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【Review】

Determination of the Most Convenient Polyester Thread Supplier in Upholstery Velvet Production by Multi Criteria Decision Making Methods: A Case from Turkey

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Abstract: Upholstery velvet manufacturers choose polyester thread types to get optimum profit by using scientific methods. The matter of determining the most convenient polyester thread supplier might be considered as a decision problem. In this study, the issue of determining the most suitable polyester thread supplier of upholstery velvet manufacturer was analyzed by MACBETH-PROMETHEE Hybrid method. Authorities of relevant businesses were chosen as decision makers. Criteria and alternatives were determined by reviewing literature regarding decision makers. The weights of criteria were evaluated by MACBETH method, however, the priority order of alternatives were evaluated separately both MACBETH and PROMETHEE methods. The fit of analyses practiced by two separate multi criteria decision making methods was tested by Spearman Rank Correlation Analysis. As a result of analyses conducted hybrid method, types of brands and threads were determined. The most basic raw material requirement of enterprises that are upholstery velvet producers is polyester thread. If thread is procured using the model of the study, polyester thread will be purchased at both the most affordable price and the desired quality. Findings were shared with authorities of relevant business.

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1. Introduction

Upholstery fabrics are widely used in automotive sector particular in interior decoration of automobiles and furniture industries by the virtue of these features. It might be used many types of natural and chemical-based fibers in line with desired performance characteristics and usage areas of fabrics. Abrasion features of fabrics depend overwhelmingly on construction, types, texturization, and filament fineness of thread, but most importantly among these, it depends on type of fibers [1]. Velvet fabrics have always been indispensable for home textile fashion [2]. Having a durable and strong structure has ensured that velvet fabrics always maintain their place as a trend among upholstery fabrics. Upholstery, drapery and decorative velvet fabrics, which are produced with the aim of combining elegance and comfort with a substantial variety of colors and patterns in luxury velvet, can be classified as follows: plain, jacquard, printed, dyed yarn, brocade, and pleat and emboss velvet fabrics [3].

When the relevant literature regarding upholstery velvet is examined, it has been seen that there is no scientific study on the supply of upholstery velvet and its production equipment. By this aspect, the study is expected to fill an important gap in the literature. By means of originality of the study, the fact that it is the first study to determine the most convenient polyester thread brand in the manufacturing of upholstery velvet by two different multi criteria decision making (MCDM) methods gives rise to thought uniqueness of the research problem. In the study, two popular MCDM methods

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were integrated [4], the decision-making trial and evaluation laboratory (DEMATEL), and VIse Kriterijumska Optimizacija kompromisno Resenje (VIKOR) to aid the cotton fiber selection decision. While the DEMATEL method deals with the relationships between the various physical properties of cotton fibers by dividing them into cause-effect groups, the VIKOR method provides the ranking of all 17 cotton fibers from the best to the worst. An application [5] on the machine overlapping problem was comprised in a weaving factory producing woolen fabric. In addition, they investigated how the number of allocated operators would provide optimum conditions to eliminate these downtimes. For this study, three of the most produced fabrics in the facility were selected and data on the loom group where these fabrics were produced were collected. According to these collected data and production costs, the optimum number of machines that an operator should serve is examined using the queuing theorem.

In general, a perception-based fabric recommendation system was develop [6] to help fashion designers choose the most suitable fabric to meet the perception of the target consumer during the design process. This knowledge-based recommendation system includes a computational model using Fuzzy AHP and Fuzzy TOPSIS algorithms. While the Fuzzy AHP method is used to structure the fabric selection problem and determine the respective weights of the relevant criteria and corresponding components, the Fuzzy TOPSIS method is used to evaluate the alternative fabrics according to the criteria obtained from the AHP process and give the overall final ranking of the respective fabric alternatives. The TOPSIS method, which is a multi-criteria decision making method in yarn selection, and ranked the yarns according to certain weights in terms of their properties was used [7]. A fabric selection problem was addressed [8] using ratio analysis and multi-objective optimization on the basis of a simple but powerful multi criteria decision making (MCDM).

