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Preliminary communication

Personnel Selection with Multi-Criteria Decision Making Methods in the Ready-to-Wear Sector

Tuğba DANIŞAN, Evrencan ÖZCAN, Tamer EREN*

Abstract: The selection of personnel to be recruited for businesses is a significant problem. This study discusses the problem of selecting a person to be hired to use a machine with various specific features in a textile factory. It was aimed to select the most suitable candidate for the job. MCDM methods were used to make an analytical selection away from subjectivity. In this study, real-life business procedures were performed. The Weighted Scoring (WS) method was used for preselection. Important criteria weights for the factory were determined with the Analytical Hierarchy Process (AHP) method. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) and Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) methods were used to make a correct selection among the candidates. The most suitable candidate for the job was selected with the methodology followed. The study differs from other studies in the literature with the evaluation criteria, combination of methods, the methodology followed.

Keywords: AHP, Personnel selection, PROMETHEE, Textile industry, TOPSIS, Weighted Scoring

1 INTRODUCTION

With the increase of competition and high technology, businesses must develop to participate in this competition and ensure their sustainability [1]. Inefficient and poor-quality work increases the labour cost even more and reduces the competitive chance of businesses [2]. For this reason, the performance of personnel in their work is an essential factor in the development of businesses. Performance of personnel varies in line with some factors such as their skills and experience in their work. The recruitment process to meet the personnel needs that arise from the growth of businesses has become a process that must be carried out carefully for these reasons. The high number of people applying for job advertisements published by the businesses and selecting the appropriate person has been a problem for the businesses. With it published by TR Presidency of Strategy and Budget, 11th Development Plan [3] by providing fast and flexible production in the textile sector has been targeted to innovative approaches. This study discussed selection problems for the personnel who have great importance in the sustainability and efficiency of production to serve the targets set in the Development Plan [3]. The personnel selection to be employed in a textile factory working on ready-to-wear was made. Many studies have been presented in the literature under personnel selection to effectively manage the recruitment process and recruit the most suitable person. MCDM methods have been used in different areas in the literature to determine suppliers [4, 5], machines [6, 43], vehicles, route, vehicles, equipment [7, 8]. Apart from these areas, Efe and Kurt [9], Jasemi and Ahmadi [10], Samanlioglu et al. [11], Luo and Xing [12], Raj Mishra et al. [13], Krishankumar et al. [14], many authors have conducted studies on personnel selection. Authors who provide problem-solving with MCDM methods have used many of these methods. For example, Gibney and Shang [15] use the AHP method to select academic staff, while Chen et al. [16] used the PROMETHEE method for selection of personnel in a company. While Kelemenis and Askounis [17] addressed determining a member to be selected for a team with the Fuzzy TOPSIS method, Lin [18] addressed the personnel selection problem for a company in Taiwan with Analytical Network Process and Data Envelopment Analysis. Again, Feng and Zhang [19] proposed an integrated approach consisting of Fuzzy TOPSIS and a mathematical model to create a support team in personnel selection. Keršulienė and Turskis [20] used the Analytical Network Processing method in the selection of architects. Zhang and Liu [21] proposed the heuristic fuzzy MCDM model used with the Gray Relational Analysis method. Baležentis et al. [22] fuzzy The Multi-Objective Optimization by Ratio Analysis (MULTIMOORA), Rouyendegh and Erkan [23] used fuzzy ELEmination and Choice Translating Reality English (ELECTRE) methods, while Kalugina and Shvydun [24] designed a computer-aided model and made personnel selection. Jasmine and Ahmadi [10] used the Fuzzy ELECTRE method. Efe and Kurt [9] made the personnel selection in assembly line balancing using the TOPSIS method.

The problem of selection in which many different methods are used, has been addressed in many different sectors. For example, in tourism [25], banking [26], health [27, 44], information systems [11-13, 28], production [29], aviation [30] and textile [31-34]. This problem has found its place. However, personnel selection in the textile industry has been a less studied topic in the literature. Especially in the textile sector, Kucuk and Atilgan [33] addressed this problem in selecting a fashion designer, and Tus and Adalı [32] in selecting marketing. While Özbek and Erol [31] dealt with selecting the sewing personnel to work in the textile industry, as in this study, Tezcan et al. [34] selected the personnel to be dismissed. In this study, a person is recruited to use a special buttonhole machine with electronic and touch panel upon an agreement with a company with high standards and quality in a textile factory working on ready-to-wear. The operation to be performed with this machine is the last operation of the sewing line. If this operation is not completed, the final product cannot be obtained, and the product cannot be delivered to the customer on time.

The problem of selecting the most suitable personnel among job applicants is critical because the cost of the machine is high and there is no spare machine to perform the same function. There are also heavy sanctions resulting

from the agreement made for the late delivery of the product. Therefore, it is necessary to choose among 30 people who apply for job advertisements published by the factory. WS, AHP, PROMETHEE, and TOPSIS methods were used in this problem. In the first phase of this study, preselection was made among 30 candidates using the WS method. As a result of the preselection, five candidates came forward. In the second phase of the study, the weights of the criteria determined for the problem were calculated using the AHP method, and the solution was made by using these criteria weights in PROMETHEE and TOPSIS methods. First, the solution was made with the PROMETHEE method, which effectively evaluates each evaluation factor within itself. Then, this solution was verified with the TOPSIS method, which is frequently used in the literature [8]. Then, personnel selection was made among five candidates. As a result of the solutions, the most suitable candidate has been selected for recruitment.

