PressAcademia
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JBEF
ISSN 2146-7943

Journal of Business, Economics and Finance YEAR 2020 VOLUME 9 ISSUE 3

SECTOR ANALYSIS OF TURKISH MARKETS USING THE PROMETHEE METHOD

DOI: 10.17261/Pressacademia.2020.1296
JBEF- V.9-ISS.3-2020(1)-p.196-208

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Date Received: May 30, 2020 **Date Accepted:** August 4, 2020

To cite this document
Altin, H., (2020). Sector analysis of Turkish markets using the Promethee method. Journal of Business, Economics and Finance (JBEF), V.9(3), p.196-208.
Permanent link to this document: http://doi.org/10.17261/Pressacademia.2020.1296

ABSTRACT

Purpose- This study has two main objectives. The first is to describe the solutions possible with the PROMETHEE method. The second is related to an analysis of sector performance in Turkish markets.
Methodology- The PROMETHEE method was used in the study**.** PROMETHEE is one of the multi-criteria decision-making MCDM methods. The best-known methods are PROMETHEE I and PROMETHEE II.
Findings- According to the PROMETHEE II method, the best-performing sectors in 2014-2016 were Manufacturing, Transportation and Storage, Information and Communications, Electricity, Gas, Steam and Airconditioning Supply, Human Health and Social Work, Wholesale and Retail Trade, Construction, Accommodation, and Food, respectively.
Conclusion- While Manufacturing and Transportation, Storage and Information, and Communications ranked in the top tiers in sector performance as expected, the Construction sector did not perform well, contrary to our expectations.

Keywords: PROMETHEE I, PROMETHEE II, Multi-Criteria Decision-Making (MCDM), decision maker, sector analysis.
JEL Codes: C00, C02, G11

1. INTRODUCTION

PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) is one of the multi-criteria decision-making MCDM techniques. It is widely used to cope with the global problems that we are experiencing. The best-known methods are PROMETHEE I and PROMETHEE II. The basic assumption of the method is that the criteria sets are mutually independent of each other. However, with some decision-making problems, this assumption is generally violated because criteria have internal interactions with each other.

To apply these methods, preference information must be given to the decision maker. This can be given directly or indirectly. While direct preference information relates to the provision of absolute values of parameters by the decision maker, indirect preference information asks the decision maker to make comparisons relating to alternatives. Proposals provided by the PROMETHEE methods depend on the values given to the parameters being considered. Generally, different parameter groups enable different comparisons among the alternatives.

Sector analysis is the statistical analysis of the economic and financial situation of a sector in an economy. This involves calculating the difference between the actual value and the expected value. The result provides an opportunity for those interested in the economy to make an overview of the performance of companies in the sector. Investors will invest in the stocks of profitable companies among these sectors by identifying profitable sectors. Managers will make strategic decisions based on the results. Therefore, analysis of sector performance is extremely important. In addition, each sector in the economy has a relationship with the others. A potential inter-sectoral shock affects all sectors. This effect is experienced at the overall economy level.

According to the Central Bank, Turkey's economy is made up of 18 main sectors and 30 sub-sectors. In this study, the performance of the eight main interrelated market sectors in Turkey was investigated using PROMETHEE methods. The findings are included in the application section.

2. LITERATURE REVIEW

In their study, Brans et al. (1986) examined PROMETHEE as a new transition method in multi-criteria analysis. Basic features of the method include simplicity, precision, and determination. Each transition method includes the determination of certain parameters (threshold values). When small deviations arise concerning values, knowing their impact on their ranking is important for the decision maker. As the decision maker generally cannot determine the precise values correctly, this problem is significant. All the parameters to be defined have economic importance so the decision maker can easily correct them. Two methods are recommended: With both, it is possible to achieve a partial sequence (PROMETHEE I) or a complete sequence (PROMETHEE II) on a finite set of applicable actions.

