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Using TOPSIS and AHP Methods in Job Distribution to Subcontractors in Apparel Companies and Comparing the Results

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Abstract

The ready-to-wear sector is one of the areas where outsourcing is used extensively due to reasons such as being a labour-intensive sector, having a wide range of products, and the time pressure caused by the very short shelf life of the product. Therefore, garment companies work with a large number of subcontractors, which raises the problem as to which subcontractor/subcontractors work will be distributed to as well as how much to each subcontractor. Using multi-criteria decision-making methods in solving this complex problem helps decision-makers make the right decisions. From this point of view, multi-criteria decision-making methods are very important decision-making tools in terms of the optimal distribution of work to subcontractors. Within the scope of the study, the TOPSIS and AHP methods were used to distribute orders to subcontractors and compared.

Key words: *Multi criteria decision making, MCDM, job distribution, supplier selection, TOPSIS, AHP, apparel.*

Introduction

As a result of the ease of communication, due to the advent of technology and globalization, businesses have started to develop some strategies in order to sustain their work in the best way. Businesses are developing strategies to protect and improve their profitability in order to increase their competitiveness. Factors that increase competition, such as quality, price, cost and flexibility cause enterprises to strive to offer higher quality and less costly products and services.

Considering the strategies for cost reduction, especially since the 1990s, it is seen that businesses have started to take advantage of outsourcing by having their activities outside of their basic capabilities done by suppliers [1].

Outsourcing is defined as businesses carrying out the activities involving their essential competencies and having all the activities outside of this scope performed by other businesses having a higher level of competency than themselves to increase their competitive advantage [2].

Although outsourcing was a method used to perform activities other than basic skills at other companies, today, the purpose of outsourcing has increased even more. So much so that businesses prefer to undergo activities within their core abilities with outsourcing [3, 4].

Factors such as increasing flexibility, reducing risks, increasing quality, downsizing of an organisation, reducing cost, increasing product range, uncontrollable functions, saving time, increasing productivity, being involved in successful enterprises, the renewing process, a wide and flexible resource pool, redistributing resources, resource transfer, following technological innovations, and overcoming the demands beyond capacity can be listed as the main reasons leading companies to this change [5-9].

Almost all of the reasons listed above have forced companies to work with subcontractors, as a result of which main company contracts and subcontracts affiliated with the main company have emerged.

Subcontracting manufacturers are independent production companies that produce parts in accordance with the recommendation and working technique of the main company [10].

Especially, companies that have a wide range of products and produce and sell in high amounts work with many subcontractors with different features. This causes the need for job distribution to subcontractors according to a certain system.

Here, the past delivery performances of subcontractors are very influential among the factors that will affect job distribution. These performance criteria can be listed as quality, price and delivery performance. In addition, factors such as the production capacity of the subcontractor, its distance to the main company, and its technological equipment are factors affecting the distribution of work [10, 11].

After determining the factors, companies should weight them with respect to job distribution to subcontractors, which is a very important step. For example, in a cost-oriented company, the price given by the subcontractor has a larger weight, while in quality-oriented businesses, the weight of the quality factor may be greater. For example, price has a greater weight in cost-oriented companies, while the weight of the quality factor may be greater in quality-oriented companies.

As can be seen from the above, the constant distribution of work to subcontractors is affected by many factors, and the fact that these have different weights is a complex problem for businesses. At this point, multi-criteria decision making methods are the most effective tools for solving this problem.

With the use of multi-criteria decision-making methods, the main company will make more accurate decisions while distributing orders, and motivate subcontractors to increase their performance. As a result, it will ensure that the order is made at the desired quality, time and cost.

Choosing the best alternative is a difficult task for decision makers, who are expected to choose the most appropriate selection from alternatives with different goals; and sometimes these alternatives may contradict each other. For this reason, most decision makers use multi criteria decision making methods when they encounter such problems. "Multi-criteria decision making" means choosing the highest priority among others; in other words, it means short evaluation, ranking and selection [12].

