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RESEARCH ARTICLE
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TOPSIS Method Application for Personal Protective Equipment Selection

Kişisel Koruyucu Donanım Seçimi İçin TOPSIS Yöntemi Uygulaması

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ABSTRACT

The technological and global changes experienced today have made the occupational health and safety sector gain a higher importance. The use of Personal Protective Equipment (PPE) developed to ensure the safety of employees may lead to the need for multi-criteria decision making for product selection due to the increase in the number of manufacturers, the increase in companies and product features, and the variability of product features. Within the scope of the research, a case study was conducted to determine the factors affecting the selection decision of the helmets to be purchased for the purpose of occupational safety at the workplace and to present a preference ranking proposal. The forty best-selling products in the helmet category on Trendyol and Hepsiburada websites were included in the scope of the relevant research. The TOPSIS method was used while making the selection in the application and the results were evaluated by comparing. The results were checked with Python coding for the TOPSIS method. Preference suggestions are presented according to the features of user rating, adding to favorites, number of comments, price, number of comments/user points and price/user points.

Keywords: Personal Protective Equipment, PPE, OHS, TOPSIS, Multi Criteria Decision Making

ÖZET

Günümüzdeki teknolojik ve küresel gelişmeler, iş sağlığı ve güvenliği sektörünün önemini artırmıştır. Çalışanların güvenliği sağlamak için geliştirilen Kişisel Koruyucu Donanımların (KKD) kullanımı, üretici sayısının çoğalması, firmaların ve ürün özelliklerinin artması ve ürün özelliklerinin değişkenliği sebebiyle ürün seçimi için çok kriterli karar verilmesi ihtiyacını doğurabilmektedir. Araştırma kapsamında iş yerinde iş güvenliği amacıyla alınacak olan baretlerin seçim kararını etkileyen faktörleri belirlemek ve tercih sıralama önerisi sunmak için örnek çalışma yapılmıştır. İlgili araştırma kapsamına Trendyol ve Hepsiburada web sitelerinde baret kategorisinde en çok satılan kırk ürün dahil edilmiştir. Yapılan uygulamada seçim yapılırken TOPSIS yöntemi kullanılmış ve sonuçlar karşılaştırılarak değerlendirilmiştir. TOPSIS yöntemi için Python kodlamaları ile sonuçlar kontrol edilmiştir. Kullanıcı puanı, favoriye ekleme, yorum sayısı, fiyat, yorum sayısı/kullanıcı puanı ve fiyat/kullanıcı puanı özelliklerine göre tercih önerileri sunulmuştur.

Anahtar Kelimeler: Kişisel Koruyucu Donanım, KKD, İSG, TOPSIS, Çok Kriterli Karar Verme

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INTRODUCTION

In order to reduce the frequency of occupational accidents, the Occupational Safety Law No. 6331 (2012) obliges a risk assessment in order to identify the hazards that exist in the workplace or that may come from outside, to analyze and rank the factors that cause these hazards to turn into risks and the risks arising from the hazards, and to decide on control measures. The risk control hierarchy is taken into account when deciding on control measures. Applications to be made according to the control hierarchy in the Occupational Health and Safety Risk Assessment Regulation No. 28512 (2012); elimination, replacement, engineering controls, administrative controls, and use of personal protective equipment. In this study, issues such as elimination, design change, collective protection measures, etc., which are at the top of the control hierarchy, are not included in the scope, and the focus is on personal protective equipment.

Personal Protective Equipment (PPE) is any device, tool or material designed to be worn, fitted or carried by persons to protect against one or more health and safety risks (Singh et al., 2022). One of the issues that attract attention worldwide and need to be emphasized is related to personal protective equipment, which is required by all employees, regardless of the sector, which is at the bottom of the risk prevention / reduction hierarchy and has not received the importance it deserves (Nill, 2019).