This study differs from other studies in the literature in the following aspects.

- WS method was used in the personnel selection problem.
- It considered criteria such as machine knowledge and sewing speed, unlike the personnel selection problems in the textile sector.
- WS, AHP, PROMETHEE, and TOPSIS methods were used in the methodology.
- The first time a step-by-step study was carried out by preselection in the personnel selection problem,
- In the application, selection was made among 30 candidates. The methodology can be applied for the selection of any desired number of people. The study offers a tool that can be used for solving recruitment problems.
- In the case of personnel selection in enterprises and especially in the human resources department, the proposed solution is applicable even if the number of applicants reaches a number that can be expressed in thousands.

2 METHODS

In daily or business life, more than one conflicting/related criterion must be considered in the decision-making process. The importance of MCDM approaches that increase the efficiency of decision-making processes is emerging. Information about the methods used for the personnel selection problem is presented in this section. The implementation phase of this study on personnel selection is included in this section, and the steps followed are shown in Fig. 1.

Firstly, the WS method was used in the study. The reason for this is to qualify from among many candidates. This can also be called preselection. In the phase, sixteen criteria were determined, such as flexible working, knowledge sharing, learning speed, attention level, reflex speed. In the first phase of this study, which was carried out in two phases, a preselection was made among thirty candidates using the WS method. Five candidates came forward as a result of the preselection. In the other phase, AHP, TOPSIS, and PROMETHEE methods were used to select the best among these five candidates. A solid result was desired to select the right candidate and compared TOPSIS with PROMETHEE results. In the sample application, 30 candidates were evaluated. The proposed approach can be applied to any problem of the desired size.

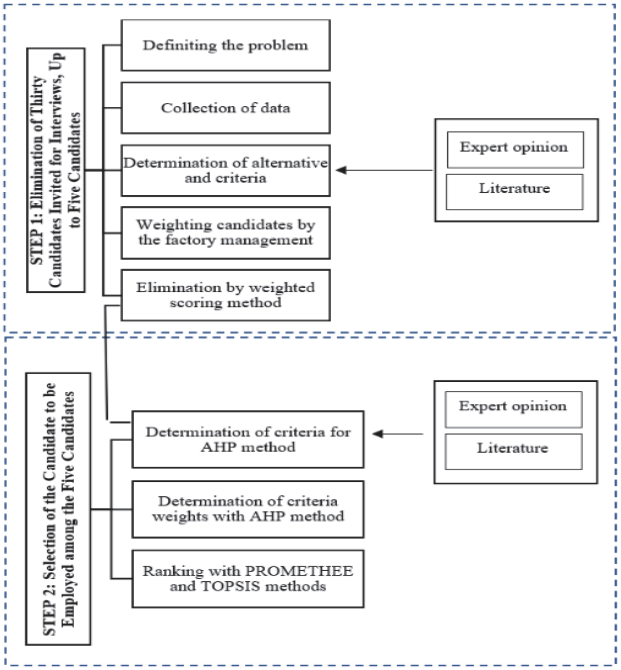

Figure 1 Application steps

2.1 Weighted Scoring

The scoring method is a method used to compare projects or alternatives based on a weighted score system. Scoring models also provide the opportunity to quantify different options or unseen benefits using many criteria. It is operated in five steps [35], and these steps are presented in Fig. 2.

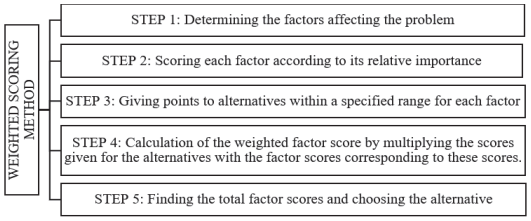

Figure 2 WS method application steps

2.2 AHP

AHP method developed by Saaty [36] is used as a singular or supportive method in many decision-making problems, and its popularity is increasing day by day. Its applications range from public administration to the business world, from industrial applications to the health sector, from loading problems to education and energy [7]. The implementation steps of AHP are given in Fig. 3.

In AHP implementation, Step 1 is the step in which a hierarchical structure with top-down goals, criteria, and alternatives is established by determining the criteria and alternatives that affect the problem. In step 2, Tab. 1, developed by Saaty [36], was used. Next, matrices were formed in which the alternatives and criteria were according to each criterion.