In his study, Cavallaro (2005) examined an actual case in conformity with sustainable development targets using the PROMETHEE method. The process of planning and evaluating sustainable energy projects is complex because the decision-making process requires the analysis of different types of information. These include environmental, technical, economic, and social data. While some of these variables can be evaluated quite easily with numerical models, others, especially those relating to environmental impacts, can be decided upon only qualitatively. For this reason, in many cases, traditional evaluation methods such as cost-benefit analysis and fundamental economic and financial indicators cannot assess all the components in an environmentally valid energy project. The PROMETHEE method provides a flexible tool that can evaluate numerous variables being measured in different ways and bring them together.

In the study of Ballı and Karasulu (2007), the fuzzy PROMETHEE method was applied to automobile selection. Many of the economic, industrial, and financial decision-making problems have multi-criteria. In this type of problem, making the optimal selection among alternatives constitutes a difficult and complex process. In recent years, different methods have been developed to solve this type of problem. Among these, the most efficient and easiest is the PROMETHEE method, which deals with problems containing criteria that can be defined in real numbers. However, in real life, some criteria are defined in linguistic terms, so it is difficult to model them numerically. To overcome this deficiency, the fuzzy cluster approach is used. The PROMETHEE method, which has been expanded by using fuzzy inputs, was applied to the selection of seven different automobiles in the same class, using price, fuel, performance, and safety criteria. The results were found to be consistent and appropriate.

In his study, Dağdeviren (2008a) proposed an integrated approach to decision-making in equipment selection using the Analytic Hierarchy Process (AHP) and PROMETHEE method. A decision approach is provided for equipment selection problems. This selection problem is based on a comparison of equipment alternatives according to the determined criteria. AHP is used to assign weights to the criteria to be used in selection. PROMETHEE is used to determine the priorities of alternatives. In this way, weighting of the criteria considered in decision-making and evaluation of these criteria with preference functions can be achieved simultaneously.

In their study, Dağdeviren and Erarslan (2008b) examined the supplier selection process of an enterprise using the PROMETHEE method. Supplier selection using PROMETHEE has two major advantages over other sorting methods. The first is that a different preference function can be used for each factor being used in the evaluation of alternative suppliers. The second is that partial and complete sorting can be obtained in relation to the alternatives. With these advantages, the effectiveness of the supplier selection process has been increased in enterprises where the system is used.

In their study, Wang et al. (2008) examined the process of finding the best option among all possible alternatives for decision problems. Various approaches have been proposed to handle multi-criteria decision problems. PROMETHEE is one of the methods for multi-criteria problem analysis. This sorting method is quite simple when compared to other techniques. Furthermore, the PROMETHEE method eliminates the vulnerability of other traditional multi-criteria decision-making techniques that cannot process fuzzy data in the real decision-making environment. It can use fuzzy data in the decision-making process to eliminate the uncertainty and subjectivity of human judgment.

Halouani et al. (2009) examined project selection in their study. Project selection is a complex decision-making problem. It contains large amounts of data that can come both from qualitative and quantitative sources. For this reason, the development of appropriate decision-making methods would facilitate the project selection task. The recommended PROMETHEE approach provides an application area in a simpler and wider form, without compromising the advantageous features of multi-criteria methods for decision makers. Also, by adding new information types to the decision-making process, it reveals a more realistic selection process by considering the correctness of data. It helps the decision maker to reach an opinion about preference structure. While the method is explained with a numeric selection problem, it can be used in the solution of other decision problems.

Zhaoxu and Min (2010) examined the multi-criteria decision-making PROMETHEE method in their study. The PROMETHEE method is based on the relationship between alternative pairs. This transition method primarily compares alternative pairs relating to each criterion. The PROMETHEE method defines the preference function to establish preference differences among alternative pairs for each criterion. Hence, to define the preference alternative from the perspective of the decision maker, it creates preference functions in relation to numerical differences between alternative pairs. The value of these functions varies between 0 and 1. As the functional value increases, the preferential difference also increases. When the value is zero, there is no preferential difference between alternative pairs. On the other hand, when the value is one, it means that one of the alternatives leaves the other very much behind.

In their study, Athawale and Chakraborty (2010) examined establishment place selection using the PROMETHEE method. There can be long term repercussions from establishment place selection decisions and moving the locations of existing facilities can be expensive. For this reason, it is important to select the most appropriate location to minimize costs for a long period concerning a specific industrial application. Establishment place selection or facility place selection is a strategic problem that has a significant impact on the performance of manufacturing corporations. Use of the PROMETHEE II method in the solution of a place selection problem provides important information to the decision maker and is an appropriate tool for solving place selection decision problems. It enables the decision maker to rank the alternatives more efficiently and easily.

