0,2)

Table 2: Evaluation of alternatives according to Criterion 2

Alternatives	EXPERT 1	EXPERT 2	EXPERT 3
1	S5(0,4,0,2,0,3)	S6(0,5,0,1,0,2)	S6(0,6,0,2,0,4)
2	S5(0,6,0,1,0,2)	S6(0,7,0,2,0,3)	S4(0,7,0,2,0,2)
3	S4(0,5,0,2,0,3)	S6(0,6,0,3,0,4)	S5(0,6,0,1,0,3)
4	S4(0,6,0,1,0,2)	S5(0,7,0,2,0,3)	S4(0,5,0,2,0,2)

Table 3: Evaluation of alternatives according to Criterion 3

Alternatives	EXPERT 1	EXPERT 2	EXPERT 3
1	S3(0,3,0,2,0,5)	S5(0,3,0,1,0,6)	S5(0,2,0,1,0,6)
2	S4(0,5,0,2,0,2)	S5(0,6,0,2,0,2)	S5(0,7,0,2,0,1)
3	S3(0,5,0,3,0,1)	S4(0,6,0,1,0,3)	S4(0,6,0,2,0,1)
4	S3(0,3,0,1,0,2)	S4(0,4,0,2,0,2)	S3(0,4,0,1,0,1)

Table 4: Evaluation of alternatives according to Criterion 4

Alternatives	EXPERT 1	EXPERT 2	EXPERT 3
1	S4(0,5,0,3,0,3)	S3(0,7,0,1,0,1)	S4(0,5,0,2,0,3)
2	S3(0,6,0,2,0,4)	S4(0,5,0,4,0,2)	S6(0,4,0,6,0,2)
3	S5(0,3,0,5,0,2)	S5(0,4,0,4,0,1)	S4(0,3,0,6,0,2)
4	S6(0,6,0,1,0,2)	S6(0,6,0,3,0,3)	S5(0,7,0,2,0,1)

The collective opinion is calculated and the SVNL collective decision matrix is obtained, which is presented in Table 5. This process is crucial to integrate the individual evaluations of the experts and obtain a joint perspective on the alternatives under study. The resulting matrix reflects the synthesis of individual opinions, allowing for a comprehensive and systematic evaluation of the alternatives under consideration.

Table 5: SVNL Collective Decision Matrix

Alternatives	C1	C2	C3	C4
1	S5.28(0.432,0.232,0.334)	S5.61(0.503,0.162,0.292)	S4.29(0.266,0.129,0.568)	S3.63(0.575,0.185,0.211)
2	S5.61(0.605,0.162,0.266)	S4.95(0.666,0.162,0.232)	S4.62(0.605,0.203,0.162)	S4.29(0.503,0.367,0.255)
3	S5.61(0.432,0.185,0.367)	S4.95(0.565,0.185,0.334)	S3.63(0.565,0.185,0.147)	S4.62(0.332,0.497,0.162)
4	S4.62(0.708,0.129,0.232)	S4.29(0.605,0.162,0.232)	S3.3(0.365,0.129,0.162)	S5.61(0.633,0.185,0.185)

The process of obtaining the weighted collective SVNL matrix is based on the specific operating rules of SVNL. The result of this calculation is presented in Table 6. This methodological approach ensures that the weights

assigned to each criterion, as well as the individual evaluations carried out by the experts, are adequately integrated. By applying these operational rules, a weighted and rigorous synthesis of individual opinions is achieved, providing a comprehensive and coherent vision of the alternatives evaluated in the study.

Table 6: Weighted collective SVNL decision matrix.

Alternatives	C1	C2	C3	C4
1	S1.06(0.107;0.75;0.8)	S1.06(0.1;0.76;0.83)	S1.06(0.074;0.6;0.87)	S1.06(0.29;0.51;0.54)
2	S1.12(0.17;0.69;0.77)	S1.12(0.152;0.76;0.8)	S1.12(0.207;0.67;0.63)	S1.12(0.244;0.67;0.58)
3	S1.12(0.107;0.71;0.82)	S1.12(0.117;0.78;0.85)	S1.12(0.188;0.66;0.62)	S1.12(0.149;0.76;0.48)
4	S0.92(0.218;0.66;0.75)	S0.92(0.13;0.76;0.8)	S0.92(0.107;0.6;0.63)	S0.92(0.33;0.51;0.51)

Decision makers, in order to incorporate their complex attitudes, determine the weight vector of the OWA operator: W = (0.25, 0.30, 0.35, 0.10). Then, we use equations (13) and (14) to calculate the measures SVNLOWAD $SVNLOWAD(A_i, A^+)$and $(SVNLOWAD(A_i, A^-)$between $A_i$the alternative and $PISA^+$and $NIS\ A^-$respectively.