Decision making is the process of selecting one or more of the available options, along with a set of criteria, to solve a particular problem and achieve the desired goal [13].

Multi-criteria decision-making (MCDM) is a branch of the most widely used methods of decision making theory. It includes ones that enable the selection of alternatives, grouping or sorting alternatives by evaluating multiple decision criteria [14].

Multi-criteria decision making methods are methods that are based on qualitative and quantitative criteria, can be easily applied and offer common solutions for different problems when deciding on a solution for a problem [15].

The problem of supplier selection has been examined by many researchers, who have made certain classifications. Some MCDM methods used today are as follows: TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), AHP (Analytic Hierarchy Process), ANP (Analytic Network Process), ELECTRE (Elimination and Choice Translating Reality English), PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluations), VIKOR (Vise Kriterijumska Optimizacija I Kompromisno Resenje), and MOORA (Multi-objective Optimization By Ratio Analysis).

The TOPSIS method, one of those used in the application part of the study, was developed by Yoon and Hwang as an alternative to the ELECTRE method in 1980 and is one of the most widely used MCDM methods. The basis of this method is that the alternative chosen should be the shortest distance to the ideal solution in the geometric sense and the farthest distance from the negative-ideal solution. The TOPSIS method assumes that each criterion has a uniformly increasing or decreasing utility trend. For this reason, it is easy to identify ideal and negative-ideal solutions. The Euclidean distance approach aims to evaluate the relative proximity of the alternatives to be chosen to the ideal solution. Thus, the order of alternatives can be generated by comparing these relative distances. [16].

The AHP method is another used in the study. Developed in the 1970s by Professor Thomas L. Saaty, it is a decision making method used for solving complex problems involving multiple criteria. AHP allows decision makers to model complex problems with a hierarchical structure showing the relationship between the main goal, criteria, sub-criteria and alternatives of the problem. The most important feature of AHP is that it includes both objective and subjective thoughts of the decision maker in the decision making process. AHP has a wide range of applications and is used effectively in many decision problems today [17].

Literature review

It is seen in the literature that MCDM methods are used in many fields, and today they are frequently used in supplier selection and evaluation. Studies obtained as a result of a literature review and short descriptions of them are given below.

One of the most important studies on the supplier selection problem in the literature is Dickson's study done in 1966. In this he prepared a questionnaire consisting of 170 questions, which was answered by 273 people selected from members of the National Purchasing Managers Association. As a result, Dickson determined 23 criteria used in supplier selection, among which the first reported is the quality criterion [18].

Arbel and Seidmmann, Beck and Lin, Tam and Tummala, Ghodsypour and Brien, as well as Zviran and Bard collected the supplier selection criteria in three groups in their studies: financial, technical and operational success [19-26]. Yurdakul and İç determined criteria to be considered in supplier selection as managerial capabilities, technological capabilities and production facilities and capacities [27].

Azimifard et al. determined weights with the AHP method and selected suppliers with the TOPSIS method in a supplier selection study in the Iranian steel industry [28]. Supçiller and Çapraz cross-evaluated the supplier selection problem with the AHP and TOPSIS methods for a corrugated box manufacturer in Turkey [29]. Barbarosoğlu and Yazgaç, Narasimhan, Nydick and Hill, and Partovi used the Analytical Hierarchy Process (AHP) method for their problem of supplier selection and suggested the use of this method [30-33].

Acar and Güner used the TOPSIS method in selecting customers for a garment business [34]. Ertuğrul used the fuzzy AHP method in choosing the best textile machine in a textile company [35]. Ertugrul and Karakaşoğlu compared the fuzzy AHP and fuzzy TOPSIS methods for selecting the location of a textile company in Turkey. The differences and similarities of both methods were discussed in [36]. Öztürk et al. made a supplier selection ofyarn to be used in a textile company operating in Bursa using the AHP method. In this study, they solved the supplier selection problem by evaluating 7 main criteria and 13 sub-criteria related to them [37].

