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RESEARCH ARTICLE

SOHCO: A Strategy for Constructing Efficient Teams

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ABSTRACT Software engineering is concerned with organizational issues, project management, and human behavior. In the process of constructing a work team, leadership faces the task of evaluating the talents and abilities of each professional and combining them into a cohesive unit that matches the profile of the project. This article describes the SOHCO technique, a strategy for forming work teams that calculates a score for each candidate based on the project profile, as well as a ranking for the work team whose desired objective most closely aligns with the project profile. This article presents exploratory research, an experiment, two real-world case studies, and a comparison of methods using WS and RW coefficients to assess ranking consistency and similarity. Results reveal that SOHCO makes constructing a work team more objective, reduces leadership effort, enhances the ability to evaluate new team arrangements, increases the probability of project success, and reduces training costs. As a limitation, the SOHCO method does not take sub-criteria weights into account.

INDEX TERMS AHP, company fit, MCDM, hard skill, hiring, soft skill, MCDA, MOOSRA, comet.

I. INTRODUCTION

Software engineering includes organizational issues, design management and human behavior [1], [2]. In this scenario, leadership has a challenge to form work teams, as there are several criteria that must be analyzed individually in the professionals and and combined between them to form the team with the highest performance and adherence to the project profile [3]. There is even a growing agenda regarding diversity and neurodiversity criteria, which can contribute to team integration and social inclusion. Microsoft and Sky take these factors into account [4], [5].

Upon receiving a new project, the leadership has an overview of the activities and maps the competencies and skills needed for the project team. With online recruitment platforms, more candidates connect with companies, making manual CV analysis complex and time-consuming [6].

Methods and tools can replace the empirical method and help in the evaluation of numerous criteria. References [7] and [8] present some of the main MCDM/MCDA (multi-criteria decision methods) that in general evaluate criteria through weights, priority criteria, or thresholds; and result in a ranking of alternatives.

This work presents the 'SOHCO' method which, inspired by MCDM/MCDA, provides not only a ranking of candidates, but also calculates a ranking of work teams based on the project profile. SOHCO also allows you to compare seniority and staff cost, reducing the amount of data that leadership must analyze.

A quantitative exploratory research was undertaken to confirm the theme of this proposal and to identify the criteria used most often by leadership throughout the team building process. This research is described

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in the **"Section III-Exploratory Survey**. The following sections are structured as follows: the **"Section II-Related Works"** describes related works; the **"Section IV-SOHCO Method"** describes the SOHCO method; the **"Section V-EXPERIMENT"** describes an experiment, two real studies and a comparative study of methods; the **"Section VI-Discussions and Limitations"** describes the results and limitations, and the **"Section VII-Conclusion"** describes the conclusion and future work.

II. RELATED WORKS

This section contains works that apply MCDM techniques to generate a ranking of alternatives. The differential of the SOHCO method is to correlate alternative options and offer the set that best adheres to the project profile.

In [9], the author uses the AHP (Analytic Hierarchy Process), authored by [10], to compare criteria using an n-level hierarchy. A later variation by the same author, the ANP (Analytic Network Process) analyzes dependencies between levels of criteria. Limitations have prevented studies on the adequacy of expert selection criteria and essential project requirements.

In [11], the author uses the ELECTRE (Elimination and Choice Expressing Reality), authored by [12], which is based on the principles of votes for and against, on the agreement and disagreement that one alternative has in relation to the other to treat imprecision using thresholds of preference and indifference. As a limitation, it was stated that the number of alternatives is limited between 3 and 8, preventing us from evaluating the performance of methods with a more significant number of other options. Furthermore, discrepancies between the rankings obtained and the decision makers' preferences are not reported.

In [13], the author uses the PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation), authored by [14], to evaluate and determine weights for the criteria based on the preference structure of decision makers and uses the thresholds of indifference and preference to indicate the value of one alternative over the other. As a limitation, mention is made of the need to examine the interdependencies between the criteria and to involve more than one leader in determining the evaluation criteria and evaluating the candidates.

In [15], the author use the MACBETH (Measuring Attractiveness by a Categorical-Based Evaluation Technique), authored by [16], which classifies alternatives according to their attractiveness. As a limitation, the author identifies the need for research on possible IT frameworks that can be used to implement the method.

In [17], the author uses the TOPSIS (Technique for Order Preference by Similarity to the Ideal Solution), authored by [18], to evaluate the performance of alternatives based on their similarity to an ideal solution. The perfect solution is formed by taking the best values of the other options during the evaluation of each decision criterion. In contrast, the negative ideal solution is created by taking the worst questions to rank the candidates. As a limitation, the author cites only one analysis in a single step, and the criteria can be analyzed in two or more steps.

In [19] the author proposes the DARIA-TOPSIS (Data vARIability Assessment Technique for Order of Preference by Similarity to Ideal Solution) which considers the dynamics of the variability of the efficiency values of the alternatives over the investigated time. It uses the GINI coefficient to determine the criteria weights over the period, the TOPSIS method to find the annual ranking of each alternative and the data correlation to calculate the efficiency of the correlation between the analyzed years. As a limitation, the author cites the fact that the framework is based on the assumptions of the MCDA, and therefore inherits all the analytical potential of this group of methods.

In [20] the author proposes the SPOTIS (Stable Preference Ordering Towards Ideal Solution) to rank alternatives based on the score established by similarity and weighted average distance from the ideal solution. As a limitation, the author cites the need to work with missing and imprecise data.

In [21] the author uses the COPRAS (Complex Proportional Assessment), authored by [22], which ranks the alternatives based on their relative importance and the ranking of the alternatives is based on the positive and negative ideal solutions. As a limitation, the author cites that the results of this method are sensitive to a small variation in data compared to other methods.

In [23] the author makes a comparison between the methods COMET (characteristic objects method) authored by [24]. that evaluates the alternatives by the vector of the values defined in the criteria, and the CODAS-COMET (combinative distance-based assessment) that complements with the evaluation of the distance between the sets of alternatives, guaranteeing greater reliability of the results. Limitations are not cited, but as future work, application with other data sets and a comparison with other MDCA methods are suggested.

In [25] the author contrasts the MULTIMOORA(Multi-Objective Optimization on the basis of Ratio Analisys Multiplicative Form), authored by [26] with the MOOSRA (Multi-Objective Optimisation on the Basis of Simple Ratio Analysis), authored by [27]. Both use maximum and minimum thresholds, as well as helpful and non-beneficial criteria. While MULTIMOORA uses a proportional approach to create a point of reference and rank alternatives, the MOOSRA technique employs a basic ratio system in which the sum of advantageous criteria is divided by the sum of non-beneficial criteria, yielding the overall score. As a limitation for both criteria, the author cites the need to work with alternatives that are known in detail beforehand. If any criterion is missing from an alternative, that alternative must be dropped from the decision process or given an extremely low token value to the missing criterion.

The Table 1 compares related works based on the selection procedure and team formation approach.

TABLE 1. Related works.

	AHP [9]	TOP [17]	ELE [11]	PRO [13]	MAC [15]	DAR [19]	SPO [20]	COP [21]	COM [23].a	COD [23].b	MUL [25].a	MOO [25].b	SOHCO
Use weight	No	Yes	No	Yes	No	Yes	Yes	Yes	No	No	No	No	Yes
Sorted ranking	Yes	Yes	No	Yes	Yes	Yes	No	Yes	No	No	No	No	Yes
Limiting criteria	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Quantitative data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Qualitative data	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Score x goal	No	Yes	No	No	No	No	Yes	Yes	Yes	Yes	Yes	No	Yes
Distance	No	No	No	No	No	No	No	No	No	Yes	No	No	No
Dynamic approach	No	No	No	No	No	Yes	No	No	No	No	No	No	No
Team formation	No	No	No	No	No	No	No	No	No	No	No	No	Yes

III. EXPLORATORY SURVEY

An exploratory survey was conducted in July 2022 with 103 team-building-experienced leaders in Brazil, with 82% in the Southeast region: 71% SP, 8% MG, and 3% in RJ. 13% of respondents are in the South, with 12% RS and 1% SC. And 6% in other regions.

