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A Spherical Fuzzy Framework for Sales Personnel Selection

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Abstract: In this paper, we aim to provide an extension of the personality style-based psychological comparative assessment of salesmen using three orientations such as task, people, and organizations ("Sales Troika" or ST). Contrasting to the classical ST model, we use spherical fuzzy set (SFS) for ranking of statements and subsequent score calculations. Personality assessment (PA) is an important aspect during the process of recruitment and selection. PA acts as one of the critical success factors for effective selection as personality significantly influences the performance of the employee. The psychological frameworks follow conventional scoring which suffers from subjective bias. The present paper attempts to offset the subjective bias (due to imprecise and uncertain information) by using SFS-based rating and calculations. The study is carried out in two steps. First, a group of five candidates applying for sales job at the junior level have taken part in the comparative assessment process. We use our framework to classify the respondents according to their style. Second, we carry out a SFS-based multi-criteria decision analysis (MCDA) for their relative ranking based on the opinions of the members of a selection panel. To carry out the comparative assessment of the candidates based on experts' ratings, we use the modified SF LOgarithmic Percentage Change-driven Objective Weighting (LOPCOW) method. We examine the stability and accuracy of the SFS-MCDA model through validity testing and sensitivity analysis. We observe a resemblance between the decision of the panel and the PA results.

Keywords: Sales Troika, personality traits, psychological assessment, spherical fuzzy sets (SFS), LOgarithmic Percentage Change-Driven Objective Weighting (LOPCOW)

1. Introduction

Personnel selection has been a critical issue for effective functioning of the organizations. The efficacy of human resource planning largely gets supported by a robust personnel selection process. Failure in developing an effective mechanism for recruitment and selection may lead to waste in time, effort, and money [1]. As the organizations have been facing a fierce time-based competition to sustain at the market place, personnel selection is one of critical success factors. Further, personnel selection ameliorates a successful talent management in the organizations.

Sales as a profession offers exciting opportunities in terms of growth potential, earning prospect, low entry barrier, challenging environments, direct interface with the markets, and options for relocation. Sales is an important function in any organization that establishes the linkage with the market and thereby helps to understand the consumers' demands and preferences. Though over the years the nature of the sales jobs has undergone a visible change, the importance and charm remain relevant. However, to become a successful sales person, one has to possess some distinguished personality traits. Churchill Jr. [2] defined salesperson performance as "behaviour that has been evaluated in terms of its contribution to the goals of the organization." The author developed a model that states a salesperson's motivation, his sales aptitude, and role perception are the key factors that drive sales performance. Similarly, in a meta-analysis of determinants of salesperson performance, it was found that personal factors, skill, role variables, aptitude motivation, and organizational or environmental factors are vital components in sales performance [3, 4]. In this context, the work of Kazén et al. [5] demonstrated the importance of the charming personality styles for an improved performance.

Rainey and Jung [6] stated that clear, specific and challenging goals, reward and recognition, training, and development have a significant influence on the performance of the salesman in the Fast-moving consumer goods sector. When goals are ambiguous, it leads to uncertainty, and the motivation decreases and makes the salesman unable to perform their optimum level. Hence, the goals must be unambiguous and clear in nature to enhance motivation which ultimately improve their performance level. Similarly, employees who are satisfied with their working conditions, including their earnings and incentives, have higher productivity as these factors reinforce their performance [7, 8] and it was also found that motivated sales team make certain that the targets are regularly met [9]. To this end, Sosnowska et al. [10] reinstated the need of psychological traits and personality assessment (PA) as a means for reliable and effective way for

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personnel selection. The present age is characterized by technology-led innovative business practices that shrink the traditional low-skilled jobs. The jobs demand not only to manage the human beings but also to manage the machines. However, that does not undermine the importance of effective people management skills which invokes some distinct personality styles.

To this end, the extant literature provides umpteen evidences for assessment of personality styles vis-à-vis personnel selection, measuring employee performance, talent nurturing, and retention. However, there has been a limited evidence of use of personality style-based selection of sales personnel. Further, personality style is a subject matter of psychological state of the human beings. Most often the assessment centers suffer from a considerable amount of subjective bias that limits the efficacy of the selection frameworks. Therefore, it is quite imperative to develop suitable models that work with vague and imprecise information under uncertain environment. The previous research shows a counted number of work in this regard. In this regard, the present study attempts to provide a multi-criteria decision analysis (MCDA) framework for personnel selection based on PA. We aim to provide an extension of the personality style-based psychological comparative assessment of salesmen using three orientations such as task, people, and organizations ("Sales Troika" or ST) as described in Pareek and Purohit [11]. Considering the fact that PA is subject to the influence of subjective bias, contrasting to the classical ST model, we use spherical fuzzy set (SFS) for ranking of statements and subsequent score calculations.

In the current work, SFS has been used for capturing the responses of the candidates related to their views on different psychological statements to assess the personality style. Further, the ratings of the selectors are recorded in terms of linguistic scales corresponding to the assigned SFS membership degrees. The evolution of SFS has taken place through a series of developments in realm of analytics with imprecise information under uncertainty such as fuzzy sets (FS) [12], intuitionistic fuzzy sets (IFS) [13], type 2 IFS [14], interval-valued IFS [15], neutrosophic fuzzy sets [16], picture fuzzy sets (PFS) [17, 18], Pythagorean fuzzy sets (PyFS) [19], and q rung orthopair fuzzy sets (qROFS) [20]. The concept of SFS stands on three-dimensional geometry subject to the condition

$$0 < \mu^2 + \upsilon^2 + \gamma^2 < 1$$

where μ, ϑ, γ are denoted as positive, negative, and hesitancy membership degrees, respectively [21]. The advantages of using SFS as mentioned in the extant literature are defined as follows [21–23]:

- Contrasting to the FS, IFS, PyFS, and qROFS, SFS takes into account all degrees of memberships such as μ, ϑ, and γ.
- With the condition $0 < \mu^2 + \vartheta^2 + \gamma^2 < 1$, SFS provides a relatively higher flexibility as compared with PFS and, hence, extends an opportunity for a granular analysis.
- SFS works at three-dimensional space which is less complex as compared with qROFS and Fermatean fuzzy sets [24].

The contributions of this paper are structured as follows. First, the present paper is a first of its kind that puts forth a SFS-based psychological assessment framework that determines the suitability of a candidate for selection in accordance to his/her personality style for the sales role. Second, in the current study we not only determine the personality style but also find out its reflection in the decision of the expert panel. Third, use of SFS in psychological or behavioral assessment is found to be rare in the extant literature. Fourth, this paper provides a new extension of the recently developed LOgarithmic Percentage Change-driven Objective Weighting (LOPCOW) method in MCDA.