In their study, Yılmaz and Dağdeviren (2011) proposed a new approach considering the uncertainty of the decision-making process in equipment selection. Within this framework, two different methods, F-PROMETHEE and ZOGP, were explored, and then a combined approach was introduced. Alternative options and the criteria set were determined according to the opinions of the decision-making team. Use of fuzzy numbers as input data enabled the criteria and preferences determined during the decision-making process to be specified more realistically. The proposed approach showed how F-PROMETHEE results would be integrated into a ZOGP model. However, when compared, the results from the F-PROMETHEE method and the proposed approach did not reach the same conclusions.

In their study, Qu et al. (2011) examined investment values and the investment decision-making process with the PROMETHEE approach. The Range-PROMETHEE method was used to sort 20 shares randomly selected from the Stock Exchange. It was found that the first five shares provided higher earnings within an investment period of 17 months. Five performance criteria were used to measure the growth potential of companies. These criteria were composed of numbers based on real financial data. Empirical studies revealed the effectiveness of the PROMETHEE method concerning investment values and the decision-making process.

In their study, Chen et al. (2011) used a linguistic PROMETHEE method to create an investment portfolio considering both quantitative information in financial reports and qualitative information including expert opinions. Financial report data affect the short-term performance of stocks. Expert opinions may reflect the potential capacity of a stock and its future performance. The preference degree of one stock can be compared with that of another, according to the criteria. Hence, a rational investment portfolio can be determined. The linguistic PROMETHEE method is not only involved in the investment portfolio decision problem but can also be used for multi-criteria decision-making problems such as third-party logistic suppliers, R&D project selection, and information system selection.

Safari et al. (2012) applied the Entropy-based PROMETHEE method to supplier selection in their study. Weights of each criterion were calculated using the Entropy method. Supplier selection is a comparison that is made to determine suppliers with the highest potential to meet the requirements of a company continuously at an acceptable cost. Selection of the right suppliers significantly reduces purchasing costs and improves corporate competitiveness. For this reason, supplier selection is one of the most important decision-making problems. In this study, a new integrated method is proposed for supplier selection.

In the study of Bogdanovic et al. (2012), an integrated approach combining AHP and PROMETHEE was proposed to select the most appropriate method for underground mining. Selection of the best mining method among various alternatives is a multi-criterion decision-making problem. The relevant problem comprises five possible mining methods and eleven criteria used to evaluate them. AHP was used to analyze the structure of the mining method selection problem and to determine the weights of the criteria. The PROMETHEE method was used to obtain the final ranking and to conduct sensitivity analysis by changing the weights. The results showed that the proposed integrated method could be used successfully in solving mining engineering problems.

Avikal et al. (2013) examined the disassembly problem with the PROMETHEE method in their study. Disassembly is the process of dismantling products, reproduction, recycling, and destruction. It is necessary to design and balance dismantling lines so that they operate efficiently. The multipurpose disassembly line method searches for a disassembly process by providing a suitable disassembly sequence, minimizing the number of jobs and idle time, and considering the environmental effects of the disassembly line of the consumed product. In the study, an intuitive method based on a multi-criterion decision-making technique is proposed. The results revealed that a significant improvement was achieved in performance compared to other heuristic methods.

Corrente et al. (2014) suggested that PROMETHEE methods and Stochastic Multiobjective Acceptability Analysis - SMAA - could be used to cope with various global problems. Integration of SMAA and PROMETHEE enables proposals to be obtained in conformity with the preference information provided by the decision maker. In the proposed methodology, the PROMETHEE method allows for the selection of preference parameters to be evaluated effectively. Thus, possible rows are obtained that give the best position to an alternative. This reveals that the method can cope with various complex world problems.