No study has been found on the suppliers of polyester thread used in the production of upholstery velvet. The reason why this review is mostly carried out in the literature is that velvet fabrics have been used frequently in Turkish folk culture in clothing, curtains and upholstery for the last hundred years. However, researchers have conducted studies that reveal different properties rather than the threads used in the production of velvet fabrics. To illustrate, in a study [9] the velvet textures were examined and velvets were grouped as weft and warp. It was compared by giving instances that the weaving techniques of weft and warp velvets showed dissimilarities. From a different standpoint, a study [10] conducted focused on corduroy mechanical finishing. Roving cutting and brushing processes that are two most important in corduroy pile were revealed and it was emphasized that the point were to be considered in these processes. Besides, in a further study [11] parameters affecting the pile strength of warp velvet fabrics were analyzed and it was seen that the pile strength, which determines the quality of use, was significantly affected by many factors. It was also stated that the optimum weft and warp densities and pile height values should be determined and the production should be carried out in line with these values in order for the velvet fabric to be produced to have the best possible pile strength value. Likewise, a linear significant relationship was observed between the increase in weft density and wear resistance. Moreover, to show the development of woven in upholstery, apparel and textile industry for transportation, in one study [12] some criteria such as threads, arrangement of threads, the movement of harnesses, the draft-in draft, the density of fabric, pile and height, and finishing applied to the fabric providing examples for technical and specifications and simulations.

2. Material and methods

2.1 Material

Considering the working areas of the relevant upholstery velvet producer enterprises, the fields of activity, financial situations, logistics opportunities and technological competencies of the enterprises in the sector were taken into account in determining the most suitable polyester thread brand. However, the study was carried out in the province of Istanbul. It has been determined that there are six enterprises in Istanbul that manufacture especially upholstery velvet. As a result of the bilateral meetings with the officials of the mentioned enterprises, it was understood that five different thread brands were preferred. Since 20/50 polyester thread is preferred mostly in upholstery velvet, the brands of the suppliers who sell the thread conforming to these

standards are taken as the basis in the study. The reason why 20/50 polyester yarn was preferred in the study is that upholstery velvet with the most suitable qualities can be produced with this type of thread in Turkey conditions. All of the five brands, which are the alternatives of the study, are the brands of the companies that manufacture 20/50 polyester yarn. In Turkey, within the framework of ethical rules, the brands of businesses cannot be declared in academic studies.

In addition, although there are many MCDM methods, MACBETH-PROMETHEE hybrid approach is thought to be sufficient in determining the most suitable polyester thread supplier. The PROMETHEE method is preferred because it is easier to apply compared to other MCDM methods and it can more easily adapt to the problems that need to be compared in terms of conflicting criteria [13-14].

The most distinctive feature that distinguishes the MACBETH method from other MCDM methods is that it can make comparisons based on verbal data instead of numerical values. In the MACBETH method, evaluations are made by considering the judgments of the decision makers in pairwise comparisons. In this method, the relative weights of the criteria are determined by means of the pairwise comparisons made with the verbal evaluations of the criteria [15].

2.2 Method

Today, although the upholstery fabric trend tends towards different products with technological developments, velvet type fabrics are preferred as upholstery fabric in sofa sets and curtains. In this situation, while upholstery fabric manufacturers are trying to adapt their technologies according to new customer trends, they have to continue their velvet production in order not to lose their customers who adopt the classical style. In the emergence of the related decision problem, the general problems in the enterprises producing upholstery velvet were examined. It has been understood that the most important of these is that the thread used in production should be supplied at the most affordable price and with the desired qualities.

Manufacturers have declared that it is essential to supply the most suitable polyester yarn (polyester thread is the primary raw material used in velvet production in Turkey) to ensure the best profit. In this direction, the problem was accepted as a supplier problem and it was thought that it could be analyzed with MCDM methods. It has been determined that the related decision problem has not been studied in the literature. It is aimed to support the upholstery velvet producer enterprises in solving the supplier problem through these data. In addition, it is thought that the study will raise awareness of academicians doing research in the textile sector about the solvability of many decision problems in the field of textile with MCDM methods.