The rest of the paper is constructed in the following manner. In Section 2, a brief summary of some of the related previous work is presented. Section 3 provides some preliminary concepts, definitions, and operations of SFS. In Section 4, a brief description of the research methodology is discussed. Section 5 mentions the procedural steps of the method applied in the current work. Section 6 exhibits the findings of the data analysis, while Section 7 summarizes the results of comparative analysis and sensitivity analysis. Section 8 provides the implications of the findings and adds some concluding remarks in addition to some of the future scope for further research.

2. Related Work

In this section, we highlight some of the related work on recruitment and selection, specific to sales personnel selection and applications of SFS in solving various real-life problems.

2.1. Related work on recruitment and selection

In this subsection, we highlight some of recent past research on recruitment and selection with special reference to applications of MCDA techniques. For instance, Priyadharshini et al. [1] applied a fuzzy TOPSIS-based model for selection of suitable employee subject to their performance on a number of criteria and subcriteria. The study of Nong and Ha [25] considered six attributes such as education, experience, personality, soft skills, physical health, and proficiency in foreign language for selection of suitable candidate for logistics function. The authors used a combined Analytic Hierarchy Process-Technique for Order Performance by Similarity to Ideal Solution (AHP-TOPSIS) model. Kwok et al. [26] adopted a randomized-controlled-trial approach in conjunction with fuzzy Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) and classical Technique for Order Performance by Similarity to Ideal Solution (TOPSIS) for personnel selection to examine the suitability of model and advocated in favor of fuzzy Technique for Order Performance by Similarity to Ideal Solution (TOPSIS). Sosnowska et al. [10] argued for inclusion of personality attributes in personnel selection problem and predicting the suitability in the long run. Personnel selection is a structured and scientific process that bears on strategic decision-making (DM) as reflected in the work of del Carmen Espinosa Robert et al. [27] which aimed to provide a Technique for Order Performance by Similarity to Ideal Solution (TOPSIS)-based model for selection of software professionals. Dumnić et al. [28] further extended the growing strand of the volume by incorporating fuzzy Choquet integral for handling uncertainty associated with the interdependency of the criteria used to select a qualified personnel. The authors considered characteristics of the candidates, their orientation toward tasks, interpersonal skills, and communication.

2.2. Selection of sales personnel

Calixto and Ferreira [29] did an analysis of several sales Key Performance Indicators (KPIs) to get a classification of the responsible salesperson to improve performance evaluation. Based

on these Key Performance Indicators (KPIs), with the help of the Naive Bayes model, they established that salesperson can be categorized into "not performing" (low growth, low target achieved), "good" (positive growth, a good target achievement), and "outstanding" (extremely high growth and high target achievement). For a salesperson to succeed, it is important to focus on the growing customer base, working on achieving targets and positive growth as many months as possible.

Considering the selling style or selling behavior of the salesperson, they must be flexible and be able to adapt to different selling approaches as they face different customers and different selling situations. Wong and Tan [30] in their study on pharmaceutical firms revealed that activity control, participation in DM, expressing confidence, and providing autonomy had a significant relationship with the salesperson adaptive selling style.

In another article, based on ST styles, it was evaluated that product-oriented, customer-oriented, routine sales-oriented, and solution-oriented styles were used by sales executives (salesman and sales manager) in selling two and four wheelers. Similarly, in another study by Rao and Misra [31] it was indicated that product-centered salesperson made a significant positive impact on customers with low needs, followed by customer centered which had an effective impact on the customers, irrespective of their need or buying pattern. There has been a rise in the need to use psychometric tests in the recruitment process to select candidates. Different psychological factors affect the recruitment process of an employee in an organization [32]. As reported by Cole et al. [33], recruiters look for candidates whose personality is in accord with the vacant position as it was found that personality largely impacts job performance.

According to Deciu [34], personality traits, mental state (emotional quotient, intelligence, thought process, etc.), and psychological functions (memory, thinking, creativity, problem-solving, etc.) are the three main factors that employers considered while selecting a candidate. Among various factors, emotion and creativity are two main factors that employers look for in candidates, especially in sales. It was found if salespeople are overconfident or under confident in their emotional skills, the sales performance gets hampered and on the other hand salesmen who are emotionally calibrated, that is with high emotional intelligence and high emotional self-efficacy, show positive avoidance emotions such as calmness and relaxation that results in good rapport with the customer [35]. Other researchers have found a positive relationship between emotional intelligence and the performance of the salesman. [36, 37]. Olšovská and Švec [32] stated that creativity is one of the main factors that recruiters look for in candidates. Creative people are more invested in their work as they look for novel solutions to different problems and it also encourages collaboration. A study was conducted by Casey [38] where it was found that there is an association between collaboration and creativity which indicates that when creative and collaborative employees work together, productivity increases. Similarly, it was found that B2B sales people uses creative selling and pursued a high level of sales innovativeness significantly and positively affected the sales performance [39]. Bansal et al. [40] in their study claimed that personality traits greatly impact an employee's performance or work management. Considering the big five personalities, four of them, extroversion, openness to experience, conscientiousness, and agreeableness, have a significant relationship with job engagement [34]. However, Hurtz and Donovan [41] stated that conscientiousness followed by extraversion is the best predictor in sales performance.

It is important for a salesperson to understand their customers' needs and wants to generate sales interaction. In a survey by Cross et al [42], the impact of customer orientation and sales person performance was examined where it was found that both the factors are positively related to each other and findings of another study revealed that openness to experience and conscientiousness were significantly and positively related to customer-oriented behavior [43]. In a similar study, it was found that social intelligence also helps the salesperson to be sensitive, receptive, and understanding the buyer's needs and wants [44]. Other personal factors that bring out the salesperson to be socially aware and socially skilful are a combination role, and self-identity, social competence, affective ability, cognitive ability, and conative abilities are responsible for increasing sales performance [45].

Bartkus et al. [46] in their study identified the influence of Type A/B behavior in sales performance where they found that Type A personality types performed better as they are more organized, aggressive, and competitive, but they also noted that Type A salesman experiences impatience which harpers their relationship with the customers. Sales performance is greatly affected by a candidate's personality, behavior, and cognitive abilities. Psychometric evaluation helps decision makers to select the right candidate and also help the organization to gain competitive edge over its competitors by hiring the right talent [47].

2.3. Related work on SFS

Some of the recent past applications of SFS in complex DM are described. SFS has been used in various real-life DM context, such as promotional strategy design [48], supplier selection problem [49], investment DM [50], healthcare such as medical diagnosis [51, 52], energy management [53], selection of 3D printers [54], process mapping [55, 56], waste disposal location selection [57], and agricultural engineering and management [58] among others. In that respect, application of SFS in psychological assessment is quite rare in the literature.

