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Personnel Selection Based on the LBWA, TOPSIS and GRA Methods: A Case Study on Foreign Trade Company

LBWA, TOPSIS ve GİA Yöntemlerine Göre Personel Seçimi: Dış Ticaret Şirketi Üzerine Örnek Bir Çalışma

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Abstract

Recruitment and personnel selection are affected by significant factors. Thus, personnel selection is one of the main decision-making problems for a company's long-term survival. The objective of this study is to identify the most suitable candidate for the export department of a company operating in Mersin, using the Level Based Weight Assessment (LBWA)-based Technique of Order Preference Similarity to the Ideal Solution (TOPSIS) and Grey Relational Analysis (GRA) methods. The criteria were determined based on the literature review and experts' opinions. The weight of criteria was calculated by the LBWA method, and the alternatives (candidates) were ranked using the TOPSIS and GRA methods. The LBWA results showed that fluency in a foreign language and team player were the most and least important criteria, respectively. The results from both methods (TOPSIS and GRA) suggested different candidates for the relevant positions. Furthermore, sensitivity analyses were conducted to assess the validity and robustness of the results. In conclusion, the findings of this study provide valuable insights to decision-makers involved in the personnel selection process.

Jel Codes: *C60, F14, M00*
Keywords: *Personnel selection, foreign trade, LBWA, TOPSIS, GRA*

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Öz

İşe alım ve personel seçimi çeşitli faktörlerden etkilenmektedir. Dolayısıyla, personel seçimi, firmaların uzun vadede ayakta kalabilmesi için temel karar verme problemlerinden biridir. Bu çalışmanın amacı, Mersin'de faaliyet gösteren bir firmanın ihracat departmanı için LBWA-tabanlı TOPSIS ve GİA yöntemlerini kullanarak en uygun adayın seçilmesidir. Kriterler literatür taraması ve uzman görüşlerine göre belirlenmiştir. Kriterlerin ağırlıkları LBWA yöntemi ile hesaplanmış ve alternatifler (adaylar) TOPSIS ve GİA yöntemleri kullanılarak sıralanmıştır. LBWA sonuçları, yabancı dilde akıcılığın ve takım oyuncusunun sırasıyla en önemli ve en az önemli kriterler olduğunu göstermiştir. Her iki yöntemden (TOPSIS ve GRA) elde edilen sonuçlara göre, ilgili pozisyon için farklı adaylar önerilmiştir. Ayrıca, sonuçların geçerliliği ve sağlamlığı duyarlılık analizi kullanılarak test edilmiştir. Sonuç olarak, bu çalışmadan elde edilen bulguların personel seçim sürecinde yer alan karar vericilere ışık tutacağı düşünülmektedir.

Jel Kodları: *C60, F14, M00*
Anahtar Kelimeler: *Personel seçimi, dış ticaret, LBWA, TOPSIS, GİA*

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1. Introduction

The process of selecting candidates who meet the requirements to carry out a specific job in the organization is known as personnel selection. Modern organizations face numerous obstacles due to the growing competition in the global market. Personnel contributions are the primary factor that will determine a company's ability to survive in the future. Therefore, the performance of personnel, including capabilities, skills, and knowledge, plays a major role in an organization's success (Zhang & Liu, 2011: 11401). Recruitment and personnel selection are affected by significant factors such as changes in work, organizations, marketing, regulations, and society. The procedures and financial allocations for recruiting, selecting, and integrating new employees into the organization vary for each organization. For example, some organizations may view the personnel selection process as a strategic decision, while others may prioritize filling positions quickly and inexpensively (Dursun & Karsak, 2010: 4324). Salgado (2017) emphasized that the key objective of the decision-making process of personnel selection is to predict the potential of employees for future performance. In order to fulfill this objective, organizations actively use personnel selection to determine which candidate is most suitable for a particular position. However, many organizations are not ready to facilitate providing the amount of funds that is required for recruitment. In general, personnel selection can be a very complicated process that depends on the goals of the organization, the availability of resources, and the preferences of the decision-makers. Therefore, it is essential to develop new decision-making strategies that could be used by organizations with a range of financial, technological, and intellectual capabilities. Besides, because of the complexity of the personnel selection problem, Multi-Criteria Decision-Making (MCDM) techniques are required to be utilized to ensure robust recruitment (Kelemenis & Askounis, 2010: 4999; Baležentis et al., 2012: 7961;).