The survey, was conducted via a form aimed to determine the topic's relevance and the criteria, methods, and tools used by leadership to form teams. And substantiate the hypotheses: Team building is an empirical process; administration finds it easier to train complex skills than soft skills; subjective criteria such as affinity, match with the company's culture, cost, and feeling are considered in the decision-making process; and the methods or tools utilized by the majority of leadership are easy-to-use spreadsheets.

The survey did not aim to reach the absolute truth, but to obtain a logical understanding of how leadership forms its teams daily.

81% of respondents agree that the job market is globalized, dynamic, and full of complex, integrated projects that require specialized teams.

68% of respondents believe that investing leadership time and energy in the recruitment and selection process reduces turnover; 87% believe that training costs are reduced; 66% believe that it contributes to team cohesion; and 57% believe that team productivity is increased.

74% of respondents prefer empirical team formation. 41% involve the team in decision-making, 31% consider affinities, 54% use feeling, and 24% prioritize the indication.

53% of respondents agree that there is a lack of professionals on the market, and 47% agree that it's hard to reconcile candidate and team profiles.

When asked about the quote People are hired for their hard skills and fired for their soft skills", 76% of respondents disagreed, and 48% consider low interaction and team integration to be dismissal factors.

In a scenario where the leadership has one open position and must choose between two candidates with the same technical skills, 67% of respondents were split between personality (34%) and soft skills (33%). Affinity with company culture (20%), feeling (7%), indication (5%), and candidate cost (1%) followed.

Figures 1 and 2 show the use and representativeness of the candidate evaluation criteria. Note that the sum of the use of these criteria in "All positions" and "Some positions" is at least 50%, indicating that subjective criteria are representative of team building processes.

When asked about the degree of impact that one criterion has on the other in the decision-making process, the research compared some pairs of criteria and found that the criterion "Soft Skills" outperforms "Feeling" with 79%, "Hard Skills" with 70% and "Cost" with 80%. There is a balance between "Cost" and "Feeling" and "Feeling" prevails with 59%. And "Hard Skills" surpasses "Indication" with 75%.

Regarding methods and tools, 45% of respondents manually analyze curricula and assign weights and/or priority to each criterion. 27% use a spreadsheet for control, while 17% employ a particular system.

The research concludes that technical and behavioral criteria are balanced considered when forming teams. In the decision-making process, subjective factors such as affinity, fit with the company's culture, cost, and feeling also play a role. When constructing teams, leaders frequently rely on personal experiences and subjective perceptions of what is optimal for projects. They would instead hire a candidate with the soft skills needed for the project and train hard skills than the other way around. Regarding methods or instruments, leadership typically employs artifacts such as electronic spreadsheets and manual candidate analysis. They typically assign weights and priorities to the criteria to aid in the decision-making process.

IV. SOHCO METHOD

SOHCO is an acronym for SOft skill, Hard skill and COMPany Fit, a method that allows you to match candidates and generate a ranking of possible team arrangements based on the profile project.

Following is a description of the SOHCO method, which consists of the following processes: the first, the leadership establishes the project profile and collects applicant assessments. In the second step, applicants scores are calculated. The third phase calculates the project relationship matrix. Calculating the team relationship matrix is the fourth step. The average percentage of team engagement is then determined.

A. PROJECT PROFILE

In this process, the method proposes that the leadership structure the profile of the project and the size of the team, mapping the competencies and skills needed for each position.

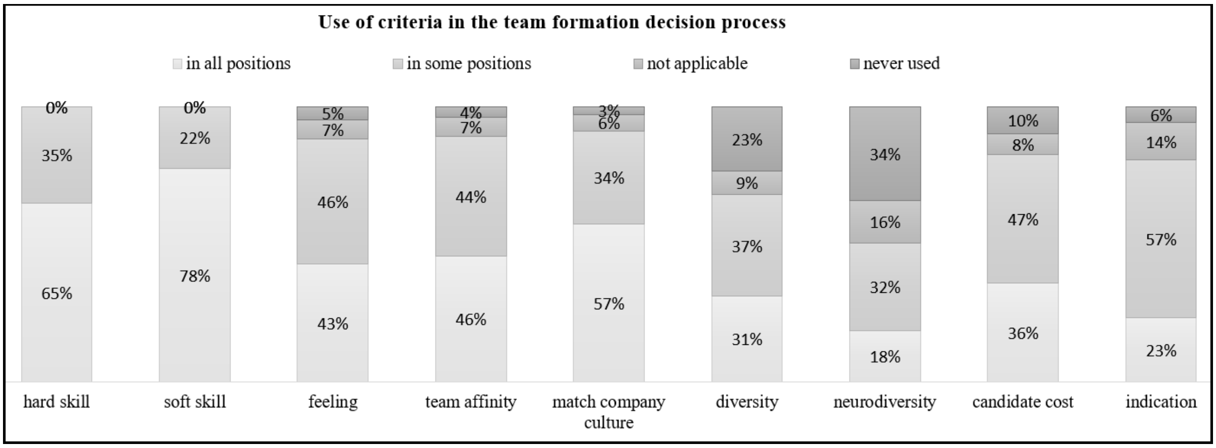

FIGURE 1. Use of criterion.

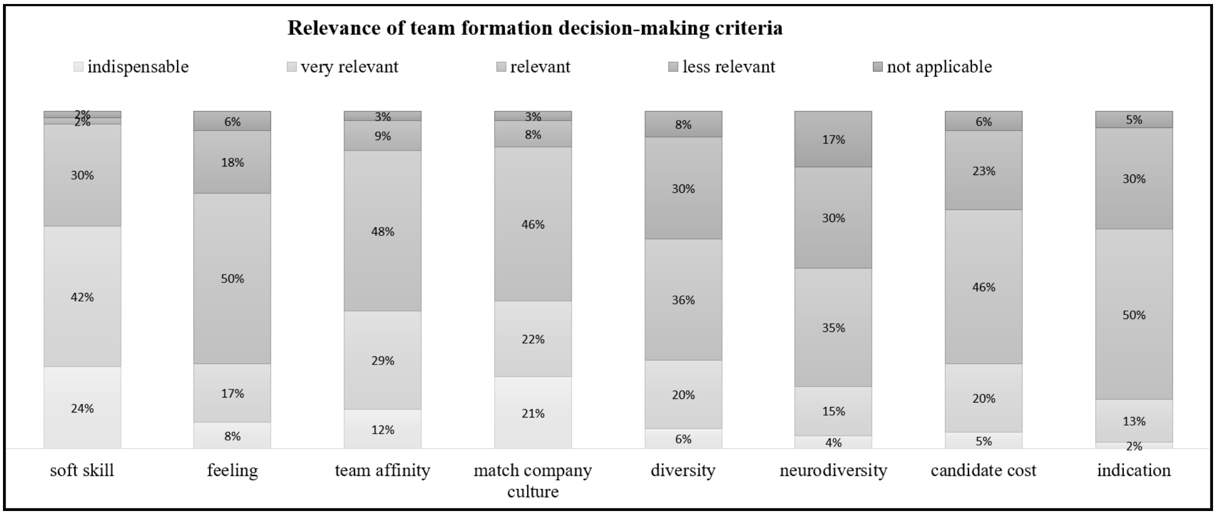

FIGURE 2. Representativeness of the criterion.