From the recently published work, it is evident that MCDA has been limitedly used in personnel selection. Further, applications of advanced variants of classical FS theory have also not been explored extensively. It is seen that personality attributes have been considered in some previous work, but the personality styles have not been assessed based on the expressions of the candidates. The present paper fills the gap in the literature by providing an improved framework that works with imprecise information (influenced by the subjective bias) under uncertainty.

2.4. Research gap

Two amply evident gaps in the extant literature are described as follows, which have motivated us to undertake the present work:

- From the literature review, we have noticed that there is a scantiness of work in the development of robust models for psychological assessment. The psychological assessment models are mostly based on crisp data which are susceptible to subjective bias. We fill the gap by providing a SFS-based psychological assessment scale.

- There is a lack of applications of PA models in the recruitment and selection process integrated with multi-perspective evaluation of the potential candidates. The current paper bridges the gap in the extant literature by developing a combined ST and MCDM-based framework with imprecise information.

3. Preliminaries

The present section exhibits some preliminary definitions, properties, and operations of SFS as developed by several researchers [21–23, 59–62].

Definition 1. SFS is defined as

$$\widetilde{S} = \{x,\ (\mu_{\tilde{S}}(x),\ \vartheta_{\tilde{S}}(x),\ \gamma_{\tilde{S}}(x))|x\ \in U\} \tag{1}$$

where

$$\mu_{\tilde{S}}(x),\ \vartheta_{\tilde{S}}(x),\ \gamma_{\tilde{S}}(x) : U\ \rightarrow [0,1];$$

$$0 \leq \mu_{\tilde{S}}(x)^2 + \vartheta_{\tilde{S}}(x)^2 + \gamma_{\tilde{S}}(x)^2 \leq 1\ \forall\ x \in U$$

$\mu_{\tilde{S}}(x)$, $\vartheta_{\tilde{S}}(x)$, $\gamma_{\tilde{S}}(x)$, respectively, are the degrees of positive, negative, and hesitancy, and U is the universe of discourse.

Definition 2. Basic Operations

Let a spherical fuzzy number (SFN) be represented as $\tilde{S} = \{\mu,\ \vartheta,\ \gamma\}$ without losing the meaning of usual terms. Let $\tilde{S}_1 = \{\mu_1,\ \vartheta_1,\ \gamma_1\}$ and $\tilde{S}_2 = \{\mu_2,\ \vartheta_2,\ \gamma_2\}$ be two SFNs. Some of the basic operations are defined as

Addition:

$$\tilde{S}_1 \oplus \tilde{S}_2 = \{(\mu_1^2 + \mu_2^2 - \mu_1^2\mu_2^2)^{1/2},\ \vartheta_1\vartheta_2,\ ((1-\mu_2^2)\gamma_1{}^2 + (1-\mu_1^2)\gamma_2{}^2 - \gamma_1{}^2\gamma_2{}^2)^{1/2}\} \tag{2}$$

Multiplication:

$$\tilde{S}_1 \oplus \tilde{S}_2 = \{\mu_1\mu_2, (\vartheta_1^2 + \vartheta_2^2 - \vartheta_1^2\vartheta_2^2)^{1/2}, ((1-\vartheta_2^2)\gamma_1{}^2 + (1-\vartheta_1^2)\gamma_2{}^2 - \gamma_1{}^2\gamma_2{}^2)^{1/2}\} \tag{3}$$

Multiplication by a scalar; $w > 0$

$$w.\tilde{S} = (1-(1-\mu^2)^w)^{1/2},\ \vartheta^w,\ ((1-\mu^2)^w - (1-\mu^2-\gamma^2)^w)^{1/2} \tag{4}$$

Power of $\tilde{S}$; $w > 0$

$$\tilde{S}^w = \{\mu^w, (1-(1-\vartheta^2)^w)^{1/2},\ ((1-\vartheta^2)^w - (1-\vartheta^2-\gamma^2)^w)^{1/2}\} \tag{5}$$

Compliment of $\tilde{S}$

$$\tilde{S}^c = \{\vartheta,\ \mu,\ \gamma\} \tag{6}$$

Definition 3. Spherical weighted average

Let $w = (w_1,\ w_2, w_3, \ldots..,\ w_n)$ be the weights of the SFNs $\tilde{S}_1,\ \tilde{S}_2,\ \tilde{S}_3 \ldots.,\ \tilde{S}_n$ where, n is finite; $w_j \in [0,1]$; $\sum_{j=1}^{n} w_j = 1$.

Spherical weighted arithmetic average (SWAA) is defined as

$$SWAA_w(\tilde{S}_1,\ \tilde{S}_2,\ \tilde{S}_3 \ldots.,\ \tilde{S}_n) = \left\{\left[1 - \prod_{i=1}^{n}(1-\mu_i^2)^{w_i}\right]^{1/2},\ \prod_{i=1}^{n}\vartheta_i^{w_i},\ \left[\prod_{i=1}^{n}(1-\mu_i^2)^{w_i} - \prod_{i=1}^{n}(1-\mu_i^2-\gamma_i^2)^{w_i}\right]^{1/2}\right\} \tag{7}$$

Spherical weighted geometric average (SWGA) is defined as

$$SWGA_w(\tilde{S}_1,\ \tilde{S}_2,\ \tilde{S}_3 \ldots.,\ \tilde{S}_n) = \left\{\prod_{i=1}^{n}\mu_i^{w_i},\ \left[1 - \prod_{i=1}^{n}(1-\vartheta_i^2)^{w_i}\right]^{1/2},\ \left[\prod_{i=1}^{n}(1-\vartheta_i^2)^{w_i} - \prod_{i=1}^{n}(1-\vartheta_i^2-\gamma_i^2)^{w_i}\right]^{1/2}\right\} \tag{8}$$

Definition 4. Score and Accuracy Function

The definitions, as given by Ashraf et al. [22], are defined as follows:

Score function (Sc)

$$Sc\ (\tilde{S}) = \frac{1}{3}\ (2 + \mu - \gamma - \vartheta) \tag{9}$$

Accuracy function (Ac)

$$Ac\ (\tilde{S}) = (\mu - \gamma) \tag{10}$$

Certainty function (Cr)

$$Cr\ (\tilde{S}) = \mu \tag{11}$$

Comparison rule:

(i) If $Sc\ (\tilde{S}_1) > Sc\ (\tilde{S}_2)$, then $\tilde{S}_1 > \tilde{S}_2$

(ii) If $Sc\ (\tilde{S}_1) < Sc\ (\tilde{S}_2)$, then $\tilde{S}_1 < \tilde{S}_2$

(iii) If $Sc\ (\tilde{S}_1) = Sc\ (\tilde{S}_2)$, then
  if $Ac\ (\tilde{S}_1) > Ac\ (\tilde{S}_2)$, then $\tilde{S}_1 > \tilde{S}_2$;
  if $Ac\ (\tilde{S}_1) < Ac\ (\tilde{S}_2)$, then $\tilde{S}_1 < \tilde{S}_2$