According to Karabašević et al. (2016), the problem of choosing the best alternative in the recruitment process is a complex problem that is associated with MCDM and is generally accompanied by imprecision and subjectivity. In the real world, decision-makers frequently rely on their intuition and experience. At this point, MCDM methods play a crucial role in reducing subjectivity and intuition in the decision-making process. Evaluating and hiring personnel for organizations are problems that can be solved using MCDM methods (Karabašević et al., 2018: 56). Consequently, MCDM methods have been extensively applied to address the personnel selection problem (Afshari et al., 2010; Kabak et al., 2012; Eroğlu et al., 2014; Chang, 2015; Urosevic et al., 2017; Ayçin, 2020; Şimşek, 2022; Demirci, 2022; Ebrahimi et al., 2023). In this paper, a hybrid model is proposed for selecting the most suitable personnel for an exporting company operating in Mersin. The LBWA, TOPSIS, and GRA methods are employed within this model. The weight of criteria is determined using the LBWA method, and the candidates are ranked using the TOPSIS and GRA methods. As stated by Nyaoga et al. (2016), Grey and TOPSIS are suitable methods for solving group decision-making problems under uncertainty. Furthermore, many studies have combined TOPSIS and GRA methods to solve complex problems (Dai et al., 2010; Wang et al., 2016; Nguyen et al., 2020; Sun & Cai, 2021; Lu et al., 2022). The LBWA method, being a relatively new subjective approach among MCDM methods, offers distinct advantages, as implied by Žižović & Pamucar

(2019). Firstly, it allows the calculation of weight coefficients with a small number of criteria comparisons. Secondly, the algorithm of the model does not become more complex with the increase in criteria. Thirdly, it allows decision-makers to present their preferences through a logical algorithm when prioritizing criteria. While the LBWA method offers several advantages, there has been a relatively limited number of studies utilizing this approach. For instance, supplier evaluation (Uluskan et al., 2022), websites performance (Gençkaya et al., 2021), assessment of public participation (Pawlewicz & Cieślak, 2022), evaluation of healthcare sector (Torkayesh et al., 2021) were conducted by the LBWA method. However, no previous study has investigated the personnel selection process for a foreign trade company using the LBWA method. Thus, this study aims to fill this research gap. The proposed model is designed with the integration of the LBWA, TOPSIS, and GRA methods. Additionally, sensitivity analyses were conducted to assess the robustness and reliability of the proposed model.

The rest of the paper is organized as follows: In the next section, the previous research in the relevant field is summarized. In Section 3, the principles of the method used in this study are demonstrated briefly. Section 4 illustrates the empirical results obtained from the proposed model. In the last section, criticism of the findings, future steps, and limitations of the research are presented.

2. Literature Review

In this section, the previous research on personnel selection is presented. A brief synopsis of the relevant literature is shown in Table 1.

Table 1: Previous Research on Personnel Selection

Author(s)	Year	Methods	Topic
Güngör et al.	2009	Fuzzy AHP	Personnel selection to fulfil the new position in a company with fuzzy AHP method.
Kelemenis & Askounis	2010	Fuzzy TOPSIS	Personnel selection for Information Technology (IT) department by fuzzy TOPSIS method.
Dursun & Karsak	2010	Tuple Fuzzy-Fuzzy TOPSIS	Personnel selection for manufacturing company by Fuzzy approaches
Dağdeviren	2010	ANP-TOPSIS	Personnel selection in manufacturing systems using a hybrid MCDM methods.
Zhang & Liu	2011	GRA	Personnel selection for software company using the GRA method.
Baležentis et al.	2012	Fuzzy MULTIMOORA	Personnel selection problem based on the linguistic reasoning under group decision.
Özbek	2015	AHP-MULTIMOORA	Personnel selection for the position of administrators of academic units by AHP-MULTIMOORA methods.

Karabašević et al.	2016	SWARA-WASPAS	Personnel selection for the position of sales manager with SWARA-WASPAS methods
Kenger & Organ	2017	ENTROPY-ARAS	Personnel selection for the bank branch in Turkey using ENTROPY-ARAS methods.
Ilgaz	2018	AHP-TOPSIS	Personnel selection for logistics sector by AHP-TOPSIS methods.
Karabašević et al.	2018	SWARA-EDAS	Personnel selection for IT department based on the SWARA-EDAS methods.
Korkmaz	2019	TOPSIS	Personnel selection for a logistics company operated in Turkey based on TOPSIS method.
Stević & Brković	2020	FUCOM-MARCOS	Personnel selection for international transport company using the FUCOM-MARCOS methods.
Ulutaş et al.	2020	Novel Grey PIPRECIA & Grey OCRA	Personnel selection for the position of manager for textile factory with PIPRECIA-OCRA methods
Popović	2021	SWARA-CoCoSo	Personnel selection problem based on SWARA-based CoCoSo methods.
Ozgörmüş et al.	2021	DEMATEL-QFD-GRA	Personnel selection for a textile company operated in Turkey based on hybrid MCDM methods.
Danışan et al.	2022	AHP-TOPSIS-PROMETHEE	Personnel selection in the ready-to-wear sector using a hybrid MCDM methods
Andrejić & Pajić	2023	BWM-CoCoSo	Personnel selection for the position of transport manager by BWM-CoCoSo methods.
Mercan & Can	2023	FUCOM	Personnel selection for an airline company with FUCOM method.