In the study of Veza et al. (2015), an approach was provided for enterprises to be compared and sorted according to their competencies. Enterprises were evaluated with the PROMETHEE method by considering the assets they owned. Economic and sociological criteria can also be added to the PROMETHEE method. All the data for the study were collected using specially designed questionnaires. Experts were interviewed to determine the criteria weights. Hence, a transparent procedure was obtained for the comparison and sorting of enterprises. However, the decision-making process can be affected by the weights of criteria. For this reason, the determination of criteria weight should also constitute a transparent process. Uncertain criteria weights should be avoided.

Mikaeil et al. (2015) predicted the cuttability of size stone at a stone factory using the PROMETHEE method. Prediction of the cuttability of stone constitutes one of the most important factors in production planning. This factor is used as an important criterion in the cost predictions and planning of stone facilities. The results revealed that the PROMETHEE method can be used to evaluate the testability of size stone in any stone factory.

In the study of Sungur and Maden (2016), the manufacturing industry was sorted using the PROMETHEE method. To successfully achieve regional development, it is necessary to determine sectoral superiorities and the sectoral concentrations of regions correctly. Sorting of sectors in the region according to specific superiority criteria is extremely important in making effective decisions regarding regional policies. Furthermore, separate evaluations were made for each criterion and partial superiorities were sorted.

In the study of Brans and De Smet (2016), the PROMETHEE-GAIA method was proposed for multi-criteria decision alternatives. The information required by PROMETHEE and GAIA is transparent and simple for both decision makers and analysts. The method begins with general remarks about multi-criteria problems and emphasizes that a multi-criterion problem cannot be evaluated without additional information regarding the preferences and priorities of decision makers. A preference function is created relating to each scale. Weights explaining the relative importance of each decision criterion are used in this process. The method enables interpretations to be made about potential sorting events.

Vulević and Dragović (2017) created sub-watershed sorting values with the PROMETHEE multi-criteria decision analysis method. In managed environments, soil and water resources are important elements in reducing the rate of erosion and the destructive effects of floods. The criteria used are land cover, precipitation, soil erosion, and topography. The importance of criteria was determined using the Analytic Hierarchy Process method. Results obtained from the PROMETHEE II method and the ArcGIS application provide valuable information regarding watershed management and the implementation of soil erosion and flood control measures.

In their study, Gul et al. (2018) proposed a fuzzy PROMETHEE method based on two different preference functions to solve material selection problems. Recent developments in the automotive industry have made consideration of material design and selection especially important. Selecting the right material can facilitate the protection of resources and ensure effective cost management. When selecting material or replacing existing material with something that performs better, decision makers generally use trial and error. They do this based on their experience of factors that caused time loss and significant cost increases. For this reason, having the appropriate model for material selection is particularly important. Material selection problems with contradictory criteria can be solved using multi-criteria decision-making methods because these techniques are used to resolve conflicting opinions with multi-criteria.

3. DATA AND METHODOLOGY

This study has two important purposes. The first is to demonstrate the effectiveness of the PROMETHEE method. The second is related to an analysis of sectoral performance in Turkish markets using the PROMETHEE method.

Eight sectors subject to evaluation in Table 1 are numbered A1-A8. These sectors are Manufacturing, Electricity, Gas, Steam and Air Conditioning Supply, Construction, Wholesale and Retail Trade and Repair of Motor Vehicles and Motorcycles, Transportation and Storage, Accommodation and Food Service Activities, Information and Communications, and Human Health and Social Work Activities, respectively. For each sector, Liquidity Ratios, Ratios of Financial Position, Turnover Ratios, and Profitability Ratios were examined and relevant evaluation criteria were determined. Evaluation criteria are respectively given as Current Ratio (%), Own Funds / Total Assets (%), Inventory Turnover (times), and Net Profit / Own Funds (%) in the range of C1-C4 in Table 1.

In the literature, various methods are proposed for determining weight degrees (degrees of importance) relating to criteria. Among these, the AHP, CRITIC, and ENTROPY methods are widely used. On the other hand, intuitive approaches can also be used in determining the weights of criteria.

The PROMETHEE method does not explain the selection of criteria weights. In the study, the weight degrees of criteria were determined to be equal. Furthermore, q and p values were determined at the minimum and maximum levels by examining the distribution of data. The data used in the study were obtained from TCMB Company Accounts (2014-2016), Statistics Department, Real Sector Data Division.