Chan and Chan used the AHP method to solve the supplier selection problem in a clothing company [38]. Tayyar and Arslan solved the best subcontractor selection problem using the AHP and VIKOR methods for a companuy that sewed orders from world-famous brands for ready-to-wear clothing [39].

Francisco Rodrigues Lima Junior and his colleagues compared the Fuzzy AHP and Fuzzy Topsis methods for supplier selection in the automotive sector [40].

Güngör et al. made a study entitled "A Supplier Selection, Evaluation and Re-Evaluation Model for Textile Retail Organizations", in which they used the AHP and ANP methods [41].

Misra et al performed the evaluation and prioritisation of production flexibility alternatives using the TOPSIS and AHP methods [42].

Jia and colleagues reviewed supplier selection problems in fashion business operations with sustainability considerations in their study using the TOPSIS method [43].

Material and method

This study used the TOPSIS and AHP methods for the experimental part. Data required for the application of these

Table 1. Weights of criteria.

Criteria	Outsourcing department 1	Weight (n-rj+1)	Weight value	Outsourcing department 2	Weight (n-rj+1)	Weight value	Weight value average
C1	1	10	0.18	1	10	0.18	0.18
C2	2	9	0.16	3	8	0.14	0.15
C3	3	8	0.14	2	9	0.16	0.15
C4	4	7	0.12	4	7	0.12	0.12
C5	6	5	0.09	5	6	0.10	0.10
C6	9	2	0.03	10	1	0.01	0.02
C7	8	3	0.05	6	5	0.09	0.07
C8	5	6	0.10	7	4	0.07	0.09
C9	10	1	0.01	9	2	0.03	0.02
C10	7	4	0.07	8	3	0.05	0.06
Total		55	1		55	1	1

Table 2. Distribution of production amount according to the order of C values.*

Subcontractors	C*	Ranking	Capacity	Planned production quantity
N	0.594	1	250.000	250.000
M	0.560	2	325.000	325.000
H	0.552	3	150.000	150.000
E	0.543	4	200.000	200.000
A	0.536	5	425.000	425.000
L	0.534	6	120.000	120.000
O	0.533	7	100.000	100.000
K	0.529	8	120.000	120.000
B	0.516	9	400.000	400.000
I	0.502	10	200.000	200.000
G	0.486	11	125.000	125.000
J	0.462	12	350.000	85.000
C	0.459	13	300.000	0
D	0.449	14	450.000	0
F	0.446	15	300.000	0

methods were obtained from questions asked to 2 outsourcing department managers of Company X. The steps of the TOPSIS and AHP methods were applied to the data and work was distributed to subcontractors according to the results, and the outcomes of both methods were compared.

Stages and implementation of TOPSIS method

Determining the criteria

In determining the criteria taken into consideration in the selection of suppliers, the literature survey and opinions of two different department managers working in company X were taken into consideration. The criteria obtained as a result of the research are as follows; Quality (C1), Term Performance (C2), Price (C3), Production Capacity of the Subcontractor (C4), Distance of the Subcontractor to the Firm (C5), Layout – Order (C6), Communication Capability (C7), Technological Equipment (C8), Business Tracking (C9), and Financial Status (C10).

Weighting of the criteria

In the weighting of the criteria determined, 2 different outsourcing department managers working in company X filled out a form to sort the criteria. The ranking method (sorting method) was used in the weighting. The weights of each criterion are determined according to the formula of (n – rj + 1) and then normalised by the sum of all the weights (∑ (n – rk + 1)) by the ranking method [44]. Then, the arithmetic average of the weight values of both managers' form results were taken and converted to be usable in the TOPSIS method. ***Table 1*** shows the weight values calculated by order of importance given to the criteria by both managers.