(iv) If $Sc\ (\tilde{S}_1) = Sc\ (\tilde{S}_2)$ and $Ac\ (\tilde{S}_1) = Ac\ (\tilde{S}_2)$, then
  If $Cr\ (\tilde{S}_1) > Cr\ (\tilde{S}_2)$, then $\tilde{S}_1 > \tilde{S}_2$

Definition 5. Defuzzification

The defuzzified value of $\tilde{S}$ is given as

$$S = \left(\left|100 \times \left[\left(3\mu - \frac{\gamma}{2}\right)^2 - \left(\frac{\vartheta}{2} - \gamma\right)^2\right]\right|\right)^{1/2} \tag{12}$$

4. Materials and Methods

In this section, we describe the research methodology used in this paper. As mentioned earlier, the present paper uses the ST framework. The framework considers three dimensions expressed as a triplet (a, b, c), wherein a is the degree of obligations for selling the products (i.e., task orientation), b is the degree of obligations for the customers (i.e., people orientation), and c is the degree of obligations for the organization (i.e., company orientation) [11]. On each such dimension, the highest degree is considered as 9 while the least degree of inclination is denoted as 1. Accordingly, there are nine different personality styles which are described in Table 1.

The nine personality styles are measured based on the views of the respondents on five factors such as sales goals (SG), DM, anxiety management (AM), conflict management (CM), and self-management (SM). Under each such factor, there are nine statements reflecting the different personality styles (see the questionnaire given in Appendix A). The respondents assign any number between 1 and 9 to the statements under each factor according to their perceived

Table 1
Personality styles of sales person (ST) (adopted from [11])

Personality style	Focus	Nature of obligation	Orientation toward		
			Task	People	Org
(1,1,1)	Routine sales	Main obligation is to aware the customers about the product and assumes that sales will take place if customers need the product	Low	Low	Low
(1,9,1)	Customer	Main obligation is to take care of the customers who have their own feelings and respond to their requirements	Low	High	Low
(9,1,1)	Product	Main focus is on selling the products adopting push selling approach and any ways to convince the customers	High	Low	Low
(9,9,1)	Finding solutions	Emphasis is given on helping the customers to find the right product to fulfill their needs by providing relevant information and ultimately influence them to sell own products	High	High	Low
(1,1,9)	Company	To uphold the brand image of the company only while assuming that good image shall lead to sales of the products	Low	Low	High
(1,9,9)	Loyalty relationship	To maintain long-term relationship and loyalty with company and the customers, consider the feelings and interests of the customers while highlighting the company's goodwill	Low	High	High
(9,1,9)	Company and product	Believe on the products of the own company as the best in class and convince the customers about the suitability of the products to meet their requirements and push sale	High	Low	High
(9,9,9)	Creative solution	Equal obligation of highest degrees for the selling of the products, maintain relationships with the customers, and help them in taking right decision and upholding the image of the company. The intention is to sell the company to the customers while building a strong bonding between the customers and the company	High	High	High
(5,5,5)	Techniques	Equal obligation of moderate degrees for sales, customers, and company but with trusted and common process lacking in innovation and creativity	Medium	Medium	Medium

importance. No two statements are allowed to be given the same number. If a statement under a specific factor is assigned with 9, the statement is assumed to have highest preference for the respondent that best suits his/her personality. The mapping of the statements under various factors with the different personality styles (known as ST keys) is given in Appendix B. After obtaining the relative priority ratings for all statements under each factor, based on the mapping table or ST keys, an aggregate score is calculated for each personality styles. The personality style that obtains the highest score is considered as the dominant personality of the concerned respondent and accordingly, his/her characteristics are figured out with the help of the descriptions given in Table 1.

In the present paper, the analysis is carried out in two steps. The schematic flow of the activities under the present research is shown in Figure 1. First, a group of five candidates applying for sales job at the junior level have taken part in the comparative assessment process. They have been given the questionnaire (Appendix A) and advised to rate each statement (on 1–9 scale with no repetition) under each factor of the ST framework. For each such rating scale (i.e., 1–9), we use a corresponding SFN equivalent (see Table 2) to avoid subjectivity associated with the rating.

After obtaining the responses (i.e., rating) as given in Appendix B, the ST keys are used to map the responses with the personality styles. Hence, under each personality style, we have the corresponding SFNs for the five factors which then get aggregated using the SWGA operator (see expression (8)). In this way, we obtain the aggregated SFN for each personality styles for the concerned respondent. Then we calculate the score, accuracy, and certainty values using expressions (9) to (11) for all the personality styles for the concerned respondent and compare the values to derive the dominant personality style.

In the next stage, we carry out a SFS-based MCDA for their relative ranking based on the opinions of the expert members of a selection panel. For this purpose, we use the factors describing the personality styles as criteria or attributes (see Table 3).

In our work, five experts have agreed to be the panel members for evaluating the suitability of the candidates. These experts are having more than 15 years of experience as a recruiter, HR professional, sales professional, psychologist, and behavioral science professor. The experts use a SFN-based rating scale (see Table 4) for assessing the candidates on various attributes (as given in Table 3). The score sheet for evaluation of the candidates is given in Appendix C.

To carry out the comparative assessment of the candidates based on experts' ratings, we use the modified SF-LOPCOW method. LOPCOW method has been recently developed by Ecer and Pamucar [63] to calculate criteria weights using objective information. LOPCOW model is derived to deal with considerably higher variations in the performance values of the alternatives with respect to the influence of the criteria, large-sized decision matrix, and presence of negative values in the decision matrix. We utilize LOPCOW method with SFNs for two purposes such as deriving the criteria weights and ranking of the candidates.

5. SF-LOPCOW Method

The procedural steps of the proposed SF-LOPCOW method are described as follows:

Figure 1
Schematic diagram: steps of the research

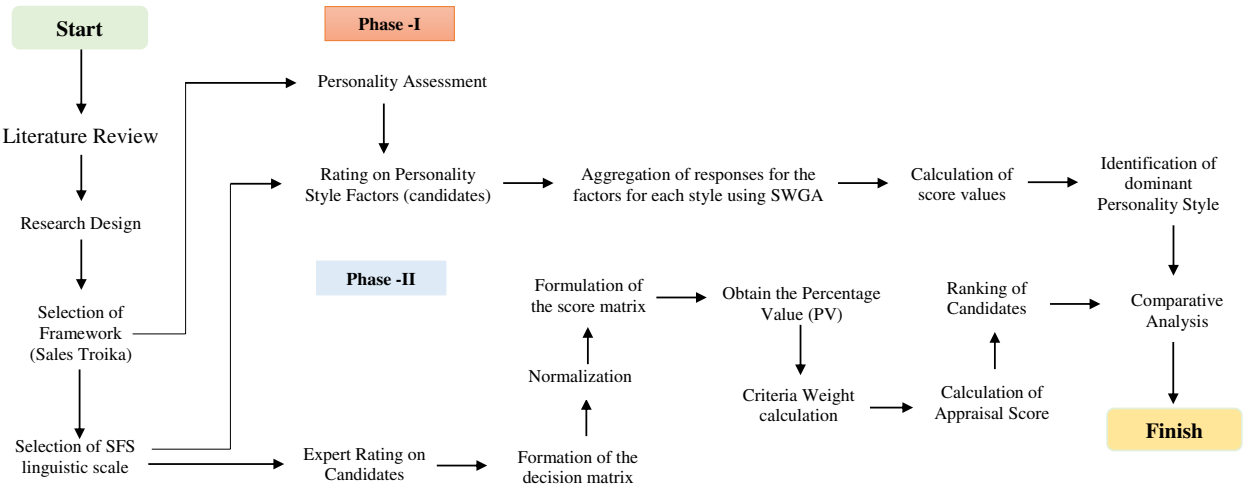


Table 2
SFNs used for the rating scale

Rating	SFN		
	μ	ν	γ
9	0.9	0.1	0.1
8	0.8	0.2	0.2
7	0.7	0.3	0.3
6	0.6	0.4	0.4
5	0.5	0.5	0.5
4	0.4	0.6	0.4
3	0.3	0.7	0.3
2	0.2	0.8	0.2
1	0.1	0.9	0.1

Table 3
Criteria or attributes for assessing the candidates

Attributes	Description
C1	Sales goals
C2	Decision-making
C3	Anxiety management
C4	Conflict management
C5	Self-management

Table 4
SFN scale for candidate assessment

Linguistic scale	SFN		
	μ	ν	γ
Very good	0.9	0.1	0.1
Good	0.7	0.3	0.3
Fair	0.5	0.5	0.5
Poor	0.3	0.7	0.3
Very poor	0.1	0.9	0.1

Step 1. *Expert rating*

Obtain the ratings of the Decision Making Unit (DMUs) subject to the criteria by each expert using the SFN scale (see Table 4). Hence, each response is a SFN.

Step 2. *Formation of the decision matrix*

Aggregate the ratings of the experts for each Decision Making Unit (DMU) subject to different criteria using the SWGA operator as defined by expression (8). This way the SF decision matrix is formed.

Let $\tilde{X} = [\tilde{x}_{ij}]_{m\times n}$ be the aggregated decision matrix, where m is the number of alternative options or Decision Making Unit (DMUs) and n is the number of criteria or attributes. All $\tilde{x}_{ij}$ follows the usual definition of SFN (see expression (1)).

Step 3. *Normalization*

Suppose $\tilde{R} = [\tilde{r}_{ij}]_{m\times n}$ is the normalized SF decision matrix. The classical LOPCOW method follows the linear max-min type of normalization scheme.

Here, we use expression (6) of the definition 2. Accordingly, the elements of $\tilde{R}$ are given as

$$\tilde{r}_{ij} = \tilde{r}_{ij}(\text{when } j \in j^{+}, \text{beneficial criteria}) \tag{13}$$

$$\tilde{r}_{ij} = \tilde{r}_{ij}{}^{c}(\text{when } j \in j^{-}, \text{non} - \text{beneficial criteria}) \tag{14}$$

Step 4. *Formulation of the score matrix*

At this step, the score values of each element of the SF decision matrix are calculated by using expression (9). Accordingly, we get the score values as

$$r_{ij} = Sc(\tilde{r}_{ij}) = \frac{1}{3}(2 + \mu_{ij} - \gamma_{ij} - \vartheta_{ij}) \tag{15}$$

Now, we follow the usual steps of the classical LOPCOW model.

Step 5. *Obtain the percentage value (PV)*

The PV for each criterion is calculated by dividing the mean square value by the standard deviation using natural log on percentage scale. The objective of this step is to reduce the gap

among the normalized values and, hence, to help in achieving considerably uniform distribution of the criteria values. The expression for PV is given as

$$P_{ij} = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{m} r_{ij}^2}{m}}}{\sigma} \right) .100 \right| \tag{16}$$

σ denotes the standard deviation

Step 6. *Calculation of the criteria weights*

The weight for the j^{th} criterion is calculated as

$$w_j = \frac{P_{ij}}{\sum_{j=1}^{n} P_{ij}} \tag{17}$$

where $\sum_{j=1}^{n} w_j = 1$ (i.e., sum of the weights of all criteria = 1)

Step 7. *Derive the appraisal scores of the alternatives*

The appraisal score of i^{th} alternative is given as

$$S_i = \sum_{j=1}^{n} w_j r_{ij} \tag{18}$$

Decision rule: The higher the value of S_i, the better the acceptability of the concerned alternative.

6. Results

In this section, we highlight the key findings using our methodology followed in the present paper. The results are presented in two stages. The first stage deals with the assessment of the personality styles of candidates (who are treated as alternatives or Decision Making Unit (DMUs) in this paper) based on their own responses to statements (see Appendix B, Table B2) pertaining to various factors (see Table 3) of the ST framework. In the second stage, the candidates are ranked by the panel of five expert members using SF-LOPCOW model.

The assigned SFNs corresponding to the responses of the candidates on the statements of various factors pertaining to the ST framework and their aggregations followed by calculation of the score values are given in Appendix D.

For example, the candidate 1 (A_1) and the ratings (in SFN) for the (1,1,1) dimension related to all the attributes (see Table 4) are (0.40, 0.60, 0.40), (0.60, 0.40, 0.40), (0.30, 0.70, 0.30), (0.30, 0.70, 0.30), and (0.40, 0.60, 0.40) based on his/her rating on the various statements pertaining to the five attributes. Now, by applying the SWGA operator we aggregate the ratings for the dimension (1,1,1) (assuming all attributes are of equal priority, i.e., 1/5). The aggregated result is also a SFN. The example of the calculation for getting the resultant SFN is demonstrated below

$$\mu = (0.4 \times 0.6 \times 0.3 \times 0.3 \times 0.4)^{(1/5)} = 0.3866$$

$$\vartheta = [1 - ((1 - 0.60^2) \times (1 - 0.40^2) \times (1 - 0.70^2) \times (1 - 0.70^2) \times (1 - 0.60^2))^{(1/5)}]^{1/2} = 0.6188$$

$$\gamma = \left[\begin{array}{l} \{((1 - 0.60^2) \times (1 - 0.40^2) \times (1 - 0.70^2) \times (1 - 0.70^2) \times (1 - 0.60^2))^{(1/5)}\} \\ -\{((1 - 0.40^2 - 0.60^2) \times (1 - 0.40^2 - 0.40^2) \times (1 - 0.30^2 - 0.70^2 \\ \times (1 - 0.30^2 - 0.70^2) \times (1 - 0.40^2 - 0.60^2))^{(1/5)}\}]^{1/2} = 0.3595 \end{array} \right.$$

In this way, we calculate the aggregated SFNs and move forward to find out the scores. For example, for the calculated SFN as shown above, the score value is derived as follows:

$$Score = \frac{1}{3}(2 + \mu - \gamma - \vartheta)$$
$$= \frac{1}{3}(2 + 0.3866 - 0.3595 - 0.6188) = 0.4695$$

Table 5 summarizes the final score values of the responses of the respondents corresponding to the five factors of the ST model for exploring the dominant personality styles.