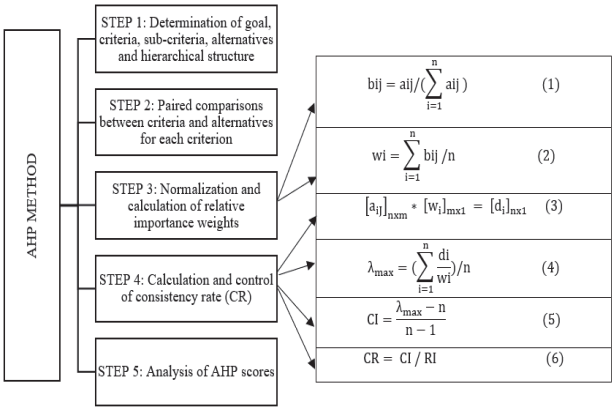

Figure 3 AHP method application steps and used equation

Table 1 Saaty importance scale

Importance values	Value definition
1	Equally important
3	Somewhat more important
5	Much more important
7	Extremely more important
9	Definitely more important
2, 4, 6, 8	Intermediate values

In Step 3, after binary comparisons, normalization was made with the formulas given in Eq. (1) and Eq. (2) in Fig. 3, and relative importance weights were calculated. Finally, as a result of the normalization process, in Step 4, the consistency rate calculation was made by calculating with the formulas presented in Eq. (3) to Eq. (6) in Fig. 3, and RI ratios in Eq. (6) were chosen from the values in Tab. 2.

Table 2 RI values

n	1	2	3	4	5	6	7
RI	0	0	0,58	0,9	1,12	1,24	1,41
n	8	9	10	11	12	13	
RI	1,45	1,49	1,51	1,48	1,56	0	

If CR < 0.1, the pairwise comparison matrix is consistent. Otherwise, binary comparisons should be reviewed, the matrix renewed, and the above calculations should be made again [7]. Finally, the alternative with the highest value is selected from the results found in Step 5.

2.3 TOPSIS

TOPSIS method was developed by Hwang and Yoon [37] in 1981 and is a method frequently used in real-life multi-criteria decision problems. This method offers decision-makers the opportunity to compare and rank alternatives. TOPSIS ranks the alternatives based on the closest to the positive ideal solution and the furthest distance from the negative ideal solution and chooses the closest alternative to the ideal solution. The method consists of 6 steps [37], and these steps are given in Fig. 4. In the TOPSIS method, the decision matrix in Step 1 is shown as in Eq. (7) in Fig. 4. In the A_{ij} matrix, m gives the number of alternatives, and n gives the criteria. After this step, a standard decision matrix is generated with the formula in Eq. (8) in Fig. 3 in Step 2. In step 3, these criteria's weight ratios (w_{ij}) are first determined to evaluate the criteria. Then, the weighted standard decision matrix, V_{ij}, is obtained by multiplying each weight value with the value of the relevant criterion in the standard decision matrix and is shown as in Eq. (9) in Fig. 4. In step 4, according to the assumption that the criteria show a monotonously increasing and decreasing trend, the maximum and minimum values in the weighted standard decision matrix are determined using Eq. (10) and Eq. (11) in Fig. 4. Using Eq. (12) and Eq. (13) in Fig. 4, the distances of the criteria values of each decision point in the matrix to the ideal and harmful ideal solution are calculated. In addition, the relative proximity to the ideal solution is calculated by using the discrimination criteria with the help of Eq. (14). C_i* value takes a value between 0 - 1. Taking this value as one means the absolute proximity of the decision point to the ideal solution and the value 0 to the negative ideal solution [9].

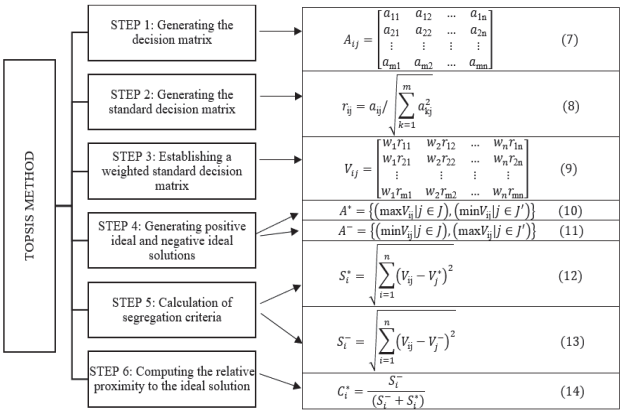

Figure 4 TOPSIS method application phases and equations

2.4 PROMETHEE

PROMETHEE method was developed by Brans [38]. It is a simple method that can be adapted for many criteria that can be expressed with actual values compared to other MCDM methods in terms of application and scope. The method determines the order of decision points with the main phases PROMETHEE I (partial order) and PROMETHEE II (total order). PROMETHEE method is based on binary comparisons of decision points according to evaluation factors. However, the main difference from other MCDM methods is that besides the importance weights that show the relationship level between the evaluation factors, each evaluation factor also considers its internal relationship. PROMETHEE method consists of 7 steps [39].

In Step 1, a data table is created where decision points and evaluation factors are defined, and the importance weights of evaluation factors are determined. In Step 2, after the preference functions are determined, in Step 3, standard preference functions for alternatives are determined by Eq. (15) in Fig. 5. With Eq. (16), preference indexes are selected with the function in Step 4. With the help of Eq. (17) and Eq. (18), after determining positive and negative superiority for an alternative a, partial priorities are determined in Step 6. There are three situations in this step. If the first situation in Eq. (19) occurs, alternative a is preferred from two alternatives, a and b. In the second case in Eq. (20), alternative a and b alternative is no different. In Eq. (21), which includes the third situation, alternatives a and b cannot be compared.

With Eq. (22) in Step 7, the absolute priorities of the alternatives are determined, and the selection is made [38].