As can be seen above, the different MCDM methods have been applied in order to find the best candidate to fill the appropriate position in the company. Furthermore, previous research showed that MCDM methods are effective tools to solve real-life problems, such as personnel selection for the department. Many businesses operating in the fields of textiles, logistics, manufacturing, and technology have resorted to MCDM methods to find the most suitable person for their organization. So far, however, no previous study has investigated personnel selection for the foreign trade department using the LBWA, TOPSIS, and GRA approaches. Thus, the current paper aims to contribute to the field of foreign trade by proposing a new model based on LBWA-based TOPSIS and GRA methods.

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3. Methodology

3.1. LBWA

The Level-Based Weight Assessment (LBWA) method was proposed by Žižović & Pamucar in 2019. The LBWA is one of the new subjective approaches to determining the weight of criteria. By applying the LBWA model, inconsistent expert preferences, which are allowed in some subjective models (Best Worst Method, BWM, and Analytic Hierarchy Process, AHP), are eliminated, obtaining ideal weight coefficient values with the use of basic mathematical apparatus. The application steps of the LBWA method are as follows (Žižović & Pamucar, 2019):

Step 1. Firstly, the most important criterion from the set of criteria is determined.

Step 2. Then, criteria are classified according to significance levels:

> ***Level S_1:*** At the level S_1 group the criteria from the set S whose significance is equal to the significance of the criterion C_1 or up to twice as less as the significance of the criterion C_1;
>
> ***Level S_2:*** At the level S_2 group the criteria from the set S whose significance is exactly twice as less as the significance of the criterion C_1 or up to three times as less as the significance of the criterion C_1;
>
> ***Level S_3:*** At the level S_3 group the criteria from the set S whose significance is exactly three times as less as the significance of the criterion C_1 or up to four times as less as the significance of the criterion C_1;
>
> ***Level S_k:*** At the level S_k group the criteria from the set S whose significance is exactly k times as less as the significance of the criterion C_1 or up to $k+1$ as less as the significance of the criterion C_1.

Based on the rules mentioned above, the decision-maker classifies the observed criteria in rough form using Eq. (1).

$$Si = \{C_{i_1}, C_{i_2}, \dots\dots\dots\dots, C_{i_s},\} = \{C_j \in S: i \le s(C_j) < i+1\} \quad (1)$$

Step 3 Eq. (2) is used to comparison of criteria according to their significance within the created subgroups (levels) of the criteria's influence.

$$r = \max\{|S_1|, |S_2|, \dots\dots\dots\dots\dots\dots\dots, |S_k|\} \quad (2)$$

Step 4. The elasticity coefficient is defined based on the maximum value of the scale for the comparison of criteria *(r)*.

Step 5. Based on Eq. (3), the influence function of the criteria is computed.

$$f(C_{i_p}) = \frac{r_0}{i \,.\, r_0 + I_{i_p}} \quad (3)$$

Step 6. By applying Eq. (4), the optimum values of the weight coefficient of criteria are calculated.

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$$w_1 = \frac{1}{f(C_2) + \cdots + f(C_n)} \quad (4)$$

According to Eq. (5), the values of the weight coefficient of the remaining criteria are determined.

$$w_j = f(C_j) \,.\, w_1 \qquad \text{j=2, 3,.....,n} \quad (5)$$

3.2. TOPSIS

The Technique of Order Preference Similarity to the Ideal Solution (TOPSIS) method was developed by Hwang & Yoon in 1981. The TOPSIS method focuses on an ideal and anti-ideal solution and compares the distance between each alternative. It has been applied in many research fields due to its simplicity and rationality (Olson, 2004; Roszkowska, 2011). The application steps of the TOPSIS method are as follows (Hwang & Yoon, 1981):

Step 1. The decision matrix is formed.

Step 2. The decision matrix is normalized using Eq. (6).

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}} \quad (6)$$

Step 3. The weighted decision matrix is composed.

Step 4. Eqs. (7-8) is used to determine the positive ideal and negative ideal solutions.

$$A^+ = \{(maxV_{ij} | j \in B), (minV_{ij} | j \in C)\} \quad i = 1,2, \ldots\ldots, m \quad (7)$$

$$A^- = \{(minV_{ij} | j \in B), (maxV_{ij} | j \in C)\} \quad i = 1,2, \ldots\ldots, m \quad (8)$$

Step 5. The separation measures for each alternative, and the relative closeness to the ideal solution is determined by Eqs. (9-10)

$$S_i^+ = \sqrt{\sum (v_{ij} - v_j^+)^2} \quad (9)$$

$$S_i^- = \sqrt{\sum (v_{ij} - v_j^-)^2} \quad (10)$$

Step 6. Eq. (11) is used to determine the relative closeness to the ideal solution, and ranking the alternatives.

$$C_i^+ = \frac{S_i^-}{S_i^+ + S_i^-}; \;\; 0 \leq C_i^* \leq 1 \quad (11)$$

The best alternative is the one closest to the ideal solution. When the C_i^+ values are ordered from the largest to smallest, the ranking of the alternatives is obtained.