The choice of weights for each criterion is up to the leadership, and depends on the relevance of each one of them to the project profile. This study also shows the criteria for evaluating candidates.

A hypothetical example of a software development team is used to demonstrate this process, with three positions, as shown in Table 2.

In the Soft skill criterion, the following will be evaluated: dominance (D), influence (I), steadiness (S), and conscientiousness(C). The Hard skill (*Phs*) and Company Fit (*Pcf*) criteria will be represented as follows: (*Ahs*, *Bhs*, *Chs*, and *Dhs*) and (*Acf*, *Bcf* and *Ccf*).The weight assigned to each criterion is 1.

Table 2 shows the leadership-defined scores. The criteria were evaluated on a scale from 0 to 100, with 0 representing little proficiencies in the candidate and 100 representing strong proficiencies.

In this example, leadership has determined that the criterion level (D) for (Leader) is 40. The position (Dev) it does not need to be as dominant as the (Leader) and has therefore determined that a score of 12 is sufficient for this position. On the other hand, it is essential for the project that (Arc) that it is very dominant; therefore, the desired score was set at 60.

TABLE 2. Profile project.

Position	Soft Skill (P_{ss})				Hard Skill (P_{hs})				Company Fit (P_{cf})			
	D	I	S	C	A_{hs}	B_{hs}	C_{hs}	D_{hs}	A_{cf}	B_{cf}	C_{cf}	D_{cf}
Leader	40	46	64	100	35	45	15	54	15	40	56	42
Dev	12	27	21	26	12	36	21	79	25	35	99	33
Arc	62	43	32	72	12	33	28	34	27	29	21	32

Note that the maximum score is not required for any position because, in this example, the leadership believes that putting three extremely dominant individuals on the same team could compromise the team's integration and cohesion. This is the type of analysis expected at this stage, as the distinction between positions is defined when their objectives are specified. This definition serves as the foundation for resolving the difficulty of determining the relationship between team positions and calculating the team relationship matrix (*ProjectTRM*) described in the IV-D matrix subsection.

B. CANDIDATE SCORE (EMPLOYEE SCORE (ES))

In this process, the method computes the candidate's score, which is a coefficient derived from the weighted average of his scores on each criterion, shown in the Equation (Employee Score (es))1.

$$es = \frac{(S_{ss} \cdot w_{S_{ss}}) + (S_{hs} \cdot w_{S_{hs}}) + (S_{cf} \cdot w_{S_{cf}})}{w_{S_{ss}} + w_{S_{hs}} + w_{S_{cf}}} \quad (1)$$

where:

- S_{ss} representation of the candidate's average percentage in the "Soft Skill" criterion compared to the "Soft Skill" criterion of the project profile;
- S_{hs} representation of the candidate's average percentage in the "Hard Skill" criterion compared to the "Hard Skill" criterion of the project profile;
- S_{cf} representation of the candidate's average percentage in the "Company Fit" criterion compared to the "Company Fit" criterion of the project profile;
- The variables $w_{S_{ss}}$, $w_{S_{hs}}$ and $w_{S_{cf}}$ represent each criterion's weighting. The default value for the weights is 1, but they can be modified.

Despite the fact that equation Employee Score (es) 1 is a simple weighted average, it is important to note that the criteria expressed by the terms *Sss*, *Shs* and S_cf are multi-scalars that correspond to a set of criteria. Consequently, the challenge is to convert a multi-scalar criterion into a score that expresses how well the candidate conforms to the project profile.

The proposed solution for this challenge is to calculate the candidate's percentage value for each criterion. Then, calculate the average percentage that represents the candidate's average range of conformance to the project profile. However, when evaluating each criterion individually, the candidate may decline short of expectations in one criterion while exceeding them in another, placing him in an average relationship. As a solution for this situation, it is suggested to calculate the product of the mean and the Pearson linear correlation as described in the General Adherence Equation (adhesion coefficient (ad)) 2. By utilizing pearson's linear correlation (r) 3, it is ensured that the profile of the project and the candidate have a similar score distribution.

$$ad = \frac{\sum_{i=1}^{n} \frac{y_i}{x_i}}{n} \cdot r \quad (2)$$

where:

- x represents of the criterion defined in the project profile;
- y represents the criterion obtained by candidate;
- n the number of elements;

and:

$$r = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{(n-1)S_x S_y} \quad (3)$$

where:

- $\bar{x}$ is the sample mean for the first variable
- S_x the standard deviation for the first variable
- $\bar{y}$ is the sample mean for the second variable
- S_y standard deviation for the second variable
- n the number of elements

Considering the didactic and hypothetical example mapped to the project profile, it is necessary at this stage to obtain the individual assesment of the candidates. As an example, the evaluations of five candidates are presented in Table 3.

Thus, the term *Sss* of the Equation Employee Score (es) 1 can be calculated using the Equation (*Sss*) 4, which represents the candidate's average percentage on the Soft Skill criterion.

$$S_{ss} = \left(\frac{\sum_{i=1}^{n} \frac{E_{ss_i}}{P_{ss_i}}}{n}\right)\left(\frac{\sum_{i=1}^{n}(P_{ss_i} - \overline{P_{ss}})(E_{ss_i} - \overline{E_{ss}})}{(n-1)S_{P_{ss}}S_{E_{ss}}}\right) \quad (4)$$

where:

- $\overline{P_{ss}}$ is the average of the terms evaluated for the project's Soft Skills needs;
- $S_{P_{ss}}$ the standard deviation of the evaluated terms for the Soft Skills needs of the project;
- $\overline{E_{ss}}$ is the average of the terms evaluated for the contributor's Soft Skills
- $S_{E_{ss}}$ standard deviation of the evaluated terms for the contributor's Soft Skills
- n the number of elements.

The scenario of the candidate "Mauricio" will be used as an example. The values of P_{ss_i} are obtained from Table 2, and of E_{ss_i} from Table 3.

Using the General Adhesion Equation (adhesion coefficient (ad)) 2 to calculate the term (*Sss*) as shown in Equations 5 and 6, it is determined that the candidate Maurcio achieved an adherence of 0.267773624, which corresponds to 26% (*Sss*(*Mauricio*).100) of the Soft Skills requirements desired for the project. This candidate's Soft Skills index is below the expected 100%.

$$S_{ss}(Mauricio) = \left(\frac{4.367092391}{4}\right)\left(\frac{549}{(4-1)(27.63)(27.00)}\right) \quad (5)$$

$$S_{ss}(Mauricio) = (1.091773098)\left(\frac{549}{2238.40}\right) = 0.267773624 \quad (6)$$

It should be noted that the purpose of the General Adherence Equation (adhesion coefficient (ad)) 4 was to calculate the term *Sss* (Soft Skill). Similarly, this equation must be applied to *Shs* and *Scf* in order to convert all terms to the same unit of measure. The candidate received a score of -9% for the term *Shs*, indicating that he or she does not meet the requirements for this criterion, and even points in the opposite direction. And for the term *Scf*, the candidate earned 89%, which indicates that he is closer to the project profile's 100% target for this criterion.

Using the Equation Employee Score (es) 1 it is objectively determined that this candidate's score was equivalent to 36%

TABLE 3. List of candidates and their assessments.