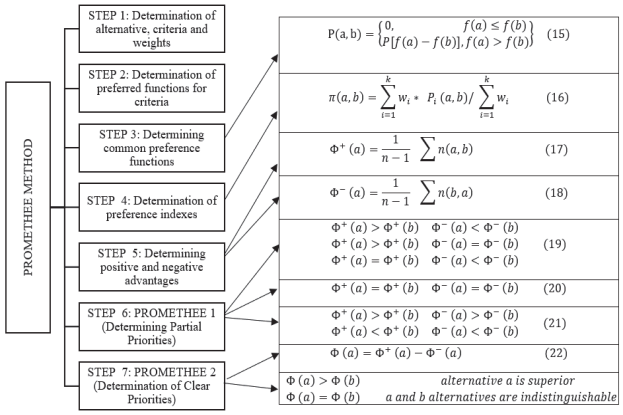

Figure 5 PROMETHEE method application steps and equations

3 RESULTS AND DISCUSSION

Businesses need to use their resources efficiently [44, 45]. Personnel is among the essential sources of labour in businesses. Evaluations for the candidate to be recruited were made by four-line chiefs, three production engineers, one production manager, and a general manager.

3.1 Elimination of Thirty Candidates Invited for Interviews, up to Five Candidates

In this section, the problem is addressed with the elimination phases among thirty candidates invited to the job post opened by the factory.

3.1.1 Problem Definition

The study was carried out in a textile factory with nearly 27 years of experience in the apparel and apparel industry. This factory which produces polo, t-shirt, sweatshirt, skirt, tunic, dress, etc. is a factory that provides services in knitted children, women, and men wear products. In this factory, where approximately 250,000 products are sewn per month and 130 people work, a person must be recruited to use a particular buttonhole machine with an electronic and touch panel. The operation to be performed with this machine is the last operation of the sewing line. If this operation is not completed, even the final product cannot be obtained, and the product cannot be delivered to the customer on time. This machine is highly costly, and there is no spare machine to perform the same function in case of any malfunction. In addition, sanctions will be applied due to the agreement made in the late delivery of the product.

For this reason, the problem of choosing the most suitable personnel among candidates applying for the job is a critical decision. In context, it is necessary to choose among thirty candidates who are considered suitable for the job and invited for an interview among those who apply for advertisements opened by the factory. First, an oral interview with factory managers was conducted. Questions about their professional competencies were asked to thirty candidates who came for the interview. Later, these candidates participated in a sewing trial under the supervision of the line chefs to make the sewing trial. As a result of this trial, the candidates were evaluated. The evaluations formed due to the oral interviews and sewing trials were brought together, and the scores used in this problem were formed. In the study, sixteen criteria such as flexible working, knowledge sharing, learning speed, attention level, reflex speed were determined to make elimination among these thirty candidates, and these criteria were weighted from 5 to 25 determined. Scoring was done in multiples of five. The factory managers made this scoring. Thirty candidates were scored between 1 and 10 according to their ability to meet these criteria. After scoring, candidates were evaluated using the WS method. In the first phase of this study, preselection was made among thirty candidates using the WS method. As a result of the preselection, five candidates came forward. In the second phase of the study, the weights of the criteria determined for the problem were calculated using the AHP method, and the solution was made by using these criteria weights in PROMETHEE and TOPSIS methods. Then, a solution was made using these weights in the TOPSIS method to compare and verify the results.

3.1.2 Collection of Data

A team provided all the data required in the study application in managerial positions established to evaluate recruitment. Therefore, 3.1.3 to the required data is given in the section.

3.1.3 Determination of Alternatives and Criteria

The alternatives in this step are 30 candidates applying for the job advertisement. In problem-solving, these candidates are specified by numbering from Candidate 1 to Candidate 30 (C1, C2, …, C30). The evaluation criteria at this phase are the criteria that are important for the business. Business managers and line chiefs determined it these criteria were used for the WS method.

The criteria are;

- flexible working
- knowledge sharing
- learning speed
- attention level
- reflex speed
- openness to innovation
- technical competence
- disposition to teamwork
- paying attention to working hours
- problem-solving ability
- claiming the institution
- paying attention to machine maintenance
- machine useability
- machine breakdown rate
- monthly wages
- responsibility

3.1.4 Weighting Candidates by the Factory Management

Planting trials were carried out under the supervision of line chiefs. Oral interviews were also conducted with the candidates. After these procedures, the factory management evaluated the candidates. Finally, the factory management determined candidates' scores. In the study, 16 criteria were determined among these 30 candidates, such as flexible working, knowledge sharing, learning speed, attention level, reflex speed, and weights were given to these criteria from 5 to 25 determined by the factory managers. As a result, thirty candidates were scored

between 1 and 10 according to their ability to meet these criteria.