2.2.1 Multi criteria decision making methods

Multi Criteria Decision Methods (MCDM) have seen an inconceivable amount of use over the last several decades. Its role in different application areas has enlarged considerably, particularly as new methods develop and as old methods improve [16]. MCDM is the process of modeling the decision process according to criteria and analyzing the decision maker in a way that maximizes the benefit to be obtained at the end of the process. If businesses mismanage their decision processes, the costs they incur can drag these businesses to bankruptcy. MCDM approaches proposed for use in such decision processes consist of approaches and methods that compare alternatives and search for the optimum solution by considering multiple conflicting criteria. The basic application steps of MCDM methods are given as determination of objectives, determination of criteria; forming of criteria set, determination of alternatives; forming of alternative set, evaluation of alternatives in line with criteria, overall assessment and decision making, and review of the decision; sensitivity analysis [17].

The MCDM methods used in the study are listed below, respectively:

2.2.1.1 MACHBETH method

The MACBETH method was developed in the 1990s to create a range scale and to calculate the relative preference levels among alternatives [18]. Decision makers are asked to make judgments about the difference in attractiveness between two alternatives at the same time from a set of semantic scale sets with seven categories, namely extreme, very strong, strong, moderate, weak, very weak, and none. The MACBETH method calculates relative attractiveness using qualitative information. In this way, decision makers do not need to display

numerically when comparing preferences. The steps of the MACBETH method can be shown as follows [19];

Step 1. First, the decision criteria are defined and then the value tree is created.

Step 2. After creating the value tree, alternatives are determined. Then, the performance levels of the alternatives are defined. At least two levels must be specified, the upper reference (good) and the lower reference (neutral) level. In this method, one hundred points are taken as the upper reference and zero points are taken as the lower references. Here, one hundred points do not mean the best and zero points do not mean the lowest level of performance. (The levels determined as good and neutral belong to the possible situations of the relevant criteria)

Step 3. A matrix is created to compare the alternatives among themselves. The matrix is sorted with the most important alternative to the left and the least important alternative to the right. What is done for the alternatives is repeated for the criteria.

Step 4. Pairwise comparisons are created for both alternatives and criteria. The following semantic judgments are used in the MACBETH method [20; 21].

Step 5. Consistency checks of the judgments are made. When there is an inconsistency, the M-MACBETH program detects where the inconsistency is [22].

Step 6. After checking that the generated judgments are consistent, these judgments are displayed as a numerical scale using linear programming models. With the help of this scale, the scores of the alternatives are determined.

Step 7. By multiplying the criterion weights and alternative scores as a matrix, the total scores of all alternatives are determined and the alternative with the highest score is selected [I,II]. The final overall score is obtained using the following model [20; 23].

$$V(Aj)=\sum_{j=1}^{n} wj(vj(Aj)) \quad [I]$$

$$\sum_{j=1}^{n} wj = 1, wj > 0 \text{ and } \begin{cases} vj\left(A_j^{good}\right) = 100 \\ vj\left(A_j^{neutral}\right) = 0 \end{cases} \quad [II]$$

(The levels determined as good and neutral belong to the possible situations of the relevant criteria)

wj: the weight of the jth criteria.

v(Aj): Point value of element Aj

The final ranking of the alternatives is determined by the values of v(Aj) [I,II] . MACBETH method is supported by M-MACBETH software (http://m-macbeth.com/demo/) developed using algorithm based on linear programming models [23].

In one study [24] ARAS and OCRA in a pattern program of fabrics that are MCDM's methods were used in a textile firm. However, the weights of criteria were determined by the MACBETH method. Besides, another study emphasizes that [25] in a firm from a garment industry operating in Izmir, weights of criterias that are considered in supplier selection by using MACBETH were determined. Alternatives of suppliers were reviewed by MACBETH and TOPSIS methods and results obtained by both two methods were compared.