Candidate	Soft Skill (E_{ss})				Hard Skill (E_{hs})				Company Fit (E_{cf})			
	D	I	S	C	A_{hs}	B_{hs}	C_{hs}	D_{hs}	A_{cf}	B_{cf}	C_{cf}	D_{cf}
Sheila(Leader)	47	42	67	39	50	82	43	77	39	69	58	80
Maurício(Leader)	31	95	51	73	49	13	16	16	35	59	47	49
André(Dev)	53	41	75	69	60	69	58	82	58	69	87	72
Felipe(Arc)	41	94	46	83	36	75	40	58	53	53	39	57
Rodrigo(Arc)	13	53	53	78	53	73	62	14	27	15	51	72

of the average percentage of adherence to the necessary criteria in the project profile, as shown in Equation Employee Score (es) 7.

$$es = \frac{(0.26) + (-0.09) + (0.89)}{3} = 0.36 \tag{7}$$

C. PROJECT RELATIONSHIP MATRIX - PROJECT$_{TRM}$

In this process, the method proposes to calculate the project relationship matrix *ProjectTRM* that expresses a desirable relative adherence pattern between team positions mapped in the project profile.

The relationship matrix for the project $Project_{TRM}$ is calculed by the Relationship Equation ($R_{eq_{ij}}$) 8.

$$R_{eq_{ij}} = \frac{(R_{ss_{ij}} \cdot w_{R_{ss_{ij}}}) + (R_{hs_{ij}} \cdot w_{R_{hs_{ij}}}) + (R_{cf_{ij}} \cdot w_{R_{cf_{ij}}})}{w_{R_{ss_{ij}}} + w_{R_{hs_{ij}}} + w_{R_{cf_{ij}}}} \tag{8}$$

where:

- R_{ss} expresses the relationship of *Soft Skills* between two positions;
- R_{hs} expresses the relationship of *Hard Skills* between two positions;
- R_{cf} expresses the relationship of *Company Fits* between two positions;
- $w_{R_{ss}}$, $w_{R_{hs}}$ and $w_{R_{cf}}$ represent the weights of each criterion. By default the weights are set to 1, however they can be adjusted;

The Relationship Equation ($R_{eq_{ij}}$) 8 possesses the same logic as the candidate score equation (Employee Score (es) 1). However, its purpose is to express the relationship coefficient between positions. Consequently, the terms of the equation R_{ss}, R_{hs} and R_{cf} must be also calculated using the General Adherence Equation (ad) 2.

Thus, the derivation of the General Adherence Equation (ad) 2 for the term R_{ss} is represented by the Equation 9, which expresses the relationship between Soft Skill of the positions. Table 4 presents the result of this term for the relationship between the positions: Leader x Leader, Leader x Developer, Leader x Arc.

$$R_{ss_{ij}} = (\frac{\sum_{k=1}^{n} \frac{O_{ss_k}}{C_{ss_k}}}{n})_{ij} \cdot (\frac{\sum_{k=1}^{n}(O_{ss_k} - \overline{O_{ss}})(C_{ss_k} - \overline{C_{ss}})}{(n-1)S_{O_{ss}}S_{C_{ss}}})_{ij} \tag{9}$$

where:

- Terms starting with "O" (rOw) express the profiles indicated in the (i) lines of the Relationship Matrix, and terms starting with "C" (Column) express the profiles indicated in the columns (j);
- As the equation deals with multi-scalar criteria, each magnitude of the criterion is expressed by the index (k);
- The term ($\overline{O_{ss}}$) is the average of the Soft Skills terms of the profile identified in the Line of the Matrix; ($S_{O_{ss}}$) the standard deviation of the Soft Skills terms of the profile identified in the Line of the Matrix;
- ($\overline{C_{ss}}$) is the average of the Soft Skills terms of the profile identified in the Column of the Matrix;
- ($S_{C_{ss}}$) the standard deviation of the Soft Skills terms of the profile identified in the Column of the Matrix;
- (n) the number of elements.

Similarly, the Equation 9 must be applied to the terms R_{hs} as shown in Table 5, and R_{cf}, as shown in Table 6.

The relationship coefficient $R_{eq_{ij}}$ calculated by the R_{ss}, R_{hs} and R_{cf} terms is shown in Table 7.

The relationship coefficient $R_{eq_{ij}}$ will be assigned to the relationship matrix of the project $Project_{TRM}$ display in Table 8.

TABLE 4. R_{ss} - relationship leader x (leader/dev/arc).

	Dss	Iss	Sss	fCss	$\overline{ss}$	r	$R_{ss_{ij}}$
Leader	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dev	0.30	0.59	0.33	0.26	0.37	0.52	0.19
Arc	1.55	0.93	0.50	0.72	0.93	0.44	0.41

TABLE 5. R_{hs} - relationship leader x (leader/dev/arc).

	Acf	Bcf	Ccf	Dcf	$\overline{cf}$	r	$R_{cf_{ij}}$
Leader	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dev	0.34	0.80	1.40	1.46	1.00	0.74	0.74
Arc	0.34	0.73	1.87	0.63	0.89	0.34	0.31

TABLE 6. R_{cf} - relationship leader x (leader/dev/arc).

	Acf	Bcf	Ccf	Dcf	$\overline{cf}$	r	$R_{cf_{ij}}$
Leader	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dev	1.67	0.88	1.77	0.79	1.27	0.78	0.99
Arc	1.80	0.73	0.38	0.76	0.92	-0.35	-0.32

TABLE 7. $R_{eq_{ij}}$ relationship leader x (leader/dev/arc).

	R_{ss}	R_{hs}	R_{cf}	$R_{eq_{ij}}$
Leader	1.00	1.00	1.00	1.00
Dev	0.19	0.74	0.99	0.64
Arc	0.41	0.31	-0.32	0.13

TABLE 8. Matriz $Project_{TRM}$.

	Leader	Dev	Arc
Leader	1.00	1.10	0.20
Dev	0.64	1.00	-0.27
Arc	0.13	-0.11	1.00

TABLE 9. Matrix $Team_{TRM}$.

	Sheila	André	Felipe
Sheila	(0.87)	0.52	0.30
André	0.69	(1.41)	-0.24
Felipe	0.01	-0.20	(1.20)

D. TEAM RELATIONSHIP MATRIX ($TEAM_{TRM}$)

In this process, the method calculates the team relationship matrix ($Team_{TRM}$) in order to obtain the adherence of each possible team. For pedagogical purposes, only a possible team consisting of the candidates Sheila, André, and Felipe, whose data are presented in Table 3, will be presented.

The resulting team relationship matrix ($Team_{TRM}$), formed is calculated using the following dynamics: the principal diagonal must be computed utilizing the candidate's scoring equation (Employee Score (es)) 1). And to calculate the upper and lower triangular matrices, you must use the Relation Equation ($R_{eq_{ij}}$) 8.

The proposed dynamics objective to consider in the Team Engagement Coefficient, the degree to which the candidate's profile adheres to the project (principal diagonal) as well as the relationship with team partners (triangular matrices). The result of the Matrix $Team_{TRM}$ for the example is displayed in Table 9.