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Personal protective equipment is an extremely important concept that requires special examination in terms of preventing occupational accidents, injuries, near misses and occupational diseases, as well as protecting and observing workers. PPE: It consists of various tools, clothing, accessories and their attachments that protect employees from near misses, injuries, occupational diseases and work accidents. Although the field studies conducted in the relevant literature have examined whether the employees use PPE or not, studies examining the functionality of the PPE used have not been disseminated. (Coia et al., 2013; Ulubeyli et al., 2014)

The legislation on the use of personal protective equipment explains the importance of the issue. The first regulation to be examined in this context is the Regulation on the Use of Personal Protective Equipment at Workplaces. In situations where the prevention or adequate reduction of risks at work cannot be achieved through collective protection based on technical measures, work organization, or working methods, this regulation's purpose is to specify the procedures and principles regarding the characteristics, supply, use, and other issues of personal protective equipment to be used. The Personal Protective Equipment (PPE) Regulation No. 30761 determined the procedures and principles regarding the protection of the health and safety of users and the free movement of personal protective equipment in the design and production of personal protective equipment available on the market. Communiqué No. 28230 on the Categorization Guidelines for Personal Protective Equipment is to determine which category personal protective equipment is included in order to carry out CE certification. In addition, there are European Union standards that define the features and qualities of personal protective equipment like TS EN ISO 20471:2013 and TS EN ISO 20471/A1 (Koçali, 2019; Çetin and Beğik, 2021)

MATERIAL AND METHOD

TOPSIS Method

People's lives are shaped by the decisions they make in every aspect of life. Every decision result in the rejection of at least one alternative. People benefit when they make the right decisions based on their options, but they suffer consequences or pay a price when they make the wrong ones. Decision-making analysis developed concurrently with this circumstance to assess the options. When faced with complex judgments spanning multiple dimensions, people can benefit from using multi-criteria decision-making techniques, according to Lin et al. (2013). According to Achillas et al. (2013), a complicated challenge is one that has immeasurable and incompatible criteria or objectives, such as cost, performance, dependability, safety, efficiency, and affordability.

The multi-criteria decision analysis approach's main goals include assisting decision makers in organizing and synthesizing data that gives them the confidence and comfort they need to make a choice, minimizing the possibility of decision post-decision regret, and ensuring satisfaction when all criteria and factors are taken into account. Making a straightforward selection from a list of options is the most prevalent category of multi-criteria decision-making problems in the traditional framework of multi-criteria decision analysis, which is frequently discussed. An integrated multi-criteria decision analysis, however, cares to include both (Belton and Shewart, 2002). The majority of multi-criteria decision-making issues in the literature tend to customize either discrete selection or mathematical programming problems.

Numerous applications of multi-criteria decision making have proved effective. Different performance criteria and weights are taken into consideration in calculations using a variety of qualitative and quantitative data-gathering techniques. These are collectively known as multi-criteria decision-making approaches and include TOPSIS, Electre, Fuzzy TOPSIS, Ahp, Fuzzy Ahp, Factor Point Method, Anp, etc. (Więckowski et al., 2023).

The TOPSIS approach was developed by Hwang and Yoon (1981) on the assumption that the alternative solution point would be the shortest distance from the positive-ideal solution and the longest distance from the negative-ideal solution. The optimal alternative is the one that is the furthest away from the negative ideal solution and the closest to the positive ideal solution. The solution that optimizes the benefit criteria and reduces the expense criteria is considered to be the positive ideal solution. On the other side, the solution that optimizes the cost criterion while minimizing the benefit criteria is known as the negative ideal solution. The TOPSIS method's algorithm consists of the following six stages: (Hwang and Yoon, 1981; Parken and Wu, 1999; Wang and Elhag, 2005; Behzadian et al., 2012).

Step 1: Creating the Decision Matrix (A)

In the decision matrix, the rows contain the alternatives to be used in decision making, and the columns the criteria to be used for comparison. The matrix A shown below is the initial decision matrix created by the decision maker. In the Aij matrix; m forming the rows represents the number of decision points, n forming the columns represents the number of evaluation factors.

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & & & . \\ . & & & . \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \qquad (1)$$

Step 2: Creating the Standard Decision Matrix (r)

The standard decision matrix is obtained by the initial decision matrix (A) and the normalization formula shown below. The standard decision matrix (R) is shown in the figure below.