This approach allows decision makers to explicitly weigh the relative importance of different criteria in the evaluation process. By employing the aforementioned equations, the relative distance between each alternative and the reference points (PIS and NIS) is quantified, providing an objective basis for comparing and ranking the alternatives based on their performance with respect to the established criteria.

For EL 1:

- SVNLOWAD(EL 1) = 0.127
- SVNLOWAD(EL 1) = 0.135
- C` (EL 1) = (0.127 + 0.135) / 2 = 0.131

For EL 2:

- SVNLOWAD (EL 2)= 0.037
- SVNLOWAD (EL 2) = 0.081
- C` (EL 2) = (0.037 + 0.081) / 2 = 0.059

For EL 3:

- SVNLOWAD (EL 3) = 0.07
- SVNLOWAD (THE 3) = 0.117
- C` (EL 3) = (0.07 + 0.117) / 2 = 0.0935

For EL 4:

- SVNLOWAD (EL 4) = 0.07
- SVNLOWAD (EL 4) = 0.005
- C` (EL 4) = (0.07 + 0.005) / 2 = 0.0375

Table 7: Relative distances between each alternative and the reference points.

	$SVNLOWAD\ (A_i, A^+)$	$(SVNLOWAD(A_i, A^-)$	C`
1	0.127	0.135	0.131

	$SVNLOWAD\ (A_i, A^+)$	$(SVNLOWAD(A_i, A^-)$	C`
2	0.037	0.081	0.059
3	0.07	0.117	0.0935
4	0.07	0.005	0.0375

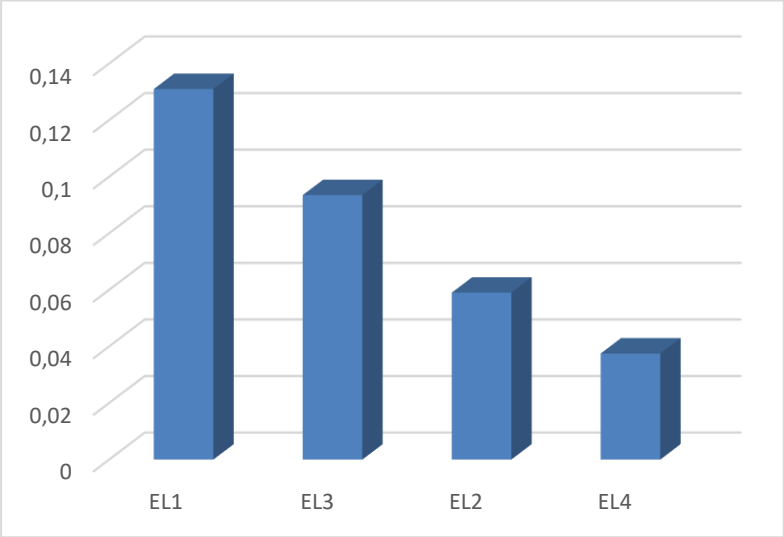

Figure 1: Relative distances between each alternative and the reference points.

Order of the leadership styles of the most prevalent leaders:

1. Autocratic Leadership
2. Transformational Leadership
3. Democratic Leadership

Leading teams effectively in the dynamic business world is a constant challenge that requires understanding various leadership styles: autocratic, democratic, transformational, and situational. Each style has unique characteristics that impact team dynamics and organizational outcomes. Autocratic leadership excels in crisis situations with its swift decision-making but may hinder long-term morale and creativity. Democratic leadership fosters participation and commitment but can slow decision-making and face challenges in reaching consensus in large teams. Transformational leadership inspires and motivates through a shared vision, enhancing commitment and performance, though it relies heavily on the leader's charisma. Situational leadership adapts to the specific needs of the team and task, offering flexibility in dynamic environments, but requires exceptional diagnostic and adaptive skills. The effectiveness of a leadership style depends on the context and organizational circumstances, with no universally superior approach. Successful leaders proactively assess situations, fostering an environment of collaboration, innovation, and continuous development to meet challenges and achieve goals sustainably.

4 Conclusion

Leading teams effectively in the dynamic business world requires understanding various leadership styles such as autocratic, democratic, transformational, and situational. Each style has unique characteristics that impact team dynamics and organizational outcomes. Autocratic leadership is efficient in crises but may reduce long-term morale and creativity. Democratic leadership fosters participation and commitment but can slow decision-making. Transformational leadership inspires and motivates through a shared vision but depends on the leader's charisma. Situational leadership adapts to the specific needs of the team and task, offering flexibility but requires exceptional diagnostic and adaptive skills. There is no universally superior approach; the key lies in the leader's ability to proactively assess and respond to situations.

Future work could explore the use of OWA operators and the neutrosophic TOPSIS method in information fusion to enhance decision-making in complex contexts. These approaches can provide a more robust and flexible framework for integrating diverse information sources and managing uncertainty, thereby optimizing leadership strategies and organizational effectiveness.

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