2.2.2 PROMETHEE method

The PROMETHEE method is among the most recently developed MCDM methods and was introduced to the MCDM literature by Brans in 1982. It was developed with applications by [26]. The PROMETHEE method has basic features such as simplicity, clarity and being balanced. Preference functions are used while prioritizing the alternatives with the method. The entire data set should be clearly articulated so that the decision maker(s) can easily make their judgments about the alternatives. While partial ranking of a limited number of

Table 1 Semantic Judgements

Semantic Categories	Quantitative Scale	Descriptions
No	0	No differences between alternatives
Very Weak	1	One alternative is very weakly important over the other
Weak	2	One alternative is very weakly important over the other
Moderate	3	One alternative is reasonable important over the other
Strong	4	One alternative is strongly important over the other
Very Strong	5	One alternative is very strongly important over the other
Extreme	6	One alternative is extremely important over the other

alternatives can be done with PROMETHEE I, which is one of the elements of the PROMETHEE method, it is possible to perform a full ranking with PROMETHEE II [23]. The PROMETHEE method provides full and partial priority ranking results as a result of the following five steps after the basic decision matrix is determined [29]. In the process of preparing the data, the alternatives, criteria and weights of the relevant decision problem are determined.

Step 1: In the PROMETHEE method, the alternatives are first evaluated by making a pairwise comparison within the framework of the criteria. The structure of the preference function in the PROMETHEE method is based on the mutual comparison of alternatives. In this process, the difference between the performance values of the two alternatives according to a certain criterion is calculated. If this difference is at a level that can be ignored by the decision maker, it does not choose between the relevant alternatives and evaluates it equally. The larger the calculated difference, the more precise the decision maker's preference. These difference values are numbers ranging from 0 to 1 and are calculated as shown in the formula below [III].

$$p[f(a), f(b)] = p[f(a)-f(b)] \quad \text{[III]}$$

a: relevant criterion
f(a): preference function of element a
p[f(a)]: preference value of function f(a)

Step 2: While evaluating the alternatives within the framework of the criteria, the decision maker should have chosen one of the 6 preference functions expressed by Brans [27; 28].

Step 3: The preference indices among the alternatives are determined by the preference functions. The preference indexes among the alternatives are determined with the help of the following two consecutive formulas [IV, V] [28].

$$\pi(a,b) = \sum_{j=1}^{n} w_j P_j(a,b) \quad \text{[IV]}$$

$$\pi(b,a) = \sum_{j=1}^{n} w_j P_j(b,a) \quad \text{[V]}$$

Pj(a,b): common preference value of alternatives a and b
π (a,b): preference index value of alternatives a and b
Wj: weight of the relevant criterion

Step 4: With the help of preference indices determined for alternatives, positive and negative trends of alternatives are determined. Positive and negative currents can be determined by the formulas given below [VI,VII] [29].

Pozitive flow:

$$\Phi^{+}(a) = \Sigma\pi(a,b) \quad \text{[VI]}$$

Negative flow:

$$\Phi^{-}(a) = \Sigma\pi(b,a) \quad \text{[VII]}$$

Φ^{+}(a): positive superiority value
Φ^{-}(a): negative superiority value
π (a,b): preference index value of elements a and b

Step 5: PROMETHEE I results can be obtained using positive and negative values of the flows. However, these results may not make it possible to prioritize alternatives. If a complete ranking of alternatives is desired, the net current values of PROMETHEE II should be calculated. This calculation can be determined by the formula given below [VIII] [27].

$$\Phi(a) = \Phi^{+}(a) - \Phi^{-}(a) \quad \text{[VIII]}$$

The higher the calculated priority and current value Φ(a) of the alternatives, the higher the performance value of the relevant alternative [VIII]. The priority order of the alternatives according to each other is expressed according to the results in PROMETHEE II [28].

This method was used in the portfolio selection [29] best choice of the car [30] modeling of security trading [31], determination of bankruptcy risk of businesses [32] determination of energy projects [33] and solution of a multi criteria financial decision problem [34].

In one study [32], the problem of ordering the sections of a textile factory in Yozgat province where women work intensively is discussed in terms of ergonomic risk. In the solution of the problem, Analytical Network Process (ANP) and PROMETHEE methods, which are among the Multi Criteria Decision Making methods, were used.