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^{m} a_{kj}^2}} \qquad A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ . & & & . \\ . & & & . \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix} \qquad (2)$$

Step 3: Creating the Weighted Standard Decision Matrix (w)

The matrix found by multiplying the weight values (wi) determined for the evaluation criteria with the standard decision matrix, is the weighted standard decision (w) matrix. The weighted standard decision matrix (w) found is shown in the figure below.

$$\sum_{i=1}^{n} w_i = 1 \qquad A_{ij} = \begin{bmatrix} w_1 r_{11} & w_2 r_{12} & \dots & w_n r_{1n} \\ w_1 r_{21} & w_2 r_{22} & \dots & w_n r_{2n} \\ . & & & . \\ . & & & . \\ w_1 r_{m1} & w_2 r_{m2} & \dots & w_n r_{mn} \end{bmatrix} \qquad (3)$$

Step 4: Creating the Positive Ideal (A+) and Negative Ideal (A-) Solution Sets

In order to create a positive ideal solution set, the largest of the weighted evaluation factors in the V matrix, that is, the column values (the smallest if the relevant evaluation factor is minimization-oriented) is selected. Finding the ideal solution set is shown in the formula below.

$$A^{+} = \{(max_i v_{ij} \mid j \in J), (min_i v_{ij} \mid j \in J)\} \qquad A^{+} = \{v_1^{+}, v_2^{+}, v_{13}^{+}, \dots, v_n^{+}\} \qquad (4)$$

The negative ideal solution set is formed by choosing the smallest of the weighted evaluation factors in the V matrix, that is, the column values (the largest if the relevant evaluation factor is in the maximization direction). Finding the negative ideal solution set is shown in the formula below.

$$A^{-} = \{(min_i v_{ij} \mid j \in J), (max_i v_{ij} \mid j \in J)\} \qquad A^{-} = \{v_1^{-}, v_2^{-}, v_{13}^{-}, \dots, v_n^{-}\} \qquad (5)$$

In the formulas shown above; If the criteria are beneficial, it shows J maximization in the positive ideal solution set and J' minimization in the negative ideal solution set. Likewise, if the criterion is cost-oriented, it characterizes J minimization in the positive ideal solution set and J' maximization in the negative ideal solution set. Both solution sets consist of m elements as much as the number of alternatives or evaluation factors.

Step 5: Calculation of Distance Between the Target Alternative

While evaluating the comparison criteria for each alternative, the distances from the positive and negative ideal solution set are calculated with the Euclidian distance approach. The deviation values of the obtained alternatives regarding the criteria are called the Positive Ideal Discrimination (Si+) and the Negative Ideal Discrimination (Si-) measure. The formula (6) is used when calculating the deviation values from the positive ideal solution set, and the formula (7) is used when calculating the deviation values from the negative ideal solution set. The number of calculated Si+ and Si- values will be equal to the number of alternatives.

$$S_i^{+} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{+})^2} \qquad (6) \qquad S_i^{-} = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^{-})^2} \qquad (7)$$

Step 6: Calculating the Relative Closeness to the Ideal Solution

While calculating the relative closeness (Ci+) of each alternative number to the ideal solution, positive and negative ideal separation measures are used. The share of the negative ideal discrimination measure in the total discrimination measure gives the closeness coefficient value. The formula showing the calculation of the closeness coefficient value is shown below. Ci* value shown in the formula is in the range of 0≤ Ci*≤1 and a Ci* value close to 1 indicates its closeness to the ideal solution, and close to 0 indicates its distance from the ideal solution.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*} \quad (8)$$

FINDINGS

Within the scope of the study, a helmet was preferred as a case study for the selection of personal protective equipment. The best-selling products until 31/07/2023 were filtered in the "Helmet" category on Trendyol and Hepsiburada websites. Care was taken to ensure that all of the helmets comply with the criteria specified in the standards and regulations. When products that are similar in both sites were removed, forty product advertisements were determined for analysis, and a working dataset was obtained.