3.1.5 Elimination by WS Method

At this stage, the scoring method was used to qualify the 30 candidates. In the scoring method, the criteria and weights used to evaluate the personnel; the scores given for each candidate are presented in Fig. 6. After applying the WS method with these scoring, the results in Fig. 7 have been reached. For example, consider the scoring of Candidate 1. First, the scores given to the criteria are added up, and this total is 250 in this study. Then, each criterion is divided into 250 points, and its percentage value is found. This value is 0.06 for flexible working criteria. Afterward, the best value is determined in the scoring given to each candidate for the flexible working criterion. This value is the value 10. Later, Candidate 1's 8 points for this criterion are multiplied by 10 points, which is the highest value in this criterion, and 80 points are found. Finally, the 80-value obtained in this step is multiplied by the percentage importance value of the flexible working criteria, and 5 points in the flexible working criteria for Candidate 1 in Fig. 7 are found. After all these processes are applied for all candidates based on each criterion, Fig. 7 is added up. The total of columns for candidate one is calculated as 60. This result shows that Candidate 1 can get 60 points as a result of the AP method. The enterprise determined 75 points as the minimum rate for the required features. Candidates who got 75 points or more as a result of the solution passed the preselection. After this solution, the total points are listed, and the top 5 candidates are determined. According to the solution result, the five candidates with the highest score were selected. These candidates are C10, C16, C21, C26, C28.

3.2 Selection of the Candidate to be Employed Among the Five Candidates

This section includes the applications for selecting the candidate to be recruited from among the five candidates selected in the previous step.

3.2.1 Determination of Criteria for AHP Method

Factory managers and line chiefs determined the criteria used in this step of the study. The main criteria used in the study are explained in Tab. 3.

3.2.2 Determination of Criteria Weights

In this step, the comparison matrix of the criteria and the criterion weights obtained from the AHP method are given in Tab. 4. The last column in Tab. 4, the "criteria weight" column, contains the values obtained for the criteria due to method. The most important criteria are PE and MK. Since these criteria are considered in selecting personnel who will use a sensitive machine in real life, the results are consistent. CR is 0.079.

Table 4 Paired comparison matrix between criteria and criteria weights

	PE	MK	SS	FK	HC	FE	Criteria weights
PE	1	2	3	6	5	5	0,38
MK	1/2	1	2	4	5	6	0,27
SS	1/3	1/2	1	4	2	3	0,16
FK	1/6	1/4	1/4	1	2	2	0,08
HC	1/5	1/5	1/2	1/2	1	3	0,07
FE	1/5	1/6	1/3	1/2	1/3	1	0,04

Criteria	Weights	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30
Flexible work	15	8	4	9	7	2	5	3	4	2	5	9	4	7	9	10	5	7	1	10	3	10	5	10	7	2	8	2	5	6	9
Information sharing	5	5	7	5	4	7	6	8	9	3	6	4	1	1	9	1	9	7	5	2	10	7	6	1	3	6	4	10	5	2	2
Learning speed	15	6	9	6	3	4	7	5	6	9	7	8	8	7	4	7	9	6	10	8	5	7	10	8	6	6	6	10	7	3	10
Attention level	25	5	7	8	8	6	6	5	10	9	8	3	1	4	1	1	5	7	8	1	8	8	6	3	5	9	9	8	6	10	6
Reflex rate	15	7	8	10	10	4	8	4	10	5	9	8	9	10	9	4	6	1	2	8	10	6	3	4	4	3	9	3	5	4	1
Openness to innovation	5	8	9	6	8	9	4	9	6	2	6	2	4	1	7	3	10	3	2	6	6	6	5	9	9	3	8	8	6	5	7
Technical proficiency	25	5	7	8	4	6	5	4	7	4	7	6	4	5	7	10	8	7	4	6	5	9	7	9	7	8	7	6	7	5	9
Tendency to teamwork	15	6	9	8	8	7	5	7	4	8	6	1	8	4	4	1	10	2	2	6	5	10	9	3	3	4	5	6	8	7	4
Paying attention to working hours	10	0	0	1	0	0	0	0	1	1	1	0	1	1	1	0	1	0	0	0	1	1	0	0	0	0	1	1	1	0	0
Problem solving ability	15	5	8	1	9	6	3	2	7	4	8	5	2	9	7	3	5	4	10	5	7	10	4	1	1	8	7	5	7	4	7
Claiming the institution he works for	10	1	1	1	1	0	0	0	0	0	1	0	1	1	0	1	1	1	1	1	1	0	0	1	0	0	1	0	1	1	1
Taking care of machine maintenance	15	1	0	1	1	0	1	0	1	0	1	1	0	1	0	0	1	0	1	1	1	1	1	1	1	1	1	0	1	1	0
Machine use ability	25	7	6	7	3	4	5	5	6	6	9	8	6	4	10	9	8	10	6	5	7	9	8	8	6	7	8	8	7	5	9
Machine failure rate (%)	20	3	4	2	3	5	4	4	5	4	1	5	2	4	5	2	1	1	2	3	4	3	1	3	5	2	3	4	1	5	4
Monthly wage (₺)	20	2651	2534	3078	2688	2803	3142	2682	2824	3054	2878	2947	3039	2534	2676	3125	3129	3087	2994	2566	2805	3047	2651	2667	3053	2598	3001	2625	3300	2642	2626
Taking responsibility	15	1	6	3	4	5	2	5	3	1	6	10	4	1	4	8	6	6	5	1	7	10	5	9	5	6	8	2	5	5	9