Another study [36] emphasizes using of the PROMETHEE-GAIA approach, one of the computer aided multi criteria decision making methods, in solving managerial accounting decisions and ranking them according to their importance. With this method, the land problem of an enterprise operating in the leather-textile sector, which will give priority to the product group that it will produce in the normal economic period and during the economic recession,

has been analyzed.

3. Result and discussion

3.1 Determination of Criterias and Alternatives

In the analysis process of the decision problem regarding the supply of the most suitable 20/50 polyester thread for upholstery velvet manufacturers, first of all, 10 managers of the relevant enterprises were accepted as decision makers and criteria and alternatives were determined in line with the targets of the sector. In the determination of the 10 decision makers whose decisions were consulted during the implementation phase of the study, the production managers and quality control officers working in the yarn producer enterprises to which the five alternatives belong were preferred. Because they are experienced and competent people in the creation and comparison of criteria.

First of all, it should be noted that this study is the first study on the optimum selection of polyester yarn used in the production of upholstery velvet in Turkey and in the world. Considering this aspect, only two criteria of the criteria, such as price and delivery time, were created by considering general supplier problems studies. However, the other seven criteria and alternatives are completely unique and are only included in this study.

At the first stage, all possible criteria were listed by considering the decision makers and the relevant literature, and objective evaluations were made among these criteria, and the nine criteria listed below were determined. As alternatives, five polyester thread suppliers, whose names are not considered ethically appropriate, were selected.

In the study, the evaluations made by the decision makers in accordance with the structure of the relevant supplier problem were taken as basis. In the analysis of the model for determining the most suitable polyester yarn brand, MACBETH and PROMETHEE methods were used in hybrid structure. Purpose, criteria and alternatives are expressed in the model created to solve the related supplier problem. As a result of the evaluations made by the decision makers, the criteria and alternatives were compared. From the data obtained as a result of these comparisons, first of all, the weights of the criteria were determined by the MACBETH method. Then, the priority order of the alternatives was determined by the MACBETH and PROMETHEE methods. The hierarchical model of the study is expressed in Fig. 1.

3.3 Determination of the most convenient polyester thread supplier by MACBETH method

3.3.1 Basic data matrix

In order for the MACBETH method to be fully implemented, the basic data set of the information obtained must be clearly displayed. The basic data set of the relevant supplier selection problem is given in Table 3.

K5: TPI (twists per inch or turns per inch) measures how much twist a yarn has, and can be calculated by counting the number of twists in an inch of yarn.

K7: Density of the Fabric Touched means that the upholstery velvet to be produced should be denser and thicker. (In Turkish conditions, upholstery velvet products, which are dense and thick compared to others, are especially preferred)

Table 2 Criterias and Alternatives

Criterias	Alternatives
C1: Price ($)/kg	A1: A Thread Brand
C2: Delivery (Day)	A2: B Thread Brand
C3: Max. Payment Term (Days)	A3: C Thread Brand
C4: Fiber length (mm)	A4: D Thread Brand
C5: Number of Twists (pcs)	A5: E Thread Brand
C6: Brightness (Decision Makers' Scores)	
C7: Density of the Fabric Touched (Wire/cm)	
C8: Strength (g/tex)	
C9: Denier	
Units:	
Wire/cm: Number of wires in one centimeter of woven fabric	
Gr/tex: The breaking strength per Tex3.2	*The model of the research*