Within the scope of the study, the scenario in which an occupational safety expert specifies a risk in the risk analysis for the use of helmets in the workplace where he is assigned and presents the senior management for immediate correction has been applied. The senior management would like to convey this task to the purchasing unit and present at least five different options to obtain approval for the purchase from the occupational safety specialist by determining the most suitable helmet on the online sales site in accordance with the features and standards specified by the occupational safety specialist. For this purpose, the purchasing specialist entered the Trendyol and Hepsiburada websites and listed the best-selling products in the helmet category. However, he saw that there were great differences in features such as price, liking, adding to favorites among the products. Not knowing which products to choose, the purchasing specialist decided to use the TOPSIS method to select the most suitable product in order to avoid any risk in terms of occupational safety. After filtering the products on the websites and reducing them to forty different helmet advertisements, he determined the decision matrices for the selection of the products. These; User Rating is Add to Favorite, Number of Comments, Price, Number of Comments/User Rating and Price/User Rating. For TOPSIS calculations, he applied the six steps mentioned in the above title in Excel and Python and arranged forty different helmets in order of preference. He determined the first five products determined in accordance with the decision matrices and presented them to the occupational safety specialist.

The application stages of the TOPSIS method, in which the alternatives are compared for the helmet selection preference, are calculated as follows.

Step 1: The Decision Matrix (A) consisting of helmet options and evaluation factors is given in Table 1.

Table 1: The Decision Matrix

Option	User Ratings	Adding to Favorites	Number of Comments	Price (TL)	Number of Comments / User Ratings	Price / User Ratings
1	5	52	30	560.00	6.00	112.00
2	5	53	32	193.90	6.40	38.78
3	4.9	2	41	525.00	8.37	107.14
4	4.9	149	24	529.00	4.90	107.96
5	4.9	119	16	54.90	3.27	11.20
6	4.9	95	12	43.25	2.45	8.83
7	4.9	23	21	279.88	4.29	57.12
8	4.8	1170	221	39.99	46.04	8.33
9	4.8	37	13	540.00	2.71	112.50
10	4.8	1305	255	629.00	53.13	131.04
11	4.8	304	53	649.00	11.04	135.21
12	4.8	219	28	689.00	5.83	143.54
13	4.8	165	12	100.00	2.50	20.83
14	4.8	61	16	90.55	3.33	18.86
15	4.8	52	36	169.00	7.50	35.21
16	4.7	473	83	47.50	17.66	10.11
17	4.7	65	10	318.90	2.13	67.85
18	4.6	216	264	59.90	57.39	13.02
19	4.6	67	16	94.05	3.48	20.45
20	4.6	112	12	180.00	2.61	39.13
21	4.5	388	57	635.00	12.67	141.11
22	4.5	58	43	119.90	9.56	26.64

23	4.5	121	64	56.82	14.22	12.63
24	4.4	313	1601	87.50	363.86	19.89
25	4.4	630	59	70.00	13.41	15.91
26	4.4	285	47	48.00	10.68	10.91
27	4.4	21	72	65.00	16.36	14.77
28	4.4	126	46	67.50	10.45	15.34
29	4.2	132	19	199.00	4.52	47.38
30	4.2	83	18	79.99	4.29	19.05
31	4.1	52	13	56.40	3.17	13.76
32	4.1	76	11	59.00	2.68	14.39
33	4.1	52	13	56.40	3.17	13.76
34	4	17	13	100.00	3.25	25.00
35	4	36	13	100.00	3.25	25.00
36	4	29	18	52.00	4.50	13.00
37	4	34	15	110.00	3.75	27.50
38	3.8	38	14	684.99	3.68	180.26
39	3.7	30	17	54.99	4.59	14.86
40	3.6	26	11	539.99	3.06	150.00

Step 2: The Standard Decision Matrix calculated with the help of the formula (2) from the decision matrix is shown in Table 2.