Figure 6 Evaluation scores of the candidates according to 16 criteria

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15	C16	C17	C18	C19	C20	C21	C22	C23	C24	C25	C26	C27	C28	C29	C30
Flexible work	5	2	5	4	1	3	2	2	1	3	5	2	4	5	6	3	4	1	6	2	6	3	6	4	1	5	1	3	4	5
Information sharing	1	1	1	1	1	1	2	2	1	1	1	0	0	2	0	2	1	1	0	2	1	1	0	1	1	1	2	1	0	0
Learning speed	4	5	4	3	2	4	3	4	3	4	5	4	4	2	4	5	4	6	5	3	4	6	5	4	4	4	6	4	2	6
Attention level	5	7	8	8	6	6	5	10	9	8	6	5	6	6	1	5	7	8	7	8	8	4	3	5	3	9	8	10	5	5
Reflex rate	4	5	6	6	2	5	2	6	5	5	5	5	5	2	4	1	3	5	6	4	2	2	2	2	5	4	5	4	4	2
Openness to innovation	2	2	1	2	2	1	2	1	0	1	0	1	0	1	1	2	1	0	1	1	1	1	2	2	1	2	2	1	1	1
Technical proficiency	5	7	8	4	6	5	4	7	4	7	6	4	5	7	10	8	7	4	6	5	9	7	9	7	8	7	6	7	5	9
Tendency to teamwork	4	5	5	5	4	3	4	2	5	4	1	5	2	2	1	6	1	1	4	3	6	5	2	2	2	3	4	5	4	2
Paying attention to working hours	0	0	4	0	0	0	0	4	4	4	0	4	4	4	0	4	0	0	0	4	4	0	0	0	0	4	4	4	0	0
Problem solving ability	3	5	1	5	4	2	1	4	2	5	3	1	5	4	2	3	2	6	3	4	6	2	1	1	5	4	3	4	2	4
Claiming the institution he works for	4	4	4	4	0	0	0	0	0	4	0	4	4	0	4	4	4	4	4	4	0	0	4	0	0	4	0	4	4	4
Taking care of machine maintenance	6	0	6	6	0	6	0	6	0	6	6	0	6	0	0	6	0	6	6	6	6	6	6	6	6	6	0	6	6	0
Machine use ability	7	6	7	3	4	5	5	6	9	8	6	4	10	9	8	10	6	5	7	9	8	8	6	7	8	8	7	5	9
Machine failure rate (%)	3	2	4	3	2	2	2	2	2	8	2	4	2	2	4	8	8	4	3	2	3	8	3	2	4	3	2	8	2	2
Monthly wage (₺)	8	8	7	8	7	6	8	7	7	7	7	7	8	8	6	6	7	7	8	7	7	8	8	7	8	7	8	6	8	8
Taking responsibility	1	4	2	2	3	1	3	2	1	4	6	2	1	2	5	4	4	3	1	4	6	3	5	3	4	5	1	3	3	5
Result	60	64	72	63	45	50	43	65	50	80	60	55	62	62	54	78	60	60	63	69	80	64	63	50	55	75	59	79	55	64

Figure 7 Results obtained with the WS method

3.2.3 Ranking with PROMETHEE and TOPSIS

A decision matrix is formed in the first step to solve the problem. This decision matrix is given in Tab. 5. The values in this table consist of points given by line chiefs due to sewing trials. TOPSIS method, which allows the distances between the ideal solution to be taken into account in the problem [8], and the PROMETHEE method, which allows the criteria to be expressed with various functions, were preferred [39]. These two methods are frequently used in the literature and provide ease of use [9, 31, 34]. Therefore, PROMETHEE and TOPSIS methods were applied using this decision matrix and weights obtained from the AHP method.

Table 5 Decision matrix

ALTERNATIVES	CRITERIA					
	PE	MK	SS	FK	HC	FE
C10	100	95	90	70	90	70
C16	80	70	80	80	80	60
C21	95	90	90	60	90	100
C26	60	80	70	50	60	90
C28	70	60	60	40	50	50

The criteria considered in evaluating alternative candidates, the values determined based on the criteria, and the weights assigned to each criterion were entered into the Visual PROMETHEE [42] package program. Each valuation criterion is a fundamental value (qualitative criteria are expressed in numerical values). Therefore, change functions are determined for each criterion. V-shape and linear functions were used because the criteria consisted of changing numerical values. In addition, these threshold values were selected due to their compliance with the data in Tab. 5. The page where the decision matrix is entered is given in Fig. 8. PROMETHEE calculates positive and negative values between +1 and -1 for each alternative. PROMETHEE results were obtained with the Visual PROMETHEE [46] package program, as shown in Fig. 9. According to the results obtained, the ranking was C10, C21, C16, C26, C28. After, a decision matrix was generated for the TOPSIS method selected to compare and verify the results. TOPSIS steps were applied sequentially. The matrix obtained as a result of these steps is presented in Tab. 6.