E. TEAM ENGAGEMENT

In this process, the method proposes to compute Team Engagement (T_{eng}). In the same way that the General Adherence Equation 2 (ad) is used to generate a comparative coefficient between candidates' criteria, it should be used to compare the matrices $Project_{TRM}$ (P_{TRM}) and $Team_{TRM}$ (T_{TRM}). Thus, Equation (T_{eng}) 10 represents the calculation of Team Engagement's (T_{eng}) coefficient.

$$T_{eng} = \left(\frac{\sum_{i=1}^{n}\sum_{j=1}^{k}\frac{T_{TRM_{ij}}}{P_{TRM_{ij}}}}{n\cdot k}\right) \cdot \left(\frac{\sum_{i=1}^{n}\sum_{j=1}^{k}(P_{TRM_{ij}}-\overline{P_{TRM}})(T_{TRM_{ij}}-\overline{T_{TRM}})}{((n\cdot k)-1)S_{P_{TRM}}S_{T_{TRM}}}\right) \tag{10}$$

where:

- $\overline{P_{TRM}}$ is the average of the elements of the array $Project_{TRM}$;
- $S_{P_{TRM}}$ the standard deviation of the elements of the array $Project_{TRM}$;
- $\overline{T_{TRM}}$ the average of the elements of the array $Team_{TRM}$;
- $S_{T_{TRM}}$ the standard deviation of the elements of the array $Team_{TRM}$;
- n the row number of the matrices;
- k the number of columns in the matrices;

TABLE 10. Team engagement - $Project_{TRM} \times Team_{TRM}$.

	Leader	Dev	Arc
Leader	0.87	0.47	1.55
Dev	1.08	1.41	0.89
Arc	0.08	1.78	1.20
average		1.04	
correlation		0.89	
engagement		0.9196 ou 91,96%	

TABLE 11. Possible team.

	Leader	Dev	Arc
Team 1	Sheila	André	Felipe
Team 2	Sheila	André	Rodrigo
Team 3	Mauricio	André	Felipe
Team 4	Mauricio	André	Rodrigo

Applying the Equation ($Teng$) 10 to the Matrices $Project_{TRM}$ (Tabela 8) and $Team_{TRM}$ (Tabela 9), the team attained an engagement of 0.919643792, or $T_{eng}.(100) = 91,96\%$ for displayed in Table 10.

For the didactic and hypothetical example used throughout the presentation of this method, with the project profile data presented in Table 2 and the candidate evaluation possibilities presented in Table 3, there are four possible team configurations, as shown in Table 11.

Figure 3 demonstrates the visual representation of the matrix $Project_{TRM}$ in comparison with the matrix $Team_{TRM}$ obtained through the SOHCO method, for each of the team possibilities.

The graphs demonstrate two series: the $Project_{TRM}$ project relationship matrix, represented by dashed lines, and the $Team_{TRM}$ team relationship matrix, represented by a continuous line.

Through Figure 3 it is evident that Team 1 is the configuration with the most similar series, indicating that this team configuration has the skills and abilities closest to the project objective. This was the team identified by the SOHCO method as adhering closest to the target of 100% of the project profile, achieving 91% engagement. Team 4, on the other hand, is the arrangement with the least similar series, with only 8% of engagement, indicating that candidates in this arrangement would require extensive training to meet the project's objectives.

Different team formations must produce a distinct coefficient of engagement, as demonstrated by the example. The closer the Team Engagement is to +1 (or 100%), the closer this team arrangement adheres to the profile established for the project.

V. EXPERIMENT

The purpose of this section is to assess whether the SOHCO method reduces leadership effort in the team building process.

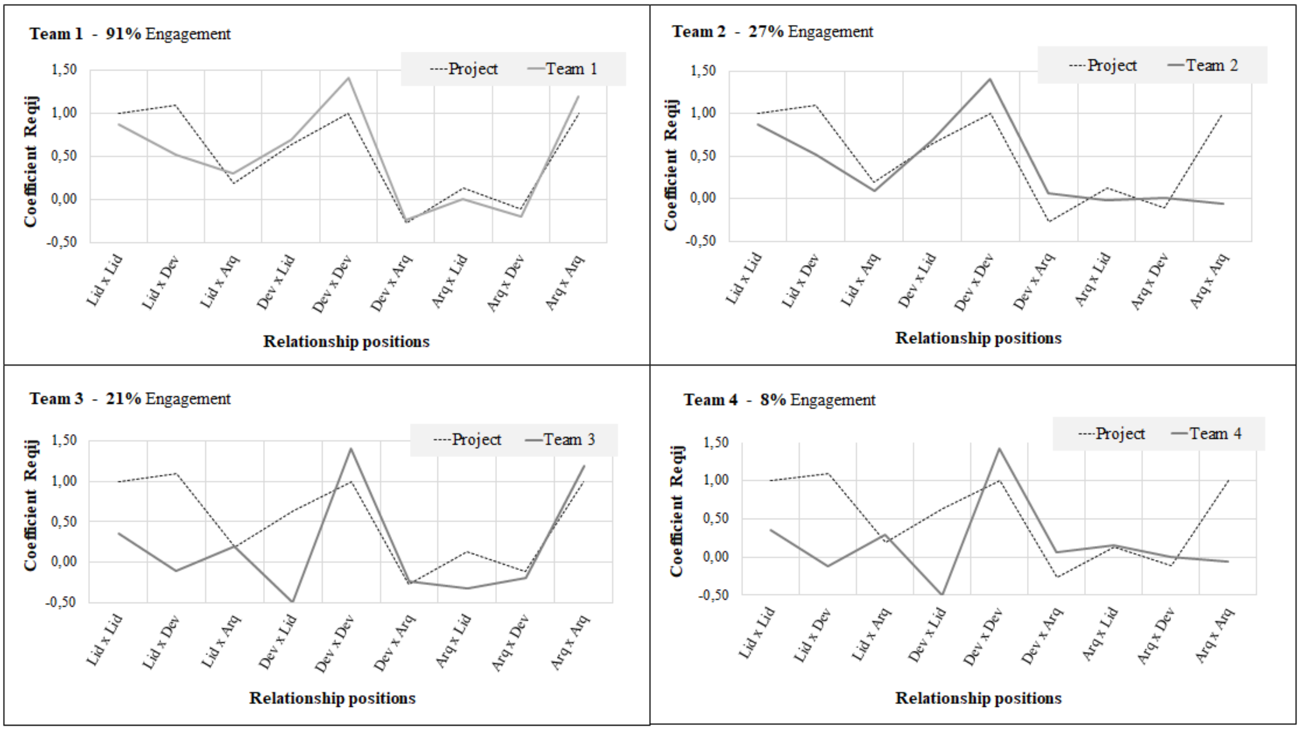

FIGURE 3. Equipes - $Project_{TRM}/Team_{TRM}$.

The experiments include the application of the SOHCO method to a fictional and real scenario, as well as a comparison of the SOHCO method with some MCDM/MCDA methods.

A. APPLICATION OF THE SOHCO METHOD - SCENARIO IN FICTION

In this experiment, eight team-building experts used SOHCO in a fictitious scenario. First, the leadership should select the project team based on the given scope and candidate evaluations. The profile of the project was then presented so that the leadership could reconsider its decision. The leadership should then employ the SOHCO method and conduct a new comparative analysis between the selected team and the team indicated by the method.

This experiment aims to determine if the SOHCO method reduces leadership effort and makes team formation more objective. 100% of the participants chose a team based on the candidates' highest scores, causing oversizing.

When the project's leadership is aware of the project's profile, 88% of the participants decide to switch teams. 57% change to the SOHCO team and 43% to a closer team. After using SOHCO, 100% of participants agree that the method is easy to apply and that the indicated team is more adherent to the project profile.

B. APPLICATION OF THE SOHCO METHOD - REAL SCENARIO

In this section, two actual case studies of SOHCO application are presented. The first was implemented in the private sector by a company specializing in the creation of projects and solutions for information technology systems. The second public sector position at the National Institute for Space Research (INPE). Due to commercial confidentiality, the companies/departments will be referred to throughout this article as Company 1 and Company 2.