Table 2: Standard Decision Matrix

Option	User Ratings	Adding to Favorites	Number of Comments	Price (TL)	Number of Comments / User Ratings	Price / User Ratings
1	0.176	0.025	0.018	0.278	0.016	0.250
2	0.176	1.862	0.019	0.096	0.017	0.087
3	0.172	0.070	0.025	0.260	0.022	0.239
4	0.172	5.234	0.014	0.262	0.013	0.241
5	0.172	4.180	0.010	0.027	0.009	0.025
6	0.172	3.337	0.007	0.021	0.006	0.020
7	0.172	0.808	0.013	0.139	0.011	0.127
8	0.169	41.100	0.132	0.020	0.122	0.019
9	0.169	1.300	0.008	0.268	0.007	0.251
10	0.169	45.842	0.153	0.312	0.141	0.292
11	0.169	10.679	0.032	0.322	0.029	0.302
12	0.169	7.693	0.017	0.342	0.015	0.320
13	0.169	5.796	0.007	0.050	0.007	0.046
14	0.169	2.143	0.010	0.045	0.009	0.042
15	0.169	1.827	0.022	0.084	0.020	0.079
16	0.165	16.616	0.050	0.024	0.047	0.023
17	0.165	2.283	0.006	0.158	0.006	0.151
18	0.162	7.588	0.158	0.030	0.152	0.029
19	0.162	2.354	0.010	0.047	0.009	0.046
20	0.162	3.934	0.007	0.089	0.007	0.087
21	0.158	13.630	0.034	0.315	0.034	0.315
22	0.158	2.037	0.026	0.059	0.025	0.059
23	0.158	4.251	0.038	0.028	0.038	0.028
24	0.155	10.995	0.959	0.043	0.963	0.044
25	0.155	22.131	0.035	0.035	0.035	0.035
26	0.155	10.012	0.028	0.024	0.028	0.024
27	0.155	0.738	0.043	0.032	0.043	0.033
28	0.155	4.426	0.028	0.033	0.028	0.034
29	0.148	4.637	0.011	0.099	0.012	0.106
30	0.148	2.916	0.011	0.040	0.011	0.042
31	0.144	1.827	0.008	0.028	0.008	0.031
32	0.144	2.670	0.007	0.029	0.007	0.032
33	0.144	1.827	0.008	0.028	0.008	0.031
34	0.141	0.597	0.008	0.050	0.009	0.056
35	0.141	1.265	0.008	0.050	0.009	0.056
36	0.141	1.019	0.011	0.026	0.012	0.029
37	0.141	1.194	0.009	0.055	0.010	0.061
38	0.133	1.335	0.008	0.340	0.010	0.402
39	0.130	1.054	0.010	0.027	0.012	0.033
40	0.126	0.913	0.007	0.268	0.008	0.335

Step 3: While creating the Weighted Standard Decision Matrix like the example in Table 3, the weights were determined so that these criteria could be compared. In determining these, preferences such as the features specified by the occupational safety expert and the site features of the helmet products purchased by the users over the internet were taken into consideration.

Table 3: Weight Values of Evaluation Criteria

User Ratings	Adding to Favorites	Number of Comments	Price (TL)	Number of Comments / User Ratings	Price / User Ratings
0.3	0.1	0.2	0.2	0.1	0.1

Step 4: The standard decision matrix and the weighted standard decision matrix (V) calculated with the help of the formula (3) are presented in the Table 4.