Scoring of subcontractors according to criteria

At this stage, the subcontractors which Company X works with were scored according to the criteria determined. Scores differ according to the criteria. While some criteria can be scored numerically, for some it is not possible to do that. Quality, delivery performance, price, the supplier's production capacity and distance to the company criteria are scored according to the numerical data of the suppliers. For the criteria of job tracking, communication ability, layout – order, technological equipment, and financial condition, relevant managers were asked to fill out an evaluation questionnaire, and the criteria were scored according to the results obtained from this questionnaire.

Calculation of normalisation rates

x_{ij} in the decision matrix values, which are the points received by subcontractors, are squared and the sum of the columns consisting of the sum of these values is obtained. For each x_{ij} value normalisation rates are calculated by dividing the value by the square root of the column to which it belongs. The formula of the normalization rate is as ***Equation (1)*** [4]. Normalisation values are shown in ***Table 3***.

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad i = 1, ..., m; j = 1, ..., n \qquad (1)$$

r_{ij} – normalisation rate of i.line j.column of matrix,

x_{ij} – i.line j.column element of score matrix.

Calculation of the weighted normalisation rates

Normalised values are weighted by multiplying the weight of the relevant criterion. The weighted normalisation rate formula is as follows [45].

$$V_{ij} = h_{ij}.\ r_{ij} \qquad i = 1, ..., m; j = 1, ..., n \qquad (2)$$

V_{ij} – weighted normalization rate of i.line j.column of matrix,

h_i – weighted value of each i. criteria.

Identification of positive-ideal and negative-ideal solutions

Positive ideal A^+ and negative ideal A^- values are found according to weighted normalisation values. The maximum values of every column in ***Table 4*** show the A^+ value. Likewise, the minimum values of each column in ***Table 4*** show the A^- value. The formula for A^+ and A^- values is as follows [4].

$$A^+ = [V_1^+, V_2^+, ..., V_n^+] \qquad (3)$$

$$A^- = [V_1^-, V_2^-, ..., V_n^-] \qquad (4)$$

A^+ – positive ideal value,

A^- – negative ideal value.

Calculation of the maximum and minimum distance to the ideal point

To calculate the distance to the maximum ideal point, positive ideal A^+ of the respective column is subtracted from the weighted normalisation values of each column. The result is squared. Then, the S^+ value is found for each line by taking the square root of the sum of squares of alternatives. To calculate the distance to the minimum ideal point, the negative ideal A^- of the respective column value is subtracted from the weighted normalisation values of each column. The result is squared. Then, the S^- value is found for each line by taking the square root of the sum of squares of alternatives. The formula for the maximum and minimum ideal spot distance is shown below.

$$S_i^+ = \sqrt{\sum_{j=i}^{n} (V_{ij} - V_j^+)^2} \quad i = 1, ..., m \quad (5)$$

S^+ – maximum distance to the ideal point.

$$S_i^- = \sqrt{\sum_{j=i}^{n} (V_{ij} - V_j^-)^2} \quad i = 1, ..., m \quad (6)$$

S^- – minimum distance to the ideal point.

Calculation of the relative proximity to the ideal solution

In this step the relative proximity of each alternative to the ideal solution is calculated. The formula for calculating proximity points is as follows.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^+} \quad i = 1, ..., m \quad 0 \leq C_i^* \leq 1 \quad (7)$$

C_i^* – ideal solution proximity value.

Making choices and sharing the production amount

The highest C^* value is selected. According to this value, alternatives are listed starting from 1. The proximity coefficient is between 0 and 1. Among the alternatives evaluated, the alternative with the highest coefficient of proximity is considered as the best. At this stage, the production quantity was shared in two ways, both according to the order of C^* values and the normalisation of C^* values.