Table 3 Criteria used in the study and their explanations

Criteria	Definition
Professional experience (PE)	The main criterion is evaluated based on some criteria such as the year in which job applicants worked, the number of companies they sew their products, and the variety of products they sew. It is a criterion that reflects candidates' expertise in their jobs.
Machine knowledge (MK)	It is the main criterion by which candidates are evaluated based on the number of machines they can use, machine types, and machine failure rate. In addition, it is a criterion that reflects candidates' skills in operating machines.
Sewing speed (SS)	It is the main criterion that reflects how the sewing speed is compared to standard times in the sewing operations of the candidates.
Fabric knowledge (FK)	It is the main criterion expressing the candidates' knowledge and experience with fabrics. Whether or not a candidate has sewing experience with the fabric type has been determined as a critical criterion that affects the sewing quality and speed.
Hand-eye coordination (HC)	It is the harmony of the control and visual region in the brain. Therefore, candidates must provide hand-eye coordination in a suitable way for the job [31].
Physical endurance (FE)	It refers to the state of being able to adapt physically to working conditions, hours, and intensity, such as staying overtime when necessary. Candidates are expected to demonstrate this compatibility [31].
Flexible working	This criterion is the flexibility of the person whether to stay overtime or not.
Knowledge sharing	It is the criterion that expresses the employee's openness to information sharing with his/her colleagues. In addition, he/she is convenient to convey his/her experience.
Learning speed	It is the criterion that expresses the speed of learning a new operation.
Attention level	Sewing machines in textile cause work accidents if not used carefully. Therefore, this criterion expresses the attention level of the employee.
Reflex speed	It is the criterion that expresses the reflex of the employee in a possible sudden event.
Openness to innovation	It is the criterion of the employee's willingness to participate in new training in her field and improve herself/himself.
Technical competence	It is the criterion that expresses the technical knowledge of the employee about the job.
Disposition to teamwork	It is the criterion that expresses the employee's compatibility with teamwork.
Paying attention to working hours	The fact that the employee can work following the working hours.
Problem-solving ability	It is the criterion that expresses having a solution-oriented approach.
Claiming the institution	This criterion evaluates the employee's willingness to work in the enterprise.
Paying attention to machine maintenance	In the continuous use of machines, yarn, etc., accumulation occurs. Therefore, the machine needs to be cleaned after a certain number of stitches. Consequently, it is the criterion that expresses the employee's ability to clean the machine.
Machine useability	It is the criterion that measures the employee's ability to use the machine.
Machine breakdown rate	As a result of the employee not using the machine carefully, malfunctions are frequently experienced. Therefore, it is the criterion that measures the number of failures experienced when the employee uses the machine for a particular time.
Monthly wages	The wage the employee expects from the business.
Responsibility	It is the criterion that evaluates the employee's sense of responsibility.

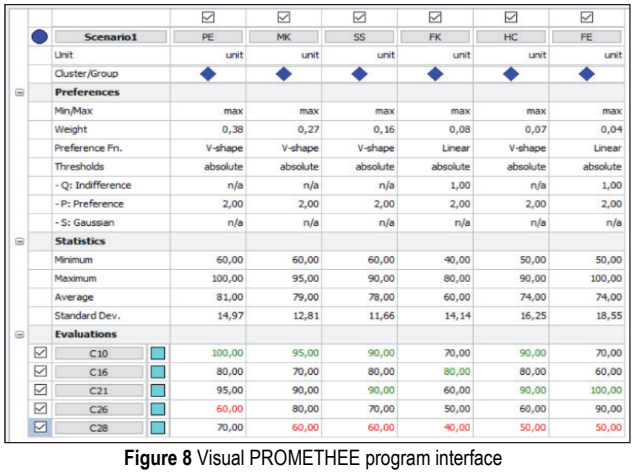

Figure 8 Visual PROMETHEE program interface

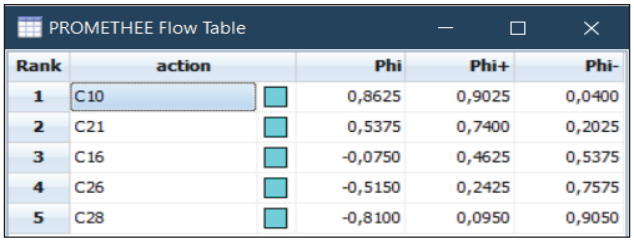

Figure 9 PROMETHEE solution result

Table 6 TOPSIS solution result

Candidates	Priority Values
C10	0,92
C16	0,48
C21	0,85
C26	0,27
C28	0,19

As a result of the two methods applied, it was concluded that C10 should be selected. The fact that the C10 stands out in the high value of machine knowledge and professional experience criteria and the selection of the candidate based on his performance in the sewing trial reflects that a result consistent with reality has been achieved. It is especially considering the high cost of the machine and the sanctions that the firm will apply in case of failure to deliver the product on time. Furthermore, it has been observed that the approach brought with this study to the problem of selecting the most suitable candidate for this job is beneficial in obtaining results. As shown in Tab. 6, although the most qualified candidate is C10, C21 comes second.

Table 7 Priority ranking of candidates according to the methods

Ranking	PROMETHEE	TOPSIS
1	C10	C10
2	C21	C21
3	C16	C16
4	C26	C26
5	C28	C28

The results are given in Tab. 7. There is little difference between them in the ranking. Therefore, if there is an obstacle to the recruitment of C10, C21 should be preferable. As a result of the solutions from the TOPSIS method, it was concluded that the C10 should be employed. Therefore, in the second step of the study, five candidates were evaluated with the applications. For these candidates, the solution was first made with the PROMETHEE method, and then the comparison and verification were made with the TOPSIS method. The same results were found in both methods. If the method results were different from each other, an additional evaluation should be made. In both methods, the candidates who come out in the first place should be looked at. It should be chosen by comparison. If the results are still very different, another method can be included in the solution. Then, the results of the three methods can be compared.