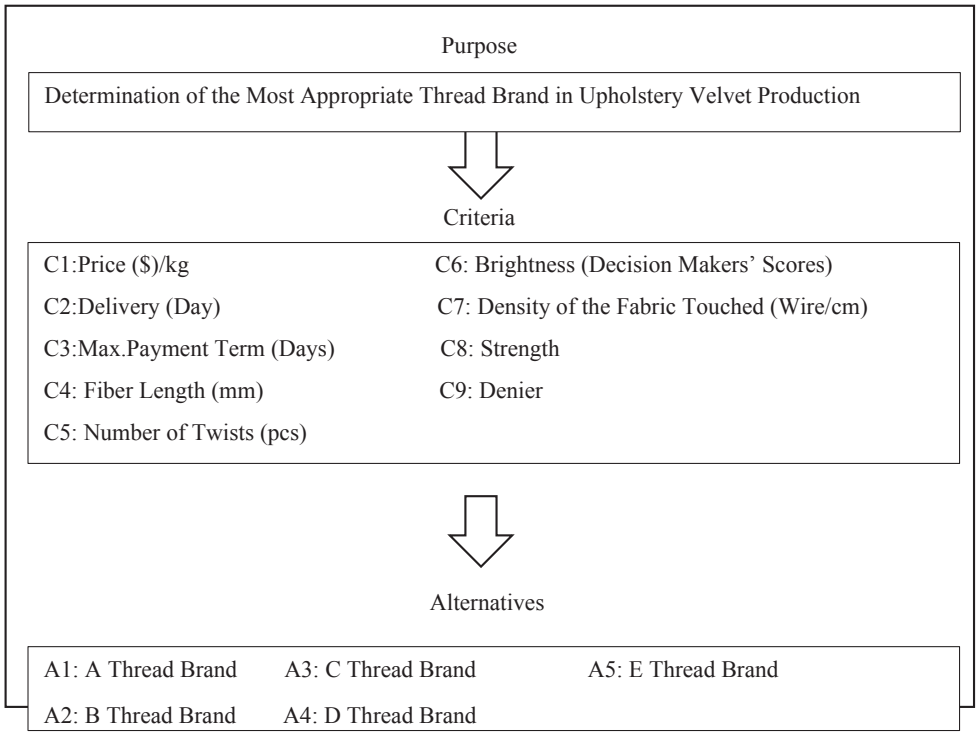

Fig. 1 The Model Regarding the Determination of the most Convenient Thread Brand

Table 3 Basic Data Set

	K1: Price ($)/kg Min.	K2: Delivery (Day) Min.	K3: Max. Pay Period (Day) Max.	K4: Fibre length (mm) Max.	K5: TPI (Piece) Max.	K6: Brightness (Decision Makers' Points) Max.	K7: Density of Fabric Touched (Tel/cm) Max.	K8: Strength (gr/Tex) Max.	K9: Denier (Piece) Max.
A Thread Brand	3.3	25.0	7.0	34.0	500	6.0	17.0	30.2	200.0
B Thread Brand	2.9	8.0	30.0	33.0	480	6.0	16.0	29.9	185.0
C Thread Brand	3.1	13.0	45.0	32.0	450	7.0	13.0	29.8	170.0
D Thread Brand	3	14.0	15.0	30.0	400	8.0	14.0	29.85	175.0
E Thread Brand	2.8	12.0.0	45.0	28.0	420	7.0	15.0	29.7	160.0

3.3.2 Values obtained when MACBETH method criterion weights calculation stages are executed

As expressed in Fig. 2, the weight values of the criteria were determined using the MACBETH method. It is seen that the biggest weight value is the price of the relevant polyester thread and secondly the delivery time.

In the MACBETH Method, after the weights of the criteria are determined, each alternative is compared one by one within the framework of the criteria. These comparisons are for determining the final priority order. The first of these comparison tables should include the comparison of alternatives according to the first criterion, the price criterion. The comparison mentioned in Table 4 is expressed. (When each alternative is compared according to price criteria, the best one is A5 (Brand E) is the worst one is A1 (Brand A))