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3.3. Grey Relational Analysis

The grey system theory was proposed by Deng Julong in 1982. Grey Relational Analysis (GRA) is part of grey system theory that can be used for solving problems, including complex interrelations between multiple factors and variables. Thus, the GRA has been proven to be helpful in dealing with inaccurate, ambiguous, and insufficient information (Kuo et al., 2008). The application steps of the GRA method are as follows (Wu, 2002):

Step 1. Preparing data set and construct decision matrix

Step 2. The reference series and comparison matrix are formed using Eq. (12).

$$x_0 = \left(x_0(j)\right), \quad and\ j = 1,2,\dots\dots,n \tag{12}$$

Step 3. Eq. (13) is used to normalize the decision matrix and construct normalized decision matrix.

$$x_i^* = \frac{x_i(j) - \min\limits_j x_i(j)}{\max\limits_j x_i(j) \_ \min\limits_j x_i(j)} \tag{13}$$

Step 4. The absolute value table is formed using Eq. (14).

$$\Delta_{0i}(j) = |x_0^*(j) - x_i^*(j)|, \qquad i = 1,2,\dots\dots,m \quad and\ j = 1,2,\dots\dots,n \tag{14}$$

Step 5. Based on Eq. (15), the grey relational coefficient for each alternative is computed.

$$\gamma_{0i}(j) = \frac{\Delta\min + ↄ\Delta max}{\Delta_{0i}(j) + ↄ\Delta max}$$
$$\Delta max = \max_i \max_j \Delta_{0i}(j) \text{ ve } \Delta min = \min_i \min_j \Delta_{0i}(j) \tag{15}$$

Step 6. Eq. (16) is utilized to determine the grey relational degree based on the different weight of criteria.

$$\Gamma_{0i} = \frac{1}{n}\sum_{j=1}^{n}[w_i(j)\gamma_{0i}(j)], \qquad i = 1,\dots\dots,m \tag{16}$$

When the values are ordered from the largest to smallest, the ranking of the alternatives is obtained.

4. Application and Results

The proposed model was applied to an exporting company operating in Mersin. The company produces citrus and requires qualified personnel to export such goods. Consequently, the company has formed an executive committee consisting of three decision-makers (DM_1, *DM2,* and DM_3). The executive committee comprises two experts in the field of international trade

and one expert in human resources. Table 2 displays the demographic information of the experts.

Table 2. Background of the experts

No	Gender	Experience	Expertise	Occupation	Educational Status
DM_1	Male	15-20 years	Export	Private sector / Boss	Master degree
DM_2	Female	15-20 years	Recruitment / HRM	Private sector / Manager	Master degree
DM_3	Male	25-30 years	International Trade	Academician / Prof. Dr	Ph.D.

As seen from Table 2, the experts participating in this study possess extensive experience and education in both the private sector and academia. Furthermore, it is evident that the selection criteria align with the expertise areas of the individuals involved in the study. The committee's objective is to select the most suitable candidate from a pool of five participants (A_1, A_2, A_3, A_4, and A_5) to fill the vacancy. Throughout the candidate selection process, decision-makers employ the LBWA method to determine the criteria weights, while utilizing the TOPSIS and GRA methods to assess the alternatives, in this case, the candidates. Initially, ten candidates applied for the position; however, five were deemed ineligible and excluded from consideration. Consequently, the decision-makers officially evaluated five candidates for the export department."

On the basis of the job analysis carried out, the personnel to be recruited to the foreign trade department will have the following responsibilities: effectively communicating with customers in the target market, sharing experiences with staff in sub-units, possessing advanced English language proficiency for official correspondence, managing the foreign trade department and fostering teamwork, monitoring customs legislation, and reporting the performance of the foreign trade department. Parallel to this, the decision will be made based on the following criteria: (C_1) communication skills; (C_2) educational background; (C_3) professional experience in foreign trade; (C_4) fluency in a foreign language; (C_5) ability to work well in a team; (C_6) computer skills relevant to the sector; (C_7) self-confidence; and (C_8) knowledge of customs legislation. These criteria were determined from the literature review (Güngör et al., 2009; Kelemenis & Askounis, 2010; Dursun & Karsak, 2010; Dağdeviren, 2010; Zhang & Liu, 2011; Baležentis et al., 2012; Karabašević et al., 2016; 2018; Ilgaz, 2018; Popović, 2021; Andrejić & Pajić, 2023) and expert opinions. In the following section, the application of the proposed model and its results are presented.

4.1. The Results Obtained from the LBWA Method

Constructing the criterion set is the first step in applying the LBWA method. The criteria set, which includes eight criteria, was created as follows: S = {C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8} ({communication skills, educational background, professional experience, fluency in a foreign language, team player, computer skills, self-confidence, familiarity with customs legislation}). Based on the opinions of the executive committee, the most important criterion was determined to be C_4 (fluency in a foreign language). Afterwards, the criterion levels were created by comparing each criterion with the most important criterion. By applying Eq. (1),

the criteria were categorized into two levels (S_1 and S_2) based on their relative importance and shown as follows: S_1 = {C_8, C_6, C_1, C_7, C_3, $C4$}, and S_2 = {C_2, C_5}. Once assigning values to each criterion, the r value was calculated using Eq. (2). According to Eqs. (3-5), the elasticity coefficient (r_0), the influence function of the criteria (f), and the value of the weight coefficient (w) were computed, respectively. Žižović & Pamucar (2019) stated that the elasticity coefficient should be $r_0 > r$. In this study, the value of the elasticity coefficient (r_0) is considered to be r_0 = 7. The influence functions of the criteria and the final weights of the criteria are presented in Table 3.