An example of result sensitivity is presented in Tab. 8. Here, the criterion weights obtained in the AHP method were changed, and new results were observed. Although the weights of the criteria changed, it was seen that the result obtained in the solution in the study was consistent. The arrival of C10 and C21 in the first two rows confirms the result.

In the literature, Kucuk and Atilgan [33] selected a fashion designer, and Tus and Adalı [32] selected a marketing person in the textile sector. While Özbek and Erol [31] dealt with selecting the sewing personnel to work in the textile industry, as in this study, Tezcan et al. [34] selected the personnel to be dismissed. All these studies have addressed the selection of personnel for various purposes in the textile sector. However, the study based on the methods and criteria used is more comprehensive than these four studies. In studies to be carried out for similar purposes, the following can be followed: first of all, make a preselection among the candidates applying for the job. Then, invite the candidates who stand out as a result of the preselection for an interview. Set evaluation criteria to use in the interview. Evaluate candidates based on these criteria. Finally, choose the most suitable candidate.

The criteria in the methodology applied are the criteria taken into account in the textile industry. Therefore, it is necessary to revise the criteria suitable for the job description for candidates to be selected in another sector.

Table 8 Solution results according to changing criteria weights

Criteria weights	TOPSIS	PROMETHEE
Equal weight	C21	C10
	C10	C21
	C16	C16
	C26	C26
	C28	C28
0,15 - 0,2 - 0,1 - 0,05 - 0,2 - 0,3	C21	C21
	C10	C10
	C26	C26
	C16	C16
	C28	C28
0,2 - 0,1 - 0,3 - 0,2 - 0,1 - 0,1	C10	C10
	C21	C21
	C16	C16
	C26	C26
	C28	C28

4 CONCLUSION

This study discusses the selection problem of the personnel to be recruited due to an agreement with a company with high standards and quality in a textile factory working on ready-to-wear. A person needs to be hired to use a particular buttonhole machine with electronic and touch panels in this textile factory. The operation to be performed with this machine is the last operation of the sewing line. If this operation is not completed, even the final product cannot be obtained, and the product cannot be delivered to the customer on time. Moreover, this machine is highly costly, and there is no spare machine to perform the same function in case of any malfunction. In addition, sanctions will be applied due to the agreement made in the late delivery of the product.

For this reason, the problem of choosing the most suitable personnel among candidates applying for a job is a critical decision. Within the scope of the problem, a selection must be made among 30 candidates who applied for the advertisement opened by the factory. WS, AHP, PROMETHEE, and TOPSIS methods were used in this problem. In this process, which has progressed in two stages, 30 candidates who applied for job postings with the WS method were eliminated. This process is operated according to the scoring determined by the factory managers. Five candidates were selected. The second phase of the study started. At this phase, the weights of the six criteria determined for the problem were calculated with the AHP method. These weights were used in PROMETHEE and TOPSIS methods to select among the five candidates. The solution was completed by making comparisons. With the solution, it was concluded that C10 should be recruited. The fact that the C10 is competent in essential criteria such as professional experience reflects the consistency of the result found in the problem-solving. If more than one person is recruited, then C10, C21, and C16 should have been selected, respectively, according to the results obtained.

As far as is known, the study is different from other studies in the literature in the following aspects: the use of the WS method in the personnel selection problem; consideration of criteria such as machine knowledge and

sewing speed different from the personnel selection problems in the textile sector; using WS, AHP, PROMETHEE and TOPSIS integration and conducting a phased study by preselection in personnel selection problem. It is the fact that the proposed solution can be used even if the number of applicants reaches a number that can be expressed in thousands in the case of personnel selection in enterprises and especially in the human resources unit. Also, with it published by TR Strategy and Budget Presidency, 11th Development Plan [3] by providing fast and flexible production in the textile sector has been targeted to innovative approaches. The selection problem was discussed for the personnel who have great importance in the sustainability and efficiency of production to serve the targets set in the Development Plan [3].

In this study, real-life business procedures were performed. First, the WS method was used for preselection. Then, essential criteria for the factory were determined with the AHP method. Finally, TOPSIS and PROMETHEE methods were used to make a correct selection among the candidates. In this study, real-life business procedures were performed. First, the WS method was used for preselection. Then, the main criteria weight were determined with the AHP method. Finally, TOPSIS and PROMETHEE methods were used to make a correct selection among the candidates. Especially, regardless of the number of applications, the solution applied is valid irrespective of the sector and unit. It has significant contributions to ensure that effective results are obtained in every field where personnel selection is required. Due to the scarcity of personnel selection studies in the textile sector, different criteria can be included in this problem in future studies. Various methods can be used to determine the scoring scale by which the candidates are evaluated.

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Contact information:

Tamer EREN, Professor
(Corresponding author)
Department of Industrial Engineering, Kırıkkale University
E-mail: tamereren@gmail.com

Evrencan ÖZCAN, Associate Professor
Department of Industrial Engineering, Kırıkkale University
E-mail: evrencan.ozcan@kku.edu.tr

Tuğba DANIŞAN, PhD Student
Department of Industrial Engineering, Kırıkkale University
E-mail: tugbadanisan@gmail.com