3.1. PROMETHEE METHOD

The study of Dağdeviren (2008, p.399-401) was used for mathematical illustration of the PROMETHEE method that was developed by J. P. Brans et al. in 1986.

$$\max\left\{ f_1(a), f_2(a), ..., f_n(a) I a \in A \right\}, \quad (1)$$

Here, A is a finite set of possible alternatives and fj denotes n criteria to be maximized. For each alternative, fj (a) is an evaluation of this alternative. When we compare two alternatives, a and b ∈ A, we should be able to express the results of these comparisons in terms of preference.

For this reason, P is a preference function. Preference function transforms the difference between evaluations of two alternatives (a and b) into a preference degree between 0 and 1 with respect to a specific criterion.

$$P_{j(a,b)} = G_j\left[f_j(a) - f_j(b) \right], \quad (2)$$

$$0 \leq P_{j(a,b)} \leq 1, \quad (3)$$

Let fj (i) be the preference function relating to criteria. Here, Gj is a non-decreasing function of the deviation (d) observed between fj (a) and fj (b).

To facilitate selection of the private preference function, six fundamental types of this preference function are proposed to the decision maker. These are ordinary function, U-shape function, V-shape function, level function, linear function, and Gauss function. In each case, it is not necessary to fix more than two parameters (threshold, q, p, or s). Indifference threshold q: is the biggest deviation that will be ignored in this criterion. It is a small value according to the measurement scale. Preference threshold p: is the smallest deviation to be considered decisive in the choice of one alternative over another. It is a great value according to the measurement scale. Gauss threshold s is only used with the Gauss preference function. It is usually fixed as an intermediate value between indifference and preference threshold.

In the PROMETHEE method, the calculations below are made for a and b alternatives.

$$\pi(a,b) = \frac{\sum_{j=1}^{n} w_j \, P_j(a,b)}{\sum_{j=1}^{n} w_j} \quad (4)$$

$$\phi^{+}(a)=\sum_{x\in A}\pi(x,a), \quad (5)$$

$$\phi^{-}(a)=\sum_{x\in A}\pi(a,x), \quad (6)$$

$$\phi(a)=\phi^{+}(a)-\phi^{-}(a). \quad (7)$$

For each alternative, π (a, b) is a general preference index belonging to set A of alternatives. ϕ+ (a) denotes positive superiority flow and ϕ- (a) denotes negative superiority flow. ϕ (a) is the net flow value.

Three main PROMETHEE methods can be used to analyze evaluation problems, namely: (1) PROMETHEE I partial sorting, (2) PROMETHEE II complete sorting, and (3) Geometrical Analytic for Interactive Aid (GAIA) analysis.

PROMETHEE II provides full sorting of alternatives from the best to the worst. Here, net flow (ϕ) is used to sort the alternatives. It is assumed that the alternative having higher net flow is superior. As PROMETHEE I does not provide full sorting, it cannot be compared to the sorting provided with PROMETHEE II.

4. FINDINGS AND DISCUSSION

In the study, PROMETHEE I and PROMETHEE II methods were used. Solutions in the PROMETHEE II method comprise seven steps. For this purpose, the study of Sündüs and Yıldırım (2018, p.187-192) was used.

Step 1. Alternatives of the Decision Maker and Determination of Criterion Weights

PROMETHEE solution processes were calculated according to the data in Table 1. In the table, alternatives of the decision maker and criterion weights are presented.

Table 1: Data Set Relating to Sector Performance

1	**A**		**B**	**C**	**D**	**E**	**F**
2			W	0.25	0.25	0.25	0.25
3	**ALTERNATIVES**	**FIRM NUMBER**		**C1**	**C2**	**C3**	**C4**
4	Manufacturing	3057	A1	145.28	35.67	2.97	11.76
5	Electricity, Gas, Steam	319	A2	108.58	33.64	12.61	0.27
6	Construction	945	A3	144.60	23.12	0.97	5.84
7	Wholesale and Retail Trade	2387	A4	133.47	28.16	4.82	4.87
8	Transportation and Storage	343	A5	125.43	43.78	13.82	0.70
9	Accommodation and Food	551	A6	103.19	28.20	3.52	-10.27
10	Information and Communications	95	A7	184.19	58.23	10.28	1.16
11	Human Health and Social Work	151	A8	113.63	29.77	9.82	1.35

Step 2. Determination of Preference Functions

Since the data used are quantitative, the fifth function preference function (linear) and the third type preference function (V type) are used. In addition, preference function parameter q and p values are determined.