Table 3: The Results of LBWA Method

Criteria	Assigned Value	The Influence Function	The Weights of the Criteria
Level S1	***I***	***f***	***w***
C_1	4	0,6363	0,1237
C_3	6	0,5384	0,1047
C_4	0	1,0000	0,1945
C_6	2	0,7000	0,1361
C_7	5	0,5833	0,1134
C_8	1	0,7777	0,1512
Level S2	**Assigned Value**	**The Influence Function**	**The Weights of the Criteria**
C_2	1	0,4666	0,0907
C_5	2	0,4375	0,0850

Finally, the vector of the weight coefficient was obtained as follows: w_j = (0,1237; 0,0907; 0,1047; 0,1945; 0,0850; 0,1361; 0,1134; 0,1512). The LBWA results showed that fluency in a foreign language (C_4), the knowledge of customs legislation (C_8) and computer skills used in the sector (C_6) were the most important criteria, while professional experience in foreign trade (C_3) educational background (C_2) and team player (C_5) were the least important criteria, respectively. After the criterion weights were determined, the alternatives were ranked through the TOPSIS and GRA methods.

4.2. The Results Obtained from the TOPSIS Method

At first, each decision-maker assigned values between 1 (very low) and 5 (very high) based on the performance of candidates regarding the criteria. Then, the decision matrix was formed by taking the geometric means of the values. Table 4 illustrates the decision matrix for each candidate.

Table 4: The Decision Matrix

Criteria / Alternatives	C_1 max	C_2 max	C_3 max	C_4 max	C_5 max	C_6 max	C_7 max	C_8 max
A_1	2,6207	4,3089	4,0000	4,3089	2,0000	4,0000	1,5874	3,3019
A_2	4,0000	3,3019	3,0000	3,6342	4,3089	4,3089	4,0000	2,6207
A_3	2,0000	4,6416	3,6342	4,6416	3,0000	4,0000	2,2894	3,3019
A_4	4,6416	3,0000	3,6342	4,0000	4,3089	4,0000	4,3089	2,2894
A_5	3,3019	4,0000	2,6207	4,3089	2,6207	4,0000	3,6342	4,0000
w_j	0,1237	0,0907	0,1047	0,1945	0,0850	0,1361	0,1134	0,1512

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Then, the decision matrix was normalized using Eq. (6) and the results are shown in Table 5.

Table 5: Normalized Decision Matrix

Criteria / Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	0,6439	0,9820	0,9733	0,9427	0,4963	0,8876	0,3991	0,8383
A_2	0,9828	0,7525	0,7300	0,7951	1,0693	0,9561	1,0057	0,6654
A_3	0,4914	1,0579	0,8843	1,0155	0,7445	0,8876	0,5756	0,8383
A_4	1,1405	0,6837	0,8843	0,8751	1,0693	0,8876	1,0833	0,5812
A_5	0,8113	0,9116	0,6377	0,9427	0,6503	0,8876	0,9137	1,0155

Afterwards, the weighted normalized decision matrix was formed, and the results are presented in Table 6.

Table 6: Weighted Normalized Decision Matrix

Criteria / Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	0,0797	0,0891	0,1019	0,1833	0,0422	0,1208	0,0453	0,1268
A_2	0,1216	0,0683	0,0764	0,1546	0,0909	0,1301	0,1140	0,1006
A_3	0,0608	0,0959	0,0926	0,1975	0,0633	0,1208	0,0653	0,1268
A_4	0,1411	0,0620	0,0926	0,1702	0,0909	0,1208	0,1229	0,0879
A_5	0,1004	0,0827	0,0668	0,1833	0,0553	0,1208	0,1036	0,1536

Eqs. (7-8) was used to determine the positive ideal and negative ideal solutions matrix depending on whether the criteria are benefit or cost based, and the results are shown in Table 7.

Table 7. Positive Ideal and Negative Ideal Solutions

Criteria	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
$A+$	0,1411	0,0959	0,1019	0,1975	0,0909	0,1301	0,1229	0,1536
$A-$	0,0608	0,0620	0,0668	0,1546	0,0422	0,1208	0,0453	0,0879

According to Eqs. (9-11), the separation measures for each alternative, the relative closeness to the ideal solution and the final ranking of alternatives was obtained, and the results are demonstrated in Table 8.

Table 8: The Final Results

Alternatives	S^+	S^-	C_i	Rank
A_1	0,1150	0,0682	0,3725	5
A_2	0,0807	0,1057	0,5671	3
A_3	0,1068	0,0775	0,4205	4
A_4	0,0799	0,1255	0,6110	1
A_5	0,0707	0,1035	0,5942	2

The results of the TOPSIS method showed that the alternative with A_4 was the most optimal personnel for exporting department of the company, followed by A_5, A_2, A_3 *and* A_1, respectively.