Table 4: Weighted Standard Decision Matrix

Option	Decision Matrix						Si+	Si-	Ci
	0.3	0.1	0.2	0.2	0.1	0.1			
1	0.05269	0.00248	0.00359	0.05552	0.00159	0.02499	0.05846	4.58663	0.987415
2	0.05269	0.18618	0.00383	0.01922	0.00169	0.00865	0.18507	4.40346	0.959667
3	0.05164	0.00703	0.00491	0.05205	0.00221	0.02391	0.05498	4.58204	0.9881
4	0.05164	0.52341	0.00287	0.05245	0.00130	0.02409	0.52383	4.06638	0.8859
5	0.05164	0.41803	0.00192	0.00544	0.00086	0.00250	0.41577	4.17226	0.9094
6	0.05164	0.33372	0.00144	0.00429	0.00065	0.00197	0.33152	4.25650	0.9277
7	0.05164	0.08079	0.00251	0.02775	0.00113	0.01274	0.08371	4.50868	0.9818
8	0.05058	4.11000	0.02646	0.00396	0.01219	0.00186	4.10763	0.51468	0.1113
9	0.05058	0.12997	0.00156	0.05354	0.00072	0.02510	0.13933	4.45939	0.9697
10	0.05058	4.58423	0.03054	0.06236	0.01406	0.02924	4.58233	0.18140	0.0381
11	0.05058	1.06790	0.00635	0.06435	0.00292	0.03017	1.06759	3.52247	0.7674
12	0.05058	0.76931	0.00335	0.06831	0.00154	0.03203	0.77022	3.82075	0.8322
13	0.05058	0.57961	0.00144	0.00991	0.00066	0.00465	0.57731	4.01086	0.8742
14	0.05058	0.21428	0.00192	0.00898	0.00088	0.00421	0.21225	4.37566	0.9537
15	0.05058	0.18267	0.00431	0.01676	0.00199	0.00786	0.18121	4.40698	0.9605
16	0.04953	1.66156	0.00994	0.00471	0.00467	0.00225	1.65915	2.93068	0.6385
17	0.04953	0.22833	0.00120	0.03162	0.00056	0.01514	0.22822	4.36134	0.9503
18	0.04848	0.75877	0.03161	0.00594	0.01519	0.00291	0.75712	3.83036	0.8350
19	0.04848	0.23536	0.00192	0.00932	0.00092	0.00456	0.23319	4.35460	0.9492
20	0.04848	0.39344	0.00144	0.01785	0.00069	0.00873	0.39140	4.19662	0.9147
21	0.04742	1.36297	0.00683	0.06296	0.00335	0.03148	1.36214	3.22792	0.7032
22	0.04742	0.20374	0.00515	0.01189	0.00253	0.00594	0.20173	4.38596	0.9560
23	0.04742	0.42505	0.00766	0.00563	0.00376	0.00282	0.42274	4.16492	0.9079
24	0.04637	1.09951	0.19172	0.00868	0.09632	0.00444	1.11761	3.48542	0.7572
25	0.04637	2.21308	0.00707	0.00694	0.00355	0.00355	2.21062	2.38122	0.5186
26	0.04637	1.00115	0.00563	0.00476	0.00283	0.00243	0.99872	3.58989	0.7823
27	0.04637	0.07377	0.00862	0.00644	0.00433	0.00330	0.07232	4.51569	0.9842
28	0.04637	0.44262	0.00551	0.00669	0.00277	0.00342	0.44025	4.14748	0.9040
29	0.04426	0.46369	0.00228	0.01973	0.00120	0.01057	0.46161	4.12639	0.8994
30	0.04426	0.29156	0.00216	0.00793	0.00113	0.00425	0.28919	4.29848	0.9370
31	0.04321	0.18267	0.00156	0.00559	0.00084	0.00307	0.18027	4.40731	0.9607
32	0.04321	0.26697	0.00132	0.00585	0.00071	0.00321	0.26456	4.32313	0.9423
33	0.04321	0.18267	0.00156	0.00559	0.00084	0.00307	0.18027	4.40731	0.9607
34	0.04215	0.05972	0.00156	0.00991	0.00086	0.00558	0.05782	4.53003	0.9874
35	0.04215	0.12646	0.00156	0.00991	0.00086	0.00558	0.12425	4.46337	0.9729
36	0.04215	0.10187	0.00216	0.00516	0.00119	0.00290	0.09950	4.48798	0.9783
37	0.04215	0.11944	0.00180	0.01091	0.00099	0.00614	0.11732	4.47036	0.9744
38	0.04005	0.13349	0.00168	0.06791	0.00098	0.04022	0.15076	4.45583	0.9673
39	0.03899	0.10538	0.00204	0.00545	0.00122	0.00332	0.10294	4.48448	0.9776
40	0.03794	0.09133	0.00132	0.05354	0.00081	0.03347	0.10654	4.49799	0.9769

Step 5: Positive and negative ideal solution sets calculated with the help of formulas (4) and (5) are shown in Table 5.

Table 5: Weighted Standard Decision Matrix

Decision Matrix	0.3	0.1	0.2	0.2	0.1	0.1
Minimum	0.03794	0.00248	0.00120	0.00396	0.00056	0.00186
Maximum	0.05269	4.58423	0.19172	0.06831	0.09632	0.04022

Step 6: Separation measures calculated with the formulas (6) and (7) are shown in the table below. The closeness coefficients calculated with the help of the formula (8) are shown in Table 6.

The principle five preference ranking that should be made according to the proximity numbers and maximum benefit analysis; 3, 1, 34, 27, 7 were found.