While the production amount is shared according to the order of C^* values, C^* values obtained as a result of TOPSIS are listed from highest to lowest starting from 1. Starting from the first subcontractor, 2.500.000 orders are distributed in order depending on the capacity of the subcontractors. Subcontractors were assumed to run at full capacity as the orders were distributed. After the distribution, it was revealed that 3 suppliers would not work with Company X for orders of that month, and 1 supplier would not work at full capacity. The distribution of the production amount is shown in ***Table 2***.

Table 3. *Sharing of the production amount according to the normalisation of C * values.*

Subcontractors	Normalisation of C* value	Capacity	Planned production quantity	Capacity difference
A	0.069	425.000	173.907	251.093
B	0.067	400.000	167.523	232.477
C	0.059	300.000	149.166	150.834
D	0.058	450.000	145.800	304.200
E	0.070	200.000	176.156	23.844
F	0.057	300.000	144.889	155.111
G	0.063	125.000	157.755	**-32.755**
H	0.071	150.000	179.087	**-29.087**
I	0.065	200.000	163.054	36.946
J	0.059	350.000	149.946	200.054
K	0.068	120.000	171.786	**-51.786**
L	0.069	120.000	173.179	**-53.179**
M	0.072	325.000	181.723	143.277
N	0.077	250.000	192.874	57.126
O	0.069	100.000	173.156	**-73.156**

Table 4. *Importance scale created by Saaty [46].*

Rating of importance	Definition	Description
1	Equally important	The two options are equally important
3	A little more important	One option is less important than another
5	Strongly important	One option is more important than another
7	Very strongly important	One option is very important compared to the other
9	Extremely important	One option is extremely important over another
2, 4, 6, 8	Intermediate values	Intermediate values used when needed

While sharing the production amounts according to the normalisation of C^* values, the production quantity was determined by subcontractor capacities and normalisation of C^* values. To calculate the normalisation of C^* values, the C^* values of each alternative are summed, and this total is divided by each C^* value. Normalisation calculation of the C^* value is shown in the formula below.

$$C^* \text{ normalization} = \frac{C^*}{\sum_i^m C^*} \quad (8)$$

Each C^* normalisation value is multiplied by the total number of orders in order to distribute the C^* value according to normalisation, and thus the distribution of quantity is made.

The most important point to be considered here is the possibility of planned units exceeding the capacity of the subcontractors. In this case, the quantities exceeding the capacity are distributed to the subcontractors with a suitable capacity, and thus all the quantities are placed. As can be seen in ***Table 3***, work was distributed to all subcontractors, with the distribution of quantity made by normalisation of the C^* value. After the distribution, it can be seen that the production numbers of G, H, K, L & O subcontractors exceed their capacities. A total of 239.963 arising from the capacity difference of the 5 enterprises here can be assigned to subcontractor D, with the highest capacity gap.

Stages and implementation of AHP method

Determining the criteria

The stage of determining the criteria taken into consideration in the distribution of works to subcontractors is the same as in the TOPSIS method. The same criteria used in the TOPSIS method are taken into account.

Determination of alternatives

In this study, the alternatives used in the implementation of the AHP method, namely subcontractors, are the same as thoseused in the TOPSIS method.

Creating the hierarchical structure

In AHP method, the aim is the top of the hierarchy. Therefore, it is very important