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4.3. The Results Obtained from the GRA Method

Firstly, the decision matrix was formed based on the opinions of the experts. Then, a reference series was determined using Eq. (12), and it's shown in Table 9-10, respectively.

Table 9: The Decision Matrix

Criteria / Alternatives	C_1 max	C_2 max	C_3 max	C_4 max	C_5 max	C_6 max	C_7 max	C_8 max
A_1	2,6207	4,3089	4,0000	4,3089	2,0000	4,0000	1,5874	3,3019
A_2	4,0000	3,3019	3,0000	3,6342	4,3089	4,3089	4,0000	2,6207
A_3	2,0000	4,6416	3,6342	4,6416	3,0000	4,0000	2,2894	3,3019
A_4	4,6416	3,0000	3,6342	4,0000	4,3089	4,0000	4,3089	2,2894
A_5	3,3019	4,0000	2,6207	4,3089	2,6207	4,0000	3,6342	4,0000
w_j	0,1237	0,0907	0,1047	0,1945	0,0850	0,1361	0,1134	0,1512

Table 10: The Decision Matrix with Reference Series

Criteria / Alternatives	C_1 max	C_2 max	C_3 max	C_4 max	C_5 max	C_6 max	C_7 max	C_8 max
Reference series	**4,6416**	**4,6416**	**4**	**4,6416**	**4,3089**	**4,3089**	**4,3089**	**4**
A_1	2,6207	4,3089	4,0000	4,3089	2,0000	4,0000	1,5874	3,3019
A_2	4,0000	3,3019	3,0000	3,6342	4,3089	4,3089	4,0000	2,6207
A_3	2,0000	4,6416	3,6342	4,6416	3,0000	4,0000	2,2894	3,3019
A_4	4,6416	3,0000	3,6342	4,0000	4,3089	4,0000	4,3089	2,2894
A_5	3,3019	4,0000	2,6207	4,3089	2,6207	4,0000	3,6342	4,0000
w_j	0,1237	0,0907	0,1047	0,1945	0,085	0,1361	0,1134	0,1512

According to Eq. (13), the decision matrix was normalized, and the results are shown in Table 11.

Table 11: Normalized Decision Matrix

Criteria / Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
Reference	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**	**1,000**
A_1	0,2350	0,7973	1,0000	0,6697	0,0000	0,0000	0,0000	0,5919
A_2	0,7571	0,1839	0,2750	0,0000	1,0000	1,0000	0,8865	0,1937
A_3	0,0000	1,0000	0,7348	1,0000	0,4331	0,0000	0,2579	0,5919
A_4	1,0000	0,0000	0,7348	0,3631	1,0000	0,0000	1,0000	0,0000
A_5	0,4928	0,6092	0,0000	0,6697	0,2688	0,0000	0,7521	1,0000

Eq. (14) was used to calculate the absolute difference between the normalized reference series and the alternative values. The absolute values are presented in Table 12.

Table 12: Absolute Values

Criteria / Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	0,7650	0,2027	0,0000	0,3303	1,0000	1,0000	1,0000	0,4081
A_2	0,2429	0,8161	0,7250	1,0000	0,0000	0,0000	0,1135	0,8063
A_3	1,0000	0,0000	0,2652	0,0000	0,5669	1,0000	0,7421	0,4081
A_4	0,0000	1,0000	0,2652	0,6369	0,0000	1,0000	0,0000	1,0000
A_5	0,5072	0,3908	1,0000	0,3303	0,7312	1,0000	0,2479	0,0000

Once the absolute value matrix was created, the grey relational coefficient matrix was formed using Eq. (15). Additionally, the grey relational degree was determined by Eq. (16). Previous research stated that the separator coefficient (ב) usually takes the value 0,5 (Hsu & Wen, 2000; Özdemir & Deste, 2009). Therefore, in this study, ב was taken as 0,5. Table 13 illustrates the results of the grey relational coefficient, grey relational degree and final ranking of alternatives.

Table 13: The Final Results

Criteria / Alternatives	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8	r_{oi}	Rank
$_1$	0,3952	0,7116	1,0000	0,6022	0,3333	0,3333	0,3333	0,5506	0,5300	5
A_2	0,6731	0,3799	0,4082	0,3333	1,0000	1,0000	0,8150	0,3828	0,5967	3
A_3	0,3333	1,0000	0,6534	1,0000	0,4687	0,3333	0,4026	0,5506	0,6089	1
A_4	1,0000	0,3333	0,6534	0,4398	1,0000	0,3333	1,0000	0,3333	0,6021	2
A_5	0,4964	0,5613	0,3333	0,6022	0,4061	0,3333	0,6685	1,0000	0,5712	4
w_j	0,1237	0,0907	0,1047	0,1945	0,085	0,1361	0,1134	0,1512	-	-
max	1,0000									
min	0,0000									
ב	0,5									

According to results obtained from the GRA method, the alternative with A_3 was the most optimal personnel for exporting department of the company, followed by A_4, A_2, A_5 and A_1, respectively. In contrast to earlier findings obtained from the TOPSIS method, the most optimal personnel are different in the GRA method. These findings were expected, as previous studies (Yiğit and Gök, 2017; Quan et al., 2019; Özcan and Çelik, 2021) have shown that the TOPSIS and GRA methods yield different rankings.