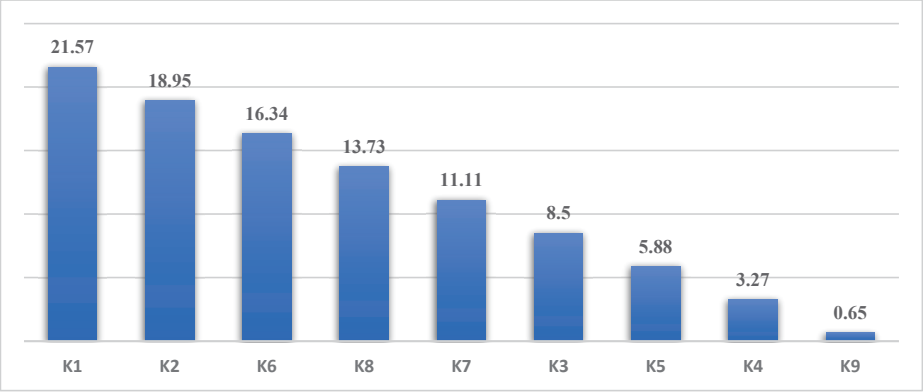

Fig. 2 Criteria Weights through MACBETH Method

Table 4 Evaluation of each Alternative through Price Criteria

	A5	A2	A3	A4	A1	Current Scale
A5	no	strong	v. strong	vstrg-extr	extreme	100
A2		no	strong	v. strong	extreme	75
A3			no	strong	v. strong	50
A4				no	strong	25
A1					no	0

Abbrevations :
v. strong: In pairwise comparison, the first criterion is very strong compared to the second
v. strg-extr: In pairwise comparison, the first criterion is very strong-extreme compared to the second

3.3.3 Final priority values of alternatives in the framework of the criteria through the MACBETH method

When the data in Table 5 is examined, it is understood that the final ranking of the alternatives consists of the Current Scale column data in Table 4. The final ranking formed as a result of the evaluation of these data together is expressed in Table 5. According to this ranking, A2 was first, A5 was second and A3 was third.

In Table 5, (A1, K1) means that the position is 0.00; It means that the ranking value of the A1 (Brand A) alternative according to the K1 criterion is zero (0.00).

3.4 Determination of the most convenient polyester thread supplier by PROMETHEE method

3.4.1 Saving the basic data matrix in the PROMETHEE method by VISUAL PROMETHEE program

There are two ways to apply the analysis steps of the PROMETHEE method. First, the formulas expressed in the previous sections of the study in the classical sense are taken into account in their hierarchical order. The second way is to determine the order of the alternatives using an intermediary program. In the study, the second method was preferred and the Visual PROMETHEE Program was used in the calculations and analysis process. In this direction, as stated in Table 7, the data of the relevant decision problem were recorded on the interfaces of the mentioned program sequentially.

Table 5 Final Ranking Regarding Alternatives through MACBETH Method

Options	Overall	K1	K2	K3	K4	K5	K6	K7	K8	K9
A1	34.64	0.00	0.00	0.00	100.00	100.00	0.00	100.00	100.00	100.00
A2	69.66	75.00	100.00	50.00	75.00	76.47	23.53	76.47	76.47	76.47
A3	44.59	25.00	52.94	100.00	50.00	52.94	70.59	0.00	29.41	52.94
A4	46.37	50.00	29.41	25.00	25.00	0.00	100.00	29.41	52.94	29.41
A5	57.74	100.00	76.47	75.00	0.00	29.41	47.06	52.94	0.00	0.00
Weights:		0.2157	0.1895	0.0850	0.0327	0.0588	0.1634	0.1111	0.1373	0.0065

Table 6 Displaying the Basic Dataset in the Visual PROMETHEE Program

Bertrand	K1	K2	K3	K4	K5	K6	K7	K8	K9
Unit	$/kg	day	day	mm	piece	piece	(wire/cm)	(gr/Tex)	piece
Cluster/Group	◆	◆	◆	◆	◆	◆	◆	◆	◆
Preferences									
Min/Max	min	min	max	max	max	max	max	max	max
Weight	0,21	0,19	0,09	0,03	0,06	0,16	0,11	0,14	0,01
Preference Fn.	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear	Linear
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
-Q: Indifference	0,13	5,36	5,00	1,61	0,50	0,63	1,00	0,15	10,00
-P: Preference	0,37	12,56	33,29	4,61	78,38	1,63	3,00	0,37	29,20
-S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics									
Minimum	2,80	8,00	7,00	28,00	400,00	6,00	13,00	29,70	160,00
Maximum	3,30	25,00	45,00	34,00	500,00	8,00	17,00	30,20	200,00
Average	3,02	14,40	28,40	31,40	450,00	6,80	15,00	29,89	178,00
Standard Dev	0,17	5,68	15,44	2,15	36,88	0,75	1,41	0,17	13,64