1) COMPANY 1 - PRIVATE SECTOR

The "Company 1" intended to assemble a five-person team: 1 Test Analyst (QA), 3 Developers (Full Stack (FUL), Front-End (FRO), and Back-End (BAC), and 1 Scrum Master (SM). The selection process resulted in the selection of fifteen candidates, with three candidates competing for each position. Which represents an analysis of 243 possible team configurations. In the project profile, the following criteria were mapped: soft skills, hard skills, and company fit. Communication (Ass), resilience (Bss), proactivity (Css), and teamwork (Dss) were evaluated as soft skills. Practical technical level (Ahs), conceptual technical level (Bhs), quality (Chs), and productivity (Dhs) were evaluated for hard skill. And for Company fit, the following were evaluated: indication (Acf), cultural compatibility (Bcf), and longevity (Ccf). The Table 12 presents the project profile.

The criteria were scored between 0 and 2, as follows: (0) when the candidate has a low index or little knowledge, (1) when the candidate demonstrates a nearly satisfactory level, and (1) when the candidate demonstrates an index that is satisfactory or exceeds expectations. The Table 13 presents the assessment of candidates

TABLE 12. Company 1 - project profile.

Position	Soft Skill (P_{ss})				Hard Skill (P_{hs})				Company Fit (P_{cf})		
	A	B	C	D	A	B	C	D	A	B	C
FUL	2	1	2	2	2	2	1	2	2	2	2
FRO	1	0	0	1	1	1	2	1	1	2	2
QA	2	1	2	1	1	2	1	1	0	2	1
BAC	1	1	1	1	1	1	1	1	1	2	2
SM	2	2	2	2	2	1	2	2	2	2	2

TABLE 13. Company 1 - candidates and assessments.

Candidates	Soft Skill (P_{ss})				Hard Skill (P_{hs})				Company Fit (P_{cf})		
	A	B	C	D	A	B	C	D	A	B	C
Ca-QA 1	1	1	2	1	2	2	2	2	2	2	2
Ca-QA 2	0	2	1	1	1	0	1	1	1	1	1
Ca-QA 3	2	1	1	1	2	1	1	1	0	1	0
Ca-FUL 4	1	2	2	2	2	2	2	2	2	2	2
Ca-FUL 5	1	1	1	1	2	1	2	2	1	2	2
Ca-FUL 6	2	2	2	2	2	1	2	2	2	2	2
Ca-FRO 7	2	1	1	2	1	1	2	1	2	2	2
Ca-FRO 8	2	2	2	2	2	1	2	2	2	2	2
Ca-FRO 9	0	0	1	2	1	0	1	1	0	1	1
Ca-BAC 10	1	1	2	2	1	1	1	1	1	2	1
Ca-BAC 11	1	1	1	1	1	1	1	0	0	0	0
Ca-BAC 12	0	1	2	2	1	1	1	1	1	2	2
Ca-SM 13	2	2	2	2	2	1	2	2	2	2	2
Ca-SM 14	1	2	1	2	1	2	1	0	1	2	2
Ca-SM 15	1	0	2	1	1	1	1	1	1	2	2

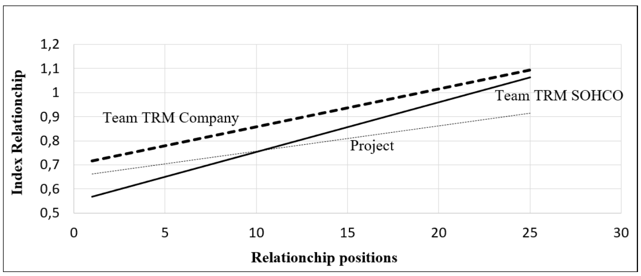

FIGURE 4. Company 1 - Matrix Team TRM.

Empirically, "Company 1" chose team 7, and the SOHCO method suggested team 25. Upon evaluating the score, it is determined that the selection of "Company 1" exceeds the requirements of the project profile (128% adherence). The only difference between the two teams is the QA position.

Comparing the trend of each series in the graph, it is possible to analyze that the selection of the company (team 7) is oversized as shown in Figure 4

The Team 7 does not necessarily represent the best option. According to the SOHCO method, the team with the greatest efficiency relative to the project profile is the team that most closely matches the Project profile. Teams in close proximity to the project profile line demonstrate a high level of adherence and can be excellent alternatives for strategic definitions.

2) COMPANY 2 - PUBLIC SECTOR

The "Company 2" intended to assemble a nine-person team: 3 scientists, 2 developers, 2 technicians, and 2 engineers. The selection process resulted in the selection of eigteen candidates were chosen: 4 candidates for the Engineer position, 6 for the researcher position, 4 for the developer position, and 4 for the technician position. Which represents an analysis of 4320 possible team configurations. In the project profile, the following criteria were mapped: soft skills, hard skills, and company fit. Proactivity (Ass), autonomy (Bss), and relationship (Css) were evaluated as soft skill. Experience (Ahs), Training (Bhs), and Space Project (Chs) were evaluated for hard skill. And for Company fit the indication (Acf). Table14 presents the project profile.

TABLE 14. Company2 - Profile project.

Position	Soft Skill (P_{ss})			Hard Skill (P_{hs})			Company Fit (P_{cf})
	A	B	C	A	B	C	A
PESQ	10	10	9	9	10	9	1
DEV	8	8	9	8	10	9	1
TEC	6	7	9	8	10	9	1
ENG	8	9	9	8	10	9	1

The criteria were scored between 0 and 10, as follow: (0) indicating a low index or little knowledge and (6) indicating a high index or knowledge exceeding expectations. Table 15 presents the assessment of candidates.

TABLE 15. Company2 - candidates and assessments.

Position	Soft Skill (P_{ss})			Hard Skill (P_{hs})			Company Fit (P_{cf})
	A	B	C	A	B	C	A
Ca-ENG 1	5	6	6	6	6	9	1
Ca-ENG 2	10	10	10	10	9	7	0
Ca-ENG 3	3	3	3	5	6	6	0
Ca-ENG 4	1	1	1	3	5	4	0
Ca-PESQ 5	7	10	10	8	10	8	0
Ca-PESQ 6	8	8	8	9	10	8	1
Ca-PESQ 7	9	8	10	7	8	8	1
Ca-PESQ 8	7	7	7	4	5	5	0
Ca-PESQ 9	5	5	5	3	4	4	0
Ca-PESQ 10	3	3	3	2	3	3	0
Ca-DEV 11	6	7	6	8	7	9	1
Ca-DEV 12	7	7	7	7	7	6	1
Ca-DEV 13	4	4	4	4	4	4	0
Ca-DEV 14	3	3	3	3	3	3	0
Ca-TEC 15	9	8	10	10	9	10	0
Ca-TEC 16	8	7	8	8	7	7	1
Ca-TEC 17	7	6	7	6	6	6	0
Ca-TEC 18	6	5	5	5	5	5	0

Empirically, "Company 2" selected "team 1", while the SOHCO method recommended "team 4271". Based on the evaluation of the score, it was found that the selection of "Company 2" inferior of the requirements of the project's profile. Despite the fact that the SOHCO-suggested team is also inferior it represents the best option among all evaluated options when comparing the candidates' qualifications to the criteria.

Comparing the trend of each series in the graph it is possible to analyse that the SOHCO method's proposal is more suitable to the project's profile is oversized as shown in Figure 5.