Table 5. Dual comparison matrix on the basis of quality criteria.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
A	1	1/3	1/2	3	1	1	2	3	7	1/5	5	1/2	1/3	7	1/3
B	3	1	2	5	3	3	4	5	9	1/3	7	2	1	1/3	1
C	2	1/2	1	4	2	2	3	4	8	1/4	6	1	1/2	1/4	1/2
D	1/3	1/5	1/4	1	1/3	1/3	1/2	1	5	1/7	3	1/4	1/5	1/7	1/5
E	1	1/3	1/2	3	1	1	2	3	7	1/5	5	1/2	1/3	1/5	1/3
F	1	1/3	1/2	3	1	1	2	3	7	1/5	5	1/2	1/3	1/5	1/3
G	1/2	1/4	1/3	2	1/2	1/2	1	2	6	1/6	4	1/3	1/4	1/6	1/4
H	1/3	1/5	1/4	1	1/3	1/3	1/2	1	5	1/7	3	1/4	1/5	1/7	1/5
I	1/7	1/9	1/8	1/5	1/7	1/7	1/6	1/5	1	1/9	1/3	1/8	1/8	1/9	1/8
J	5	3	4	7	5	5	6	7	9	1	9	4	3	1	3
K	1/5	1/7	1/6	1/3	1/5	1/5	1/4	1/3	3	1/9	1	1/6	1/7	1/9	1/7
L	2	1/2	1	4	2	2	3	4	8	1/4	6	1	1/2	1/4	1/2
M	3	1	2	5	3	3	4	5	8	1/3	7	2	1	1/3	1
N	1/7	3	4	7	5	5	6	7	9	1	9	4	3	1	3
O	3	1	2	5	3	3	4	5	8	1/3	7	2	1	1/3	1
	22,7	11,9	18,6	50,5	27,5	27,5	38,4	50,5	100	4,8	77,3	18,6	11,9	4,8	11,9

Table 6. Sharing of the production amount.

Subcontactors	Multiplication values	Ranking	Capacity	Planned production quantity
B	0.094	1	400.000	400.000
J	0.092	2	350.000	350.000
M	0.086	3	325.000	325.000
A	0.084	4	425.000	425.000
D	0.082	5	450.000	450.000
L	0.081	6	120.000	120.000
O	0.077	7	100.000	100.000
N	0.075	8	250.000	250.000
G	0.059	9	125.000	80.000
H	0.057	10	150.000	0
F	0.050	11	300.000	0
E	0.047	12	200.000	0
C	0.045	13	300.000	0
K	0.039	14	120.000	0
I	0.026	15	200.000	0

to determine the purpose correctly. After the goal, at a lower level, there are criteria that affect it. If there are any sub-criteria, these are also under the main criteria. Alternatives are at the lowest level of the hierarchical structure [45].

In a hierarchical structure, each set of criteria creates a hierarchy level. A hierarchical structure should be created, as a result of meticulous work, that represents the problem best. Especially, determining the number and level of criteria that will affect the outcome is very important in terms of the consistency of dual comparisons [46].

Creation of dual comparison matrices

The terms in dual comparison matrices show how many times the criteria are important to each other. The matrix's a_{ij} element shows the decision maker's answer to the question of how important feature i is to feature j.The terms located on the matrix's diagonal side have a value of 1. If a_{ij} is the dual comparison value of feature i and feature j, it consists of $1/a_{ij.}$ This feature is called the reciprocal feature [47].

While showing how important the terms in the comparison matrices are relative to each other, the importance scale, consisting of numbers, indicates the importance of the options used. This scale consists of 5 main values and 4 intermediate values. In ***Table 4*** the table of importance created by Saaty is shown [46].

Table 5 shows the dual comparison matrix based on the quality criteria of the suppliers, with column totals included. Likewise, for all other criteria, dual comparison matrices are created on a supplier basis.

Calculation of priority vectors

Once the binary comparison matrices are created, each element in the matrix is normalised by dividing it by its own column sum. Thus, a normalised dual comparison matrix is created. The normalization value is calculated with ***Equation (9)*** [45].

$$r_{ij}=\frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \qquad (9)$$

r_{ij} – normalisation rate of i.line j.column of matrix,
a_{ij} – i.line j.column element of dual comparison matrix.

The column sum of the normalised matrix becomes 1. Then, according to formula 10, each row sum is divided by the matrix size and averaged. The sum of these averages becomes 1 [45]. These calculated values are the supplier weights of importance for each criterion. Thus, priority vectors are obtained.

$$W_i=\left(\frac{1}{n}\right) \sum_{i=1}^{n} r_{ij} \qquad i, j = 1, 2, ..., n \qquad (10)$$

W_i – priority vector value of each i.criteria.