It is seen that the candidate 1 (A1) has a dominant (9,9,9) personality style as the score value (0.7552) is highest under this style than others. The score values are calculated based on his/her responses to various statements under different factors (see Table 3) of the ST while utilizing the SFN scale (see Table 2) and ST keys (see Appendix B, Table B1). Therefore, candidate 1 is a person of focus on task, people, and organizations to the highest degree and he/she is having a creative solution mindset. From an organizational perspective, in the present scenario this type of personality is well-accepted. However, at this stage conclusion cannot be drawn as the experts' decision is yet not revealed. Looking at the score values under various styles for the other candidates it may be referred as candidates 3 and 4 (i.e., A3 and A4) are having an impoverished type of personality with focus on routine sales and having least care for task, people, and organization. The candidate A2 does not have concern for sales, rather he/she wants to maintain a long-term relationship with customers and organizations. This type of personality is well-behaved but not a good task master. On the other hand, the person A5 follows a middle-of-the road approach as he/she has moderate concern for the task, people, and organization. Hence, after the first stage result, apparently, the candidate A1 is a suitable one for the sales job.

Now, we present the outcome of the assessment done by the expert panel using the SFN linguistic scale (see Table 4) while

Table 5
Assessment of the personality style (based on the responses of candidates)

	Score values under various Sales Troika personality styles								
Candidate	(1,1,1)	(1,9,1)	(9,1,1)	(9,9,1)	(1,1,9)	(1,9,9)	(9,1,9)	(9.9,9)	(5,5,5)
A1	0.4695	0.4784	0.3697	0.5287	0.6682	0.7211	0.5180	0.7552	0.3929
A2	0.5548	0.5745	0.4007	0.4724	0.4566	0.7270	0.3912	0.6723	0.4830
A3	0.7356	0.4524	0.4701	0.4243	0.4733	0.4803	0.4488	0.5965	0.5757
A4	0.7038	0.5894	0.3933	0.4936	0.5187	0.6636	0.3880	0.7000	0.4025
A5	0.6218	0.4576	0.4729	0.5017	0.5894	0.5220	0.3929	0.4542	0.6304

Table 6
Normalized SF decision matrix for candidate selection

	Attributes														
Candidate	C1			C2			C3			C4			C5		
A1	0.8139	0.2069	0.2113	0.6882	0.3311	0.3473	0.7740	0.2425	0.2462	0.5165	0.4998	0.4020	0.7740	0.2425	0.2462
A2	0.7361	0.2730	0.2751	0.5720	0.4355	0.4482	0.5909	0.4353	0.3053	0.7740	0.2425	0.2462	0.3936	0.6176	0.3484
A3	0.5720	0.4355	0.4482	0.2954	0.7152	0.3291	0.5909	0.4353	0.3053	0.4514	0.5529	0.4598	0.3323	0.6702	0.3406
A4	0.3272	0.6873	0.3660	0.8559	0.1629	0.1667	0.3323	0.6702	0.3406	0.4829	0.5275	0.4343	0.3680	0.6363	0.3804
A5	0.8559	0.1629	0.1667	0.6119	0.3972	0.4117	0.7361	0.2730	0.2751	0.6119	0.3972	0.4117	0.5524	0.4693	0.3606

Table 7
Score values of the elements of the SF decision matrix for candidate selection

	Attribute				
Candidate	C1	C2	C3	C4	C5
A1	0.8421	0.7618	0.7293	0.7986	0.8421
A2	0.7733	0.5628	0.6168	0.6699	0.4759
A3	0.5628	0.4170	0.6168	0.4796	0.4405
A4	0.4246	0.8421	0.4405	0.5070	0.4504
A5	0.8421	0.6010	0.7293	0.6010	0.5742

utilizing the five factors of the ST model as attributes or criteria. It may be noted that all these criteria are of beneficial nature from the perspective of personnel selection. Using the score sheet (see Appendix C), the experts rated the candidates which then have been aggregated (using SWGA) to form the SF decision matrix (see Table 6).

The ratings of the experts are given in Appendix E. In our case since we do not have any non-beneficial criteria, we need not to derive separate normalized SF decision matrix. The SF decision matrix is itself the normalized SF decision matrix. Hence, we move to calculate the score values of the elements of the SF decision matrix using expression (9). Table 7 exhibits the score values.

Now, we calculate the criteria weights following the steps of the LOPCOW (see expressions (15)–(16)). An example of such calculation is given below

$$P_1 = \left| \ln \left(\frac{\sqrt{\frac{\sum_{i=1}^{5} r_{i1}^2}{5}}}{\sigma} \right) .100 \right| = \ln\left(\frac{0.7090}{0.1870}\right) \approx 133.29$$

$$w_1 = \frac{P_1}{\sum_{j=1}^{5} P_j} = \frac{133.29}{717.79} = 0.1857$$

$$w_5 = \frac{P_5}{\sum_{j=1}^{5} P_j} = \frac{123.2299}{717.79} = 0.1681$$

In this way, all other criteria weights are given in Table 8.

It is seen that based on the opinions of the experts, the order of preferences of the criteria are C3 (AM) > C4 (CM) > C2 (DM) > C1 (SG) > C5 (SM). Sales target often imposes mental stress that acts as a barrier to communication and critical thinking. Often excessive stress and anxiety lead to loss of temper and sales persons get into arguments. Further, to achieve the sales target and build long-term relationship with the customers (also with the superiors in the organization) it is important to effectively manage the conflicts. A clarity in thinking with control over the stress and ability to win others help in appropriate DM. In addition, during the sales encounter, the sales persons need to take prudent and quick decisions. All these qualities essentially lead to conversion of the sales target. Management of self significantly depends on balancing the work and life, keeping sound mental health, and thinking with clarity and DM. Therefore, the result as given in Table 8 is quite justified. Now, we use expression (18) to get the final appraisal score for each candidate. For example, the appraisal score for candidate 4 can be calculated (using expression (18)) as

Table 8
Criteria weights

Criteria	C1	C2	C3	C4	C5
Mean square	0.5027	0.4283	0.4037	0.3870	0.3324
SD	0.1870	0.1680	0.1182	0.1293	0.1681
PV	133.2911	136.0056	168.1570	157.1070	123.2299
w_j	0.1857	0.1895	0.2343	0.2189	0.1717

$$S_4 = \sum_{j=1}^{5} w_j r_{4j} = w_1 r_{41} + w_2 r_{42} + w_3 r_{43} + w_4 r_{44} + w_5 r_{45}$$
$$= 0.0789 + 0.1596 + 0.1032 + 0.1110 + 0.0773 = 0.52991$$

In the similar way, the appraisal scores for other candidates are calculated. Table 9 provides the ranking of the candidates.