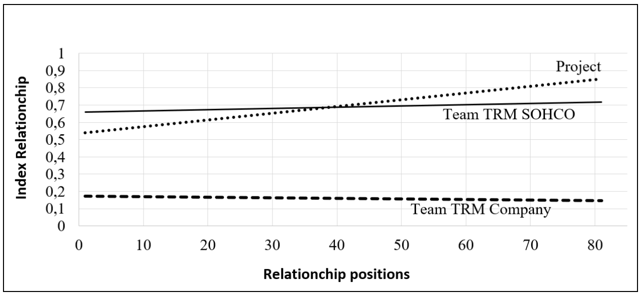

FIGURE 5. Company 2 - Matrix Team TRM.

This case study presents team oversizing, a common occurrence in the traditional selection model. In general, the selection of candidates in this model is performed in isolation, with only the highest scores of each individual being considered. By opting for this strategy, the recruiter leader disregards the fact that individual relationships can be detrimental to the team. In addition, the company may incur unnecessary expenses if the recruiting manager considers only the most qualified candidates without considering the project's requirements.

C. METHODS COMPARISON

The literature did not contain a comparative research on work team formation, so the methodologies were compared using another application. This section evaluates the SOHCO method's consistency in Więckowski [8] laptop evaluation and selection problem.

This study applies TOPSIS, COPRAS, SPOTIS, and COMET algorithms to laptop selection and compares them to MULTIMOORA and MOOSRA outcomes. The result verifies that the methods are consistent and dependable, assuring consistency with the reference method. In the comparative investigation, the SOHCO technique yielded similar and consistent results.

Table 16 shows the weighted decision matrix from Więckowski [8]. The problem was to evaluate seven laptop options (A1–A7) using ten criteria (C1….C10): the parameters taken into account for the evaluation of the laptops are processor speed (C1 - weight 0.297) (in Ghz), cache memory (C2 - weight 0.025) (in MB), storage (C3 - weight 0.035) (in GB), display card memory (C4 - weight 0.076) (in GB), memory (RAM) (in GB) (C5 - weight 0.154), screen resolution (C6 - weight 0.053) [value judgment on a scale of 1–3; 1: the worst (1366 × 768 pixels), 2: medium (1600 × 900 pixels), 3: the best (1920 × 1080 pixels)], screen size (C7 - weight 0.104) (in inches), brand reliability (C8 - weight 0.017) (value judgment on a scale of 1–10; 1: the worst and 10: the best), weight (C9 - weight 0.025) (in kg), and cost (C10 - weight 0.214).

The MULTIMOORA and MOOSRA reference method's best alternative was utilized to define the project profile and apply the SOHCO approach to the suggested problem. Table 17 illustrates the ranking and the various approaches used in the study Więckowski [8].

TABLE 16. Weighted decision matrix for the problem of laptop selection.

	A1	A2	A3	A4	A5	A6	A7
C1	1.0395	0.9207	1.0692	0.891	0.9801	1.0692	1.0395
C2	0.15	0.1	0.15	0.1	0.15	0.15	0.15
C3	43.96	35	70	35	35.28	35	43.96
C4	0.304	0.152	0.304	0.152	0.304	0.152	0.152
C5	2.464	1.232	2.464	1.232	1.848	2.464	2.464
C6	0.159	0.053	0.159	0.106	0.106	0.159	0.053
C7	1.7992	1.6224	1.7992	1.7992	1.6224	1.6224	1.6224
C8	0.136	0.085	0.085	0.085	0.136	0.085	0.102
C9	0.0705	0.077	0.0725	0.065	0.0575	0.07	0.0725
C10	877.4	813.2	856	749	813.2	856	856

TABLE 17. Ranking of laptop assessment methods.

	A1	A2	A3	A4	A5	A6	A7
Reference	2	7	1	6	3	4	5
TOPSIS	3	7	1	6	5	2	4
COPRAS	2	7	1	6	3	4	5
SPOTIS	2	7	1	6	4	3	5
COMET	3	7	1	6	5	2	4
SOHCO	2	6	1	7	4	3	5

MULTIMOORA, MOOSRA, and COPRAS ranked similarly. And the TOPSIS, SPOTIS, COMET, and SOHCO techniques produced comparable outcomes, differing by one or two positions with respect to the reference. Więckowski employs two coefficients to evaluate this ranking [8]: **WS similarity coefficient**, which assigns larger weight to the items in the top portion of the ranking. This coefficient is calculated using the expression *WS* 11. In addition, the **Weighted Spearman Correlation Coefficient** permits the comparison of two vectors. It uses the weights to determine the significance of changes that arise. This coefficient is calculated using the expression *RW* 12.

$$WS = 1 - \sum (2^{-x_i} \frac{|x_i - y_i|}{\max(|x_i - 1|, |x_i - n|)}) \tag{11}$$

where:

- x_i means position in the reference ranking;
- y_i is the position in the second ranking; and
- **n** is a number of ranked elements.

$$RW = 1 - \frac{6 \sum (x_i - y_i)^2 ((n - x_i + 1) + (n - y_i + 1))}{n(n^3 + n^2 - n - 1)} \tag{12}$$

where the same elements as in the Equation 11 are utilized.

The WS and RW coefficients determined in accordance with the MULTIMOORA and MOOSRA reference methods are shown in Table 18. The results demonstrate that the COPRAS approach ranked the reference equally. SPOTIS and SOHCO techniques demonstrated a lesser degree of resemblance than COPRAS, however, they generated results that were more similar to the reference than TOPSIS and COMET.

Despite the disparities between the ranks, the correlation between their results and the similarity of the SOHCO technique is substantial, ensuring a high degree of stability in the outcomes.

TABLE 18. Correlations with reference ranking of MULTIMOORA and MOOSRA methods.

Coeficient	TOPSIS	COPRAS	SPOTIS	COMET	SOHCO
WS	0.838	1.000	0.948	0.838	0.943
RW	0.799	1.000	0.960	0.799	0.946

This comparison was conducted to evaluate the similarity of the ranking obtained by the SOHCO method; however, its objective goes beyond the ranking of the alternatives, resulting in an evaluation of the set of the best combination of alternatives. In the case of the formation of work teams, SOHCO generates not only a ranking of candidates, but also a ranking of possibilities for the team that best fits the project's profile.

VI. DISCUSSIONS AND LIMITATIONS

The SOHCO method, like other multicriteria decision methods, can be used to obtain a ranking of candidates. However, its potential is even greater because it also calculates a ranking of the work team that is closest to the project's profile.

According to the survey, leaders tend to focus on the candidate with the highest score when forming the work team, ignoring the fact that interpersonal relationships can impact the overall performance of the team. On the other hand, when leadership knows the profile of the project, their decisions are more aligned with SOHCO results.

The comparison presented in the section V-C demonstrates that the SOHCO method presents a ranking of candidates very similar and consistent with the results of methods such as COPRAS, SPOTIS, TOPSIS, COMET, MULTIMOORA and MOOSRA.

As a limitation, the SOHCO method allows leadership to assign weights at the criteria level, but not at sub-criteria.

Overall, the SOHCO method can be an effective decision-making tool for project team formation. The method makes the process more agile and more objective by relying less on subjective factors. In the public sector, there is a peculiarity in that the hiring model is by public tender, scholarship selection or outsourcing, and where public notices are prepared to favor the choice of professionals with the highest score, without taking into account the analysis of behavioral and professional skills of skills that will form the same team.

VII. CONCLUSION

This study introduces the SOHCO approach, a work team building strategy influenced by the MCDM/MCDA multicriteria decision methods that delivers not only a rating of applicants but also a ranking of the team that follows most closely to the project's desired profile.

To validate the method, verify the relevance of the theme, and learn about the criteria and tools used by leaders to build their work teams, an exploratory study was conducted, which included an experiment of applying the method to a fictitious case, two real case studies in the public and private sectors, and a comparison of the SOHCO ranking with the ranking of other MCDA methods to evaluate the WS and RW coefficients that result in the degree of consistency and similarity.