Table 7 Final Ranking of Alternatives through VISUAL PROMETHEE Program

Rank	Car	Phi	Phi^+	Phi^-
1	B Thread Brand	0,1235	0,2376	0,1141
2	E Thread Brand	0,1206	0,2508	0,1303
3	D Thread Brand	−0,0015	0,1917	0,1933
4	C Thread Brand	−0,0314	0,1601	0,1915
5	A Thread Brand	−0,2112	0,2560	0,4672

In the fourth row of Table 6, the weights of the criteria are listed under the name of "Weights" as obtained in the MACBETH method.

3.4.2 Expressing the final ranking of alternatives in the VISUAL PROMETHEE program

When the data in Table 7 is examined, it is understood that the final ranking of the alternatives is determined by considering the Phi values in Table 7 and the Basic Data Matrix (Statistics) data in Table 6. The final ranking resulting from this evaluation is given in Table 8.

3.4.3 Interpretation of findings by Spearman Rank Correlation Analysis

When Table 8 is examined carefully, it is seen that the analysis results of the MACBETH method and the analysis results of the PROMETHEE method overlap at a high rate. However, Spearman Rank Correlation Analysis was applied to the results obtained by two different methods in terms of expressing the detailed values. As a result of the analysis, the correlation coefficient was found to be 0,9. This result shows that there is a strong positive correlation between the rankings obtained by the two different methods. As a result of the analyzes carried

Table 8 Rank Correlation Analysis Findings

Brands	*MACBETH Ranking*	*PROMETHEE Ranking*	*d^2 (distance of rank)*
A1: A Thread Brand	5	5	0
A2: B Thread Brand	1	1	0
A3: C Thread Brand	3	4	1
A4: D Thread Brand	4	3	1
A5: E Thread Brand	2	2	0
		Total=	2

out with two different MCDM methods, the reasons why very close results are obtained with each other are considered to be effective;

1- The validity and reliability of the analyzes carried out in the application part of the study,
2- Considering the same criterion weights in both methods,
3- Using the same basic data matrix in both methods,
4- MCDM methods use almost the same basic analysis steps when evaluating alternatives,

4. Conclusion

Today, the most important element among the production raw materials of enterprises producing upholstery fabrics is yarn. Especially in the production of upholstery velvet, high quality and affordable polyester thread is the most important profit factor for manufacturers.

The reason for this is that the latest system velvet machines are very sensitive and polyester yarn below a certain quality causes malfunctions. In addition, customers prefer velvet fabrics woven with high quality polyester thread. In this direction, upholstery velvet manufacturers should supply polyester thread with certain properties to produce velvet of optimum quality. In the study, it has been shown that the most suitable polyester thread supply can be made using MCDM methods with maximum quality and minimum cost. If polyester yarn is purchased by the enterprises producing upholstery velvet, considering the model of the study, the enterprises that are the manufacturers of upholstery velvet will have supplied the most basic raw material needs of 20/50 polyester thread, both at the most affordable price and in the desired quality. If these conditions are met in the relevant enterprises, maximum efficiency is achieved while minimum cost is realized.

When the relevant literature was examined in depth, the results could not be compared because there was no study using MCDM methods in determining the most suitable polyester thread brand in the production of upholstery velvet. With this aspect, the study is expected to fill an important gap in the literature.

The results were shared with the authorities of the relevant enterprises. Recommendations were made to the relevant enterprises to take into account the analysis results obtained using scientific methods. In determining the raw material requirement for the production of different fabric types, the number and quality of the relevant criteria and alternatives can be changed based on the model of the study, so that up-to-date models can be designed to determine the optimum supplier.

In future studies on similar subjects, it is thought that decision problems of different supply items, especially in upholstery fabric production, can be analyzed with current decision making methods.

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