7. Validation and Sensitivity Analysis

To validate the result of candidate ranking using SF-LOPCOW method, we follow a comparison with the outcome based on other methods as demonstrated in the extant literature (e.g., [64]). Validation of the MCDM results is an essential requirement as the outcome is influenced by any changes in the underlying conditions [65]. To this end, we carry out the candidate ranking using the

Table 9
Candidate ranking

Candidate	Appraisal Score	Rank
A1	0.79094	1
A2	0.62305	3
A3	0.5086	5
A4	0.52991	4
A5	0.67123	2

Table 10
Comparison of ranking (using SF-LOPCOW, SF-MABAC, and SF-EDAS methods)

	Ranking			
Candidate	SF-LOPCOW	SF-MABAC	SF-EDAS	Classical LOPCOW
A1	1	1	1	1
A2	3	3	3	3
A3	5	5	5	5
A4	4	4	4	4
A5	2	2	2	2

Table 11
Experimental cases for the sensitivity analysis (scheme A)

W_j	C1	C2	C3	C4	C5	Sum
Calculated/ original	0.1857	0.1895	0.2343	0.2189	0.1717	1.00
Exp. 1	**0.2343**	0.1895	**0.1857**	0.2189	0.1717	1.00
Exp. 2	0.1857	**0.2343**	**0.1895**	0.2189	0.1717	1.00
Exp. 3	0.1857	0.1895	**0.2189**	**0.2343**	0.1717	1.00
Exp. 4	0.1857	0.1895	**0.1717**	0.2189	**0.2343**	1.00
Exp. 5	**0.1717**	0.1895	0.2343	0.2189	**0.1857**	1.00
Exp. 6	0.1857	**0.1717**	0.2343	0.2189	**0.1895**	1.00
Exp. 7	0.1857	0.1895	0.2343	**0.1717**	**0.2189**	1.00
Exp. 8	**0.2189**	0.1895	0.2343	**0.1857**	0.1717	1.00
Exp. 9	0.1857	**0.2189**	0.2343	**0.1895**	0.1717	1.00
Exp. 10	**0.1895**	**0.1857**	0.2343	0.2189	0.1717	1.00

The bold values are indication of the criteria weight exchanges.

multi-attributive border approximation area comparison (MABAC) method [66] and evaluation based on distance from average solution (EDAS) method [67] with SF extension. Table 10 summarizes the comparative analysis of the results.

It is seen that all methods provide the same ranking to the candidates. Hence, the result obtained using SF-LOPCOW method is justified. The need for SF-LOPCOW method may not be felt in this problem because the number of alternatives and criteria is less. However, in real-life complex cases wherein a lot of conflicting criteria would influence a good number of alternatives and a large number of decision makers take part in the study, the requirement of SFS will be critical as it allows to handle subjective bias quite efficiently. We now move to examine the stability in the results as sometimes with the changes in the grounded conditions, the outcome of MCDM analysis suffers from notable variations [68]. Hence, we perform the sensitivity analysis by using two schemes. For scheme A, we adopt weight exchanges among the criteria. Table 11 provides the criteria weights under different experimental scenarios.

Figure 2
Result of sensitivity analysis (scheme A) – comparative ranking

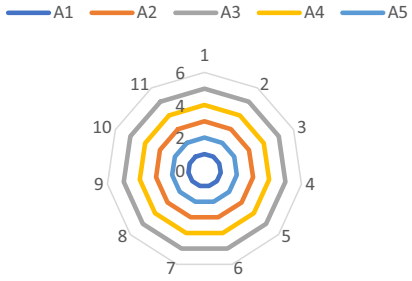


Table 12 shows the ranking of the candidates under various experimental cases which is pictorially depicted in Figure 1.

It is observed that there is no change in the comparative ranking of the candidates despite the changes in the criteria weights. The same is reflected in Figure 2. However, to get further confirmation, we check for possible variations in the appraisal scores of the candidates under various situations (see Table 13) and plot the same (Figure 3). We note that there have not been any significant changes in the appraisal scores too. Hence, we conclude that the outcome of SF-LOPCOW is stable.

For scheme B, we follow two steps in accordance with the practice of Pamucar et al. [65]:

(i) Decrease the weight of the highest criterion (i.e., C3) by 2% with respect to the original calculated case at each experimental case and add the reduced amount proportionally to all other weights.
(ii) Increase the weight of the lowest criterion (i.e., C5) by 2% with respect to the original calculated case at each experimental case and deduct the reduced amount proportionally from all other weights.

Accordingly, we generate 30 such scenarios and the derived criteria weights (for scheme B) are mentioned in Appendix F. The outcome of the sensitivity analysis (scheme B) is shown in Figure 4. We do not notice any change in the ranking order.

It may be noted that the outcomes of scheme A and B are same which indicate that our method can produce stable result.

8. Conclusion

Personnel selection is a complex DM process as it involves both quantitative eligibility like qualifications and marks, special trainings, scores obtained in the entrance test, etc. and qualitative factors like background, communication skill, behavioral skills,

Table 12
Ranking of the candidates under various experimental cases (sensitivity analysis, scheme A)

	Ranking										
Candidate	Original	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9	Exp. 10
A1	1	1	1	1	1	1	1	1	1	1	1
A2	3	3	3	3	3	3	3	3	3	3	3
A3	5	5	5	5	5	5	5	5	5	5	5
A4	4	4	4	4	4	4	4	4	4	4	4
A5	2	2	2	2	2	2	2	2	2	2	2

Table 13
Appraisal scores of the candidates under various experimental cases (sensitivity analysis, scheme A)

	Performance score values										
Candidate	Original	Exp. 1	Exp. 2	Exp. 3	Exp. 4	Exp. 5	Exp. 6	Exp. 7	Exp. 8	Exp. 9	Exp. 10
A1	0.7909	0.7964	0.7924	0.7920	0.7980	0.7909	0.7924	0.7930	0.7924	0.7899	0.7912
A2	0.6231	0.6307	0.6206	0.6239	0.6142	0.6189	0.6215	0.6139	0.6265	0.6199	0.6238
A3	0.5086	0.5060	0.4997	0.5065	0.4976	0.5069	0.5090	0.5068	0.5114	0.5068	0.5092
A4	0.5299	0.5291	0.5479	0.5309	0.5305	0.5303	0.5229	0.5272	0.5272	0.5398	0.5283
A5	0.6712	0.6767	0.6655	0.6693	0.6615	0.6675	0.6708	0.6700	0.6792	0.6712	0.6721