Table 2: Preference Function and Extended Data Set

1	A	B	C	D	E	F
2			0.25	0.25	0.25	0.25
3	Alternatives		C1	C2	C3	C4
4	Manufacturing	A1	145.28	35.67	2.97	11.76
5	Electricity, Gas, Steam	A2	108.58	33.64	12.61	0.27
6	Construction	A3	144.60	23.12	0.97	5.84
7	Wholesale and Retail Trade	A4	133.47	28.16	4.82	4.87
8	Transportation and Storage	A5	125.43	43.78	13.82	0.70
9	Accommodation and Food	A6	103.19	28.20	3.52	-10.27
10	Information and Communications	A7	184.19	58.23	10.28	1.16
11	Human Health and Social Work	A8	113.63	29.77	9.82	1.35
12		q	103.19	23.12	0.97	-10.27
13		p	184.19	58.23	13.82	11.76

Step 3. Determination of Common Preference Functions and Preference Indices

The common preference functions related to C1 criteria and the results of determining the preference indices are shown in Table 3 and Table 4.

Table 3: Obtaining D(Ai,Aj) Values as per C1 Criterion

G	H	I	J	K	L	M	N	O	P
3	**C1**	1	2	3	4	5	6	7	8
4	$D(A_i,A_j)$	A1	A2	A3	A4	A5	A6	A7	A8
5	A1	0.00	36.70	0.68	11.81	19.85	42.09	-38.91	31.65
6	A2	-36.70	0.00	-36.02	-24.89	-16.85	5.39	-75.61	-5.05
7	A3	-0.68	36.02	0.00	11.13	19.17	41.41	-39.59	30.97
8	A4	-11.81	24.89	-11.13	0.00	8.04	30.28	-50.72	19.84
9	A5	-19.85	16.85	-19.17	-8.04	0.00	22.24	-58.76	11.80
10	A6	-42.09	-5.39	-41.41	-30.28	-22.24	0.00	-81.00	-10.44
11	A7	38.91	75.61	39.59	50.72	58.76	81.00	0.00	70.56
12	A8	-31.65	5.05	-30.97	-19.84	-11.80	10.44	-70.56	0.00

For this calculation, in I5 cell; =$C4-INDEX($C$4:$C$11;I$3;1) formula has been written.

Table 4: Obtaining Pj(Ai,Aj) values as per C1 Criterion

G	H	I	J	K	L	M	N	O	P
17	**C1**	1	2	3	4	5	6	7	8
18	$P_j(A_i,A_j)$	A1	A2	A3	A4	A5	A6	A7	A8
19	A1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	A2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	A3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

22	A4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	A5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	A6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	A7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
26	A8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For this calculation, in I19 cell; =IF(I5<=$C$12;0;IF(AND($C$12<I5;I5<=$C$13);((I5-$C$12)/($C$13-$C$12));1)) formula has been written.

The common preference functions related to the C2 criterion and the results of determining the preference indices are shown in Table 5 and Table 6.

Table 5: Obtaining D(Ai,Aj) Values as per C2 Criterion

Q	R	S	T	U	V	W	X	Y	Z
3	**C2**	1	2	3	4	5	6	7	8
4	$D(A_i,A_j)$	A1	A2	A3	A4	A5	A6	A7	A8
5	A1	0.00	2.03	12.55	7.51	-8.11	7.47	-22.56	5.90
6	A2	-2.03	0.00	10.52	5.48	-10.14	5.43	-24.59	3.87
7	A3	-12.55	-10.52	0.00	-5.04	-20.66	-5.08	-35.11	-6.65
8	A4	-7.51	-5.48	5.04	0.00	-15.62	-0.04	-30.07	-1.61
9	A5	8.11	10.14	20.66	15.62	0.00	15.58	-14.45	14.01
10	A6	-7.47	-5.43	5.08	0.04	-15.58	0.00	-30.03	-1.57
11	A7	22.56	24.59	35.11	30.07	14.45	30.03	0.00	28.46
12	A8	-5.90	-3.87	6.65	1.61	-14.01	1.57	-28.46	0.00

For this calculation, in S5 cell; =$D4-INDEX($D$4:$D$11;S$3;1) formula has been written.