Calculation of weighted priority vectors

The priority vectors obtained for each criterion are multiplied by the values in the respective column in the dual comparison matrix for the relevant criterion. The sum of rows from these products gives weighted priority vector values [48].

Calculation of the consistency rate

After the decision maker has created the dual comparison matrices, the decision maker should check whether the comparisons made are consistent. The consistency rate is calculated according to ***Equation (11)*** [45].

$$CR=\frac{CI}{RI} \qquad (11)$$

CR – consistency rate,
CI – consistency index,
RI – random index.

In order to calculate the CR, the CI value must first be calculated. The CI value is calculated according to ***Equation (12)*** as follows [45].

$$CI=\frac{\lambda_{max} - n}{n-1} \qquad (12)$$

λ_{max} – maximum eigenvalue.

In order to calculate the CI value, the λ_{max} value should be calculated. The weighted priority vector values are divided by their corresponding priority vector values. The arithmetic mean of the values obtained produces the λ_{max} value, calculated according to formula 13 below [45].

$$\lambda_{max} = \frac{1}{n} \cdot \sum_{i=1}^{n} \left[\frac{\sum_{j=1}^{n} a_{ij} \cdot w_j}{w_i}\right] \quad (13)$$

The CI value can be calculated after the λ_{max} value is found.

RI values are needed to calculate the consistency rate. RI values are fixed values, found in studies conducted by Saaty et al. The RI value for a matrix of size 15 is 1.59 [49].

If the consistency rate is below 0.10, the comparison matrix is designated consistent. If the consistency rate is greater than 0.10, it is decided that the matrix is inconsistent, and the decision maker is recommended to review the comparisons [49].

Making calculations among the criteria

After these steps, the same steps applied for subcontractors are also applied among the criteria considered in the distribution of work. The dual comparison matrix between the criteria themselves, priority vector values, weighted priority vector values and the consistency rate are calculated in the same way.

After calculation of the priority vector and weighted priority vector values, the calculated λ_{max} value was found to be 10,2331 for the criteria. The CI value was calculated as 0.0259. Since the matrix size is 10, the CR value calculated with the 1.49 RI value was found to be 0.0174.

In order to distribute work after these calculations, priority vector values of the alternatives calculated using criteria are multiplied by the priority vector values calculated between the criteria. A total is calculated for each row. The sum of the column with row total values becomes 1. The values obtained as a result of the row totals will be used to allocate the production amount during the distribution of work.

Sharing the production amount

The row totals obtained as a result of the product of the priority vector values are used to allocate the production quantity. The highest value is selected from the results obtained. According to this value, the results are sorted from highest to lowest, ranging from 0 to 1. The supplier with the highest value is considered the best. The distribution of production amounts is shown in ***Table 6***. Subcontractors were assumed to run at full capacity as the orders were distributed. After this distribution, it was revealed that 9 suppliers would not work with Company X for the orders of that month, and 6 companies would not work at all.

Results and discussion

When the results of work distribution made with the TOPSIS and AHP methods are analysed, it is concluded that both methods can be used effectively in job distribution to subcontractors.

The results obtained can be listed as follows:

1. With the TOPSIS method work can be distributed to subcontractors based on C* values.
   Thus, orders are distributed to subcontractors according to the C* values. There is no obligation to distribute work to all subcontractors here, and work distribution is carried out by fulfiling their capacities, starting from the first subcontractor in the list. According to the results of this study, although the capacity of the J subcontractor is 350.000, 85.000 jobs were distributed to it (***Table 7***).