Table 6: Weighted Standard Decision Matrix

Ranking of Preferences	Option	Ci
1	**3**	0.988142
2	**1**	0.987415
3	**34**	0.987397
4	**27**	0.984236
5	**7**	0.981772
6	36	0.978311
7	39	0.977561
8	40	0.976861
9	37	0.974428
10	35	0.972916
11	9	0.969703
12	38	0.967273
13	31	0.960704
14	33	0.960704
15	15	0.960505
16	2	0.959667
17	22	0.956028
18	14	0.953737
19	17	0.950274
20	19	0.949171
21	32	0.942333
22	30	0.936963
23	6	0.927742
24	20	0.91469
25	5	0.909379
26	23	0.907852
27	28	0.904037
28	29	0.899388
29	4	0.88588
30	13	0.874174
31	18	0.83496
32	12	0.832232
33	26	0.782348
34	11	0.767412
35	24	0.757202
36	21	0.703241
37	16	0.638516
38	25	0.518576
39	8	0.111347
40	10	0.03808

The TOPSIS steps used within the scope of the study were also converted into Python code in order to be more easily applicable for the readers. As can be seen in Figure 1, 6 different steps are coded one by one to the Python codes and their explanations are given next to them.

```
Xval=length(X(:,1));
Y = zeros([Xval,length(W)]);
%% calculating the normalized matrix
for j=1:length(W)
    for i=1:Xval
    Y(i,j)=X(i,j)/sqrt(sum((X(:,j).^2)));
    end
end
Normalized_Matrix = num2str([Y])
%% calculating the weighted mormalized matrix
for j=1:length(W)
    for i=1:Xval
        Yw(i,j)=Y(i,j).*W(j);
    end
end
Weighted_Normalized_Matrix = num2str([Yw])
%% calculating the positive and negative best

for j=1:length(W)
    if Wcriteria(1,j)== 0
        Vp(1,j)= min(Yw(:,j));
        Vn(1,j)= max(Yw(:,j));
    else
        Vp(1,j)= max(Yw(:,j));
        Vn(1,j)= min(Yw(:,j));
    end
end
 Positive_best = num2str([Vp])
 Negative_best = num2str([Vn])

%% Euclidean distance from Ideal Best and Worst
for j=1:length(W)
    for i=1:Xval
        Sp(i,j)=((Yw(i,j)-Vp(j)).^2);
        Sn(i,j)=((Yw(i,j)-Vn(j)).^2);
    end
end

for i=1:Xval
    Splus(i)=sqrt(sum(Sp(i,:)));
    Snegative(i)=sqrt(sum(Sn(i,:)));
end
%% calculating the performance score
P=zeros(Xval,1);
for i=1:Xval
    P(i)=Snegative(i)/(Splus(i)+Snegative(i));
end
Performance_Score =  num2str([P])
```

Figure 1: Python Codes for TOPSIS Method

CONCLUSION

Personal Protective Equipment (PPE) consists of vital equipment and accessories to protect workers from work accidents, injuries, occupational diseases and near misses. It is extremely important to investigate the use of PPE for employees who spend most of the day at work in their working life. The use of PPE protects the employee from work accidents, occupational diseases, injuries and near misses, and enables him to work in a healthier and safer way.

Increasing the importance of OHS and creating awareness of the use of PPE by employees are among the duties and responsibilities of the organization and the state. The employer is obliged to provide the employee with PPE suitable for the work organization and working environment free of charge, and the employee is obliged to use these PPE. The state is responsible for enacting laws and regulations on OHS and PPE and is under an obligation to supervise employers. For this reason, together with OHS, PPEs are also included in a triple responsibility framework. It is the responsibility of employers and business management to raise PPE awareness to employees.

This research guides the selection of personal protective equipment for other researchers who will progress in their field or similar subject, as well as the choice of all equipment to be purchased for occupational health and safety. In addition, the codes in this study can be used not only in this field, but also for the outcome of the hypotheses to be established on the basis of preference in daily life. In future studies, it can be aimed to expand the results by conducting surveys and statistical analyzes in order to conduct research on other types of personal protective equipment and to determine the decision matrix more clearly.

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