In overall, the findings of this study imply that the SOHCO approach can facilitate the development of work teams with less effort. And as future work, it is suggested that the SOHCO approach be applied to other types of data, such as material selection; that the leadership be allowed to establish weights for the sub-criteria; and that an application be developed to work with a bigger amount of data.

REFERENCES

[1] H. S. Kilic, A. E. Demirci, and D. Delen, "An integrated decision analysis methodology based on IF-DEMATEL and IF-ELECTRE for personnel selection," *Decis. Support Syst.*, vol. 137, Oct. 2020, Art. no. 113360.

[2] D. Gómez-Zará, L. A. DeChurch, and N. S. Contractor, "A taxonomy of team-assembly systems: Understanding how people use technologies to form teams," *Proc. ACM Hum.-Comput. Interact.*, vol. 4, no. 2, pp. 1–36, Oct. 2020.

[3] S. K. Land, "The importance of deliberate team building: A project-focused competence-based approach," *IEEE Eng. Manag. Rev.*, vol. 47, no. 2, pp. 18–22, Jun. 2019.

[4] N. Novielli and A. Serebrenik, "Sentiment and emotion in software engineering," *IEEE Softw.*, vol. 36, no. 5, pp. 6–23, Sep. 2019.

[5] J. Tang, "Understanding the telework experience of people with disabilities," *Proc. ACM Hum.-Comput. Interact.*, vol. 5, no. 1, pp. 1–27, Apr. 2021, doi: 10.1145/3449104.

[6] M. A. Iqbal, F. A. Ammar, A. R. Aldaihani, T. K. U. Khan, and A. Shah, "Predicting most effective software development teams by mapping MBTI personality traits with software lifecycle activities," in *Proc. IEEE 6th Int. Conf. Eng. Technol. Appl. Sci. (ICETAS)*, Dec. 2019, pp. 1–5.

[7] M. Marttunen, J. Lienert, and V. Belton, "Structuring problems for multi-criteria decision analysis in practice: A literature review of method combinations," *Eur. J. Oper. Res.*, vol. 263, no. 1, pp. 1–17, Nov. 2017.

[8] J. Więckowski and Z. Szyjewski, "Practical study of selected multi-criteria methods comparison," *Proc. Comput. Sci.*, vol. 207, pp. 4565–4573, Jan. 2022.

[9] A. Mediouni, N. Zufferey, N. Subramanian, and N. Cheikhrouhou, "Fit between humanitarian professionals and project requirements: Hybrid group decision procedure to reduce uncertainty in decision-making," *Ann. Oper. Res.*, vol. 283, nos. 1–2, pp. 471–496, Dec. 2019.

[10] T. L. Saaty, "What is the analytic hierarchy process?" in *Mathematical Models for Decision Support*. Cham, Switzerland: Springer, 1988, pp. 109–121.

[11] D. A. G. Chavira, J. C. L. Lopez, J. J. S. Noriega, and J. L. P. Retamales, "A multicriteria outranking modeling approach for personnel selection," in *Proc. IEEE Int. Conf. Fuzzy Syst. (FUZZ-IEEE)*, Jul. 2017, pp. 1–6.

[12] B. Roy, "The outranking approach and the foundations of electre methods," *Theory Decis.*, vol. 31, no. 1, pp. 49–73, Jul. 1991, doi: 10.1007/BF00134132.

[13] A. R. Afshari, M. Anisseh, M. R. Shahraki, and S. Hooshyar, "Promethee use in personnel selection," in *Proc. Int. Conf. ICT Manage. Global Competitiveness Econ. Growth Emerg. Economies*, 2016, pp. 1–7.

[14] J. P. Brans, P. Vincke, and B. Mareschal, "How to select and how to rank projects: The promethee method," *Eur. J. Oper. Res.*, vol. 24, no. 2, pp. 228–238, Feb. 1986. [Online]. Available: https://www.sciencedirect.com/science/article/pii/0377221786900445

[15] L. C. Nunes, P. R. Pinheiro, M. C. D. Pinheiro, M. S. Filho, and R. E. C. Nunes, "Toward a novel method to support decision-making process in health and behavioral factors analysis for the composition of IT projects teams," *Neural Comput. Appl.*, vol. 32, no. 15, pp. 11019–11040, Aug. 2020.

[16] C. A. B. e Costa and J.-C. Vansnick, *General Overview of the Macbeth Approach*. Boston, MA, USA: Springer, 1995, pp. 93–100, doi: 10.1007/978-1-4757-2383-0_6.

[17] K. Petridis, G. Drogalas, and E. Zografidou, "Internal auditor selection using a TOPSIS/non-linear programming model," *Ann. Oper. Res.*, vol. 296, nos. 1–2, pp. 513–539, Jan. 2021.
[18] C.-L. Hwang and K. Yoon, *Methods for Multiple Attribute Decision Making*. Berlin, Germany: Springer, 1981, pp. 58–191, doi: 10.1007/978-3-642-48318-9_3.
[19] J. Wątróbski, A. Bączkiewicz, E. Ziemba, and W. Sałabun, "Sustainable cities and communities assessment using the DARIA-TOPSIS method," *Sustain. Cities Soc.*, vol. 83, Aug. 2022, Art. no. 103926.
[20] J. Dezert, A. Tchamova, D. Han, and J.-M. Tacnet, "The SPOTIS rank reversal free method for multi-criteria decision-making support," in *Proc. IEEE 23rd Int. Conf. Inf. Fusion (FUSION)*, Jul. 2020, pp. 1–8.
[21] S. Narayanamoorthy, L. Ramya, S. Kalaiselvan, J. V. Kureethara, and D. Kang, "Use of DEMATEL and COPRAS method to select best alternative fuel for control of impact of greenhouse gas emissions," *Socio-Econ. Planning Sci.*, vol. 76, Aug. 2021, Art. no. 100996.
[22] R. Bausys, E. K. Zavadskas, and A. Kaklauskas, *Application of Neutrosophic Set to Multicriteria Decision Making by COPRAS*. New Delhi, India: Infinite Study, 2015.
[23] J. Wątróbski, A. Bączkiewicz, R. Król, and W. Sałabun, "Green electricity generation assessment using the CODAS-COMET method," *Ecol. Indicators*, vol. 143, Oct. 2022, Art. no. 109391.
[24] W. Sałabun, "The characteristic objects method: A new distance-based approach to multicriteria decision-making problems," *J. Multi-Criteria Decis. Anal.*, vol. 22, nos. 1–2, pp. 37–50, Jan. 2015.
[25] E. A. Adalı and A. T. Işık, "The multi-objective decision making methods based on MULTIMOORA and MOOSRA for the laptop selection problem," *J. Ind. Eng. Int.*, vol. 13, no. 2, pp. 229–237, 2017.
[26] M. Kracka, W. K. M. Brauers, and E. K. Zavadskas, "Ranking heating losses in a building by applying the MULTIMOORA," *Eng. Econ.*, vol. 21, no. 4, pp. 1–8, Oct. 2010.
[27] M. C. Das, B. Sarkar, and S. Ray, "Decision making under conflicting environment: A new MCDM method," *Int. J. Appl. Decis. Sci.*, vol. 5, no. 2, pp. 142–162, 2012.

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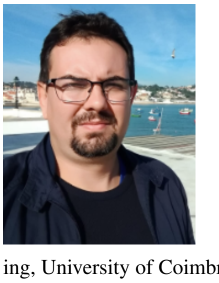

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