2. With the TOPSIS method work can be distributed to subcontractors based on the normalisation values of C* values. In the distribution of work done in this way, work is distributed to all subcontractors. Here, the normalisation value determines the assignment. The important thing to note at this juncture is the possibility of exceeding the capacity of the subcontractor with the amount distributed. In this case, the quantities exceeding the capacity are distributed to subcontractors of suitable capacity, and thus all the quantities are placed.

3. In the distribution of work done according to the AHP method, the product of the total production amount planned for that month can be distributed to subcontractors, starting from the contract with the highest value and ordering the multiplication values from small to large. Job distribution here is similar to the distribution of work done with TOPSIS based on C* values, and there is no obligation to distribute work to all subcontractors.

When the results of items 1 & 3 summarided, it can be seen that the results of methods TOPSIS and AHP have both similarities and differences between them, as shown in ***Table 7***.

Table 7. *Comparison of both TOPSIS and AHP.*

Subcontractors	Capacity	TOPSIS C* (Planned production quantity)	AHP (Planned production quantity)
N	250.000	250.000	250.000
M	325.000	325.000	325.000
A	425.000	425.000	425.000
L	120.000	120.000	120.000
O	100.000	100.000	100.000
B	400.000	400.000	400.000
C	300.000	0	0
F	300.000	0	0
H	150.000	150.000	0
E	200.000	200.000	0
K	120.000	120.000	0
I	200.000	200.000	0
G	125.000	125.000	80.000
J	350.000	85.000	350.000
D	450.000	0	450.000

As can be seen from ***Table 7***, as a result of the work distribution done by both methods, the same amount of work was distributed to subcontractors N, M, A, L, O, B, C and F, and the amount of production distributed to other subcontractors (H, E, K, I, G, J, D) varied. This led to the conclusion that there are similarities and differences between both methods.

Conclusions

Outsourcing is preferred by companies operating in almost every sector due to the advantages it provides. In the ready-to-wear sector, being labor-intensive, almost all of production activities are carried out by subcontractors. Especially, companies with high production volumes can work with dozens of subcontractors to complete the same order at the same time.

Therefore, when dozens of subcontractors and many factors come together, making a correct and accurate decision does not seem possible without using scientific methods. Multi-criteria decision making methods provide great benefits for businesses in this respect. Making accurate decisions in job distribution to subcontractors will provide a company with the advantage of quality products and timely delivery.

One of the main objectives of this study was to enable ready-to-wear companies to become more conscious of using these methods and to make the use of these methods widespread.

For this purpose, an application of the methods was made in a garment company, where information about the suppliers of the company and data of previous deliveries (quality, delivery performance, etc.) were brought together. Then, in line with information in the literature and the opinions of 2 different outsourcing unit officials working in the company, the factors and their weights were determined, and then the TOPSIS and AHP methods were applied and the alternatives ranked. When the ranking results are examined, it is revealed that there are similarities and differences in supplier selections made according to the TOPSIS and AHP methods. As an example, supplier L ranked 6th in both methods, while supplier M ranked 2nd in the TOPSIS method and 3rd in the AHP method.

It is noteworthy that the basic system of both methods in decision making is different. In the TOPSIS method, the decision maker gives an absolute value for each criterion, while in the AHP method, each factor is proportioned to another factor. This results in the decision maker having different alternatives under the circumstances. The decision maker should be very careful when creating a dual comparison matrix, especially in the AHP method. For example, a decision maker can give 3 points to the quality criterion of supplier B's superiority over supplier A, but another decision maker can evaluate this with a value of 5. This can produce different results and change the order. In the AHP method, the personal interpretation of the decision maker can affect the result.

Unlike other studies in the literature in this paper, two different methods with separate application examples are used for the solution of the same problem, and the differences between them are revealed. Thus, decision makers will be able to choose one of the two methods that suits their logic.

One of the other results of the study is that, thanks to the use of these methods, businesses can evaluate their suppliers with a scientific approach and reveal their superiorities with numerical data. It guides both outsourced businesses and suppliers by revealing the aspects that suppliers need to improve.

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