Figure 3
Result of sensitivity analysis (scheme A) – comparison of the appraisal scores

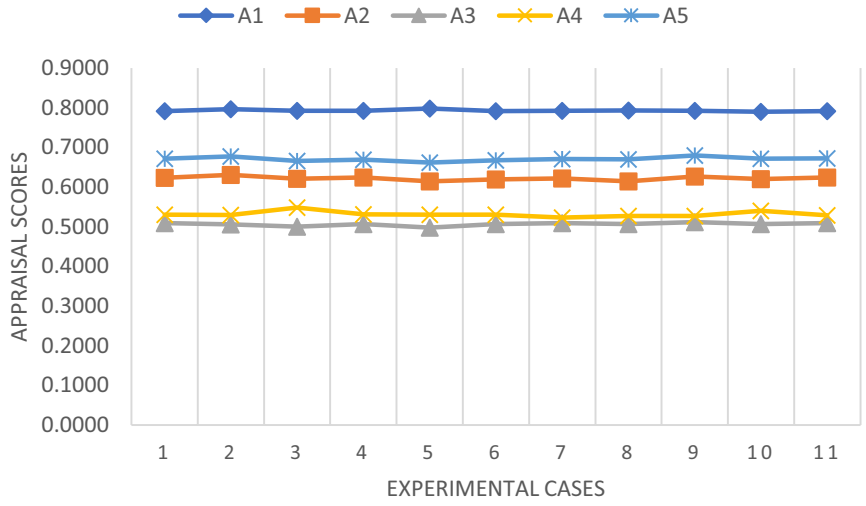
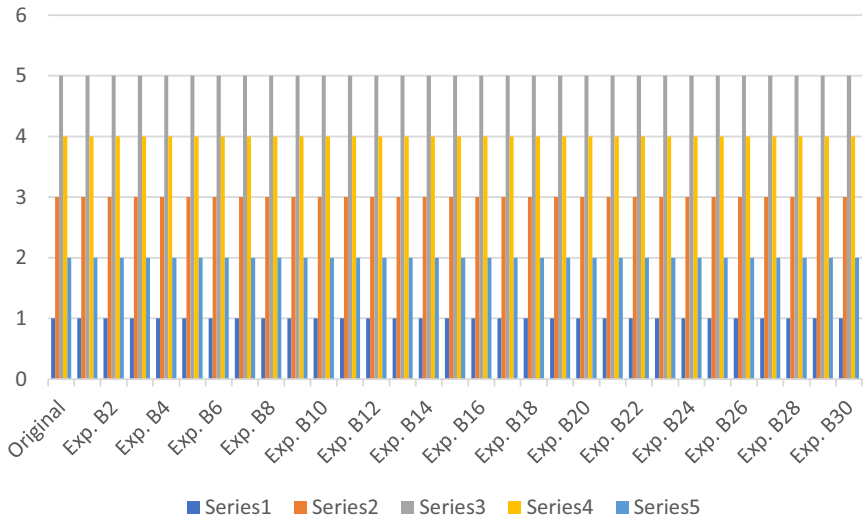


Figure 4
Result of sensitivity analysis (scheme B) – comparative ranking



and psychological stability and personality. The decision is influenced by a considerable amount of subjective bias due to the presence of the qualitative factors and human judgment of the interview panel members. In the present study, an attempt has been made to put forth an improved framework for personnel selection for a challenging job role such as sales. The candidates have been judged through a two-stage process based on their personality styles vis-à-vis sales profession. A well-known PA framework such as ST has been considered for the purpose of PA. The ST framework considers three orientations of the persons such as task/product, people, and organization. To reduce the effect of subjective bias, SFS has been used. The candidates have

been evaluated on the basis of their opinions related to the nine statements under each of the five factors of the ST framework such as SG, DM, AM, CM, and SM. According to their responses, the personality styles have been figured out and mapped with the nine applicable styles as proposed in the ST model. We observe that one candidate (A1) has strong concerns for sales/task, people, and organization, while A5 follows a middle-of-the road approach as he/she has moderate concern for the task, people, and organization. The candidate A2 does not have concern for sales, rather he/she wants to maintain a long-term relationship with customers and organizations. The other candidates 3 and 4 (i.e., A3 and A4) are having an impoverished type of personality with focus on routine sales and having least care for task, people, and organization. In the second stage, based on the evaluation of the interview panel comprising of five experts (considering the five factors of the ST framework as criteria) using the proposed SF-LOPCOW method, it is revealed that A1 holds the first rank and is most suitable candidate. In effect, it is observed that suitability of a candidate depends on his/her degree of concern for all three aspects such sales/products/task, people/customer, and parent organization. The chance of getting selected increases with the higher degrees of concern for all three aspects. Further, we have made a comparison of the candidates using classical LOPCOW, SF-MABAC, SF-LOPCOW, and SF-EDAS methods. We have found that all these methods (including our SF-LOPCOW method) select the candidate A1 as the best selection. To check the stability of the result given the changes in the underlying conditions (e.g., criteria weights), we have carried out the sensitivity analysis by interchanging the criteria weights and varying the weights proportionately. We have found that there is no change in the ranking order. Hence, the newly modified SF-LOPCOW model shows stability in the result to select the candidate A1 as the best option.

The present paper sheds a new direction to the selection process for the recruiters and selectors. It provides a robust framework with abilities to reduce subjective bias for more authentic and fair judgment. ST framework is a comprehensive framework for assessing personality styles but yet to be explored and extended more. Our SF-LOPCOW model provides stable and reasonably accurate solution, withstand variations in the size of the decision matrix and negative values, and provides considerably uniform distributions of the criteria weights while exhibiting a better analysis with imprecise information. However, one possible limitation of this model is that it does not consider the degree of refusal. Further, the present model is not considering the effect of the variations in the performance values largely.

The present paper may be further extended by incorporating other perspectives of behavioral assessment and carrying out the comparative analysis using our model. Further, a comprehensive analysis may be done with both quantitative and qualitative aspects together. In addition, a causal analysis may be carried to examine the impact of personality styles on job performance, career progression, employee satisfaction, and retention vis-à-vis technological progress. Nevertheless, we do hope that the present paper shall be of interest for the readers and may invoke wider applications with new research in the stated field.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

Author Contribution Statement

Sanjib Biswas: Conceptualization, Methodology, Software, Validation, Formal analysis, Resources, Writing – original draft, Writing – review & editing, Project administration. **Shreya Chatterjee:** Conceptualization, Formal analysis, Investigation, Data curation, Writing – original draft, Visualization. **Shuvendu Majumder:** Conceptualization, Validation, Investigation, Resources, Writing – review & editing, Supervision.

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