4.4. Sensitivity Analyses

In this study, sensitivity analyses were conducted on two scenarios. The first scenario is associated with the value of the elasticity coefficient (r_0). As mentioned above, $r_0 = 7$ was taken into account for this investigation. To observe the impact of the elasticity coefficient on rankings, r_0 was modified between 7 and 13. In the second scenario, the values of the separator coefficient (ב) were altered. While some researchers (Özdemir & Deste, 2009; Özbek, 2017) have stated that the ב value does not affect rankings, this study tested values between 0.5 and 1.0. The overall results from the sensitivity analyses are presented in Figure 1 and 2, respectively.

Figure 1: Sensitivity Analysis (r_0)

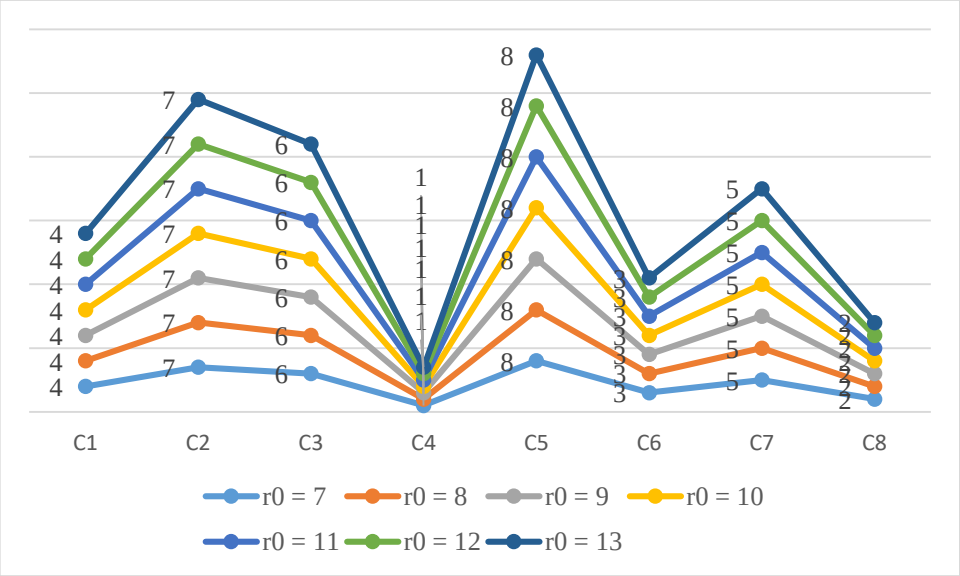
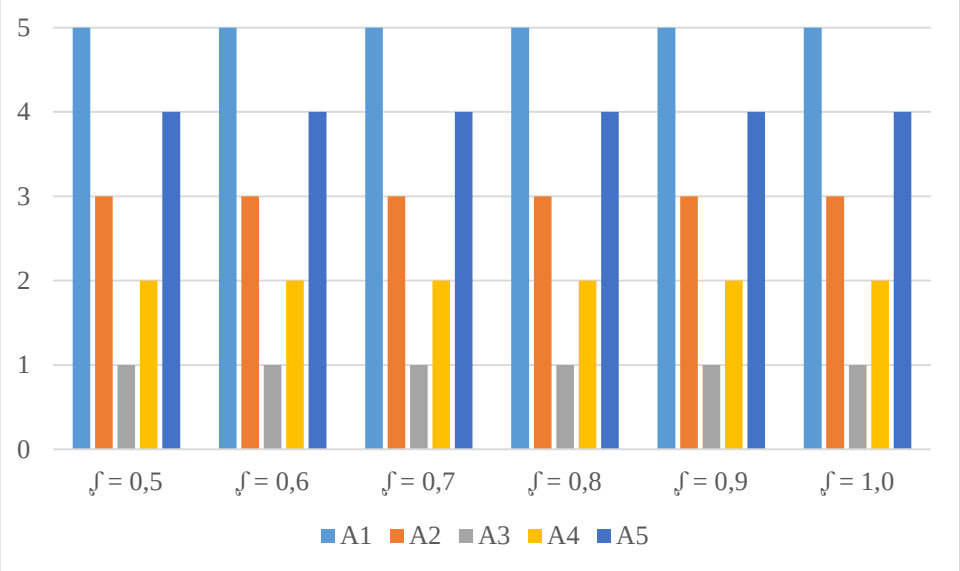


Figure 2: Sensitivity Analysis (ב)



Sensitivity analyses revealed that the results obtained from the proposed model were validated. As shown in Figure 1, modifying the elasticity coefficient did not change the ranking of the criteria based on their weight. Furthermore, modifying the separator coefficient (ב) did not change the ranking of alternatives (Figure 2). Thus, it can be concluded that the validity and robustness of the proposed model are confirmed.

5. Discussion and Conclusion

Personnel are one of the most important inputs for organizations such as companies, institutions, and public administrations to maintain their operations. The process of selecting

appropriate candidates based on their qualifications, skill, knowledge, and competence from the pool of job applicants is called personnel selection. Organizations apply different methods to determine who is qualified and who is unqualified among applicants. Over the last few decades, MCDM methods have been widely used to select most suitable person for a vacant position in the organization. For instance, in various industries, such as Public Relations (Chang, 2015), Healthcare (Uslu et al., 2021), Information Technology (Stanujkic et al., 2018), Security (Dadelo et al., 2014), Tourism (Urosevic et al., 2017), Textiles (Ulutaş et al., 2020) and Logistics (Altuntaş & Yıldırım, 2022) have been analyzed by different MCDM methods. Correspondingly, in this paper, the personnel selection problem was examined using different MCDM methods. This study aimed to select the most suitable candidate for the export department of a company operating in Mersin, according to the LBWA, TOPSIS, and GRA methods.

In this investigation, the LBWA method was used to calculate the weight of criteria. The LBWA results demonstrated that fluency in a foreign language, the knowledge of customs legislation, and computer skills used in the sector were the most important criteria, respectively. Conversely, professional experience in foreign trade, educational background and being a team player were the least important criteria, respectively. One of the most obvious findings to emerge from this study is the impact of technical skills. Indeed, these findings may help us to understand the importance of technical skills, such as foreign languages, computer skills and customs regulation in international trade. The present findings seem to be consistent with other research (Dağdeviren, 2010; Ilgaz, 2018; Ayçin, 2020; Uslu et al., 2021) which found that technical qualifications are more important than conceptual abilities. Thus, it can be concluded that foreign language, computer programs and customs regulations play critical role in exporting activities.

After the weight of criteria was determined, the optimal candidate for the relevant position was examined by the TOPSIS and GRA methods. The results of the TOPSIS method showed that the alternative A_4 was the most optimal personnel for the exporting department of the company, followed by A_5, A_2, A_3 *and* A_1, respectively. According to results obtained from the GRA method, the alternative with A_3 was the most optimal personnel for the exporting department of the company, followed by A_4, A_2, A_5 and A_1, respectively. In contrast to earlier findings obtained from the TOPSIS method, the most optimal personnel are different in the GRA method. For instance, the 4th candidate is the most suitable option for the exporting department in the TOPSIS method, while the 3rd candidate is the most suitable option for exporting department in the GRA method. The rank of alternatives according to the presented methods shows that the alternatives A_4 and A_3 are the best-ranked alternatives. Consequently, two different options based on two different approaches have been put forward for the relevant position.

As stated by Pamucar et al. (2020), after evaluating alternatives, it's important to test the validation of the results by sensitivity analysis. In this study, sensitivity analyses were carried out on two scenarios: changing the value of the elasticity coefficient and the separator coefficient. Sensitivity analyses revealed that the results obtained from the proposed model were validated. Thus, it can be concluded that the validity and robustness of the proposed

model are confirmed. It is worth noting that the findings obtained from this study will provide insight to decision-makers involved in the personnel selection process. Moreover, it can be applied to other sectors by making some changes to the criteria in the proposed model.

Based on this research, some managerial implications have been suggested to the relevant field:

(1) Ensure that candidates possess the necessary skills, such as knowledge of customs regulations, fluency in foreign languages, and computer skills, to be success in the export department.

(2) Prioritize technical skills, such as proficiency in computer applications relevant to the sector, as such qualifications are critical for managing export-related tasks efficiently.

(3) Encourage ongoing learning and professional development among personnel in the export department to keep pace with evolving market trends, regulations, and technologies.

(4) Establish a mechanism for performance assessments to observe the efficiency of personnel in achieving departmental aims and objectives, and provide constructive feedback to facilitate enhancement.

(5) Assign resources towards enhancing recruitment and selection process, incorporating suitable assessment techniques, to attract and retain top talent for the export department.

Although this study offers valuable insights into the process of personnel selection, it is important to acknowledge several limitations. The main limitation of the current study is the relatively low number of decision-makers. Increasing the number of decision-makers could enhance the robustness and reliability of the findings by incorporating diverse perspectives and expertise. Therefore, future research may benefit from considering a larger and more diverse group of decision-makers. Furthermore, this study could be repeated by exploring additional criteria and employing a wider range of MCDM techniques. Additionally, by incorporating diverse criteria, like cultural alignment, leadership aptitude, or adaptability, a more comprehensive assessment of candidates could be achieved. Moreover, integrating various MCDM techniques beyond those applied in this research, such as FUCOM, BWM, CRADIS, RSMVC, and SPOTIS, could provide alternative perspectives and insights into personnel selection.

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