Table 6: Obtaining Pj(Ai,Aj) Values as per C2 Criterion

Q	R	S	T	U	V	W	X	Y	Z
17	**C2**	1	2	3	4	5	6	7	8
18	$P_j(A_i,A_j)$	A1	A2	A3	A4	A5	A6	A7	A8
19	A1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	A2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	A3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	A4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	A5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	A6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	A7	0.00	0.04	0.34	0.20	0.00	0.20	0.00	0.15
26	A8	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

For this calculation, in S19 cell, =IF(S5<=$D$12;0;IF(AND($D$12<S5;S5<=$D$13);((S5-$D$12)/($D$13-$D$12));1)) formula has been written.

The common preference functions related to the C3 criteria and the results of determining the preference indices are shown in Table 7 and Table 8.

Table 7: Obtaining D(Ai,Aj) Values as per C3 Criterion

AA	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**	**AJ**
3	**C3**	1	2	3	4	5	6	7	8
4	$D(A_i,A_J)$	A1	A2	A3	A4	A5	A6	A7	A8
5	A1	0.00	-9.64	2.00	-1.85	-10.85	-0.55	-7.31	-6.85
6	A2	9.64	0.00	11.64	7.79	-1.21	9.10	2.33	2.79
7	A3	-2.00	-11.64	0.00	-3.85	-12.85	-2.55	-9.31	-8.85
8	A4	1.85	-7.79	3.85	0.00	-9.00	1.31	-5.46	-5.00
9	A5	10.85	1.21	12.85	9.00	0.00	10.31	3.54	4.00
10	A6	0.55	-9.10	2.55	-1.31	-10.31	0.00	-6.76	-6.30
11	A7	7.31	-2.33	9.31	5.46	-3.54	6.76	0.00	0.46
12	A8	6.85	-2.79	8.85	5.00	-4.00	6.30	-0.46	0.00

For this calculation, in AC5 cell, =$E4-INDEX($E$4:$E$11;AC$3;1) formula has been written.

Table 8: Obtaining Pj(Ai,Aj) Values as per C3 Criterion

AA	**AB**	**AC**	**AD**	**AE**	**AF**	**AG**	**AH**	**AI**	**AJ**
17	**C3**	1	2	3	4	5	6	7	8
18	$P_j(A_i,A_j)$	A1	A2	A3	A4	A5	A6	A7	A8
19	A1	0.00	0.00	0.08	0.00	0.00	0.00	0.00	0.00
20	A2	0.67	0.00	0.83	0.53	0.00	0.63	0.11	0.14
21	A3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	A4	0.07	0.00	0.22	0.00	0.00	0.03	0.00	0.00
23	A5	0.77	0.02	0.92	0.62	0.00	0.73	0.20	0.24
24	A6	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00
25	A7	0.49	0.00	0.65	0.35	0.00	0.45	0.00	0.00
26	A8	0.46	0.00	0.61	0.31	0.00	0.42	0.00	0.00

For this calculation, in AC19 cell, =IF(AC5<=$E$12;0;IF(AND($E$12<AC5;AC5<=$E$13);((AC5-$E$12)/($E$13-$E$12));1)) formula has been written.

The common preference functions related to the C4 criterion and the results of determining the preference indices are shown in Table 9 and Table 10.

Table 9: Obtaining D(Ai,Aj) Values as per C4 Criterion

AK	**AL**	**AM**	**AN**	**AO**	**AP**	**AQ**	**AR**	**AS**	**AT**
3	**C4**	1	2	3	4	5	6	7	8
4	$D(A_i,A_j)$	A1	A2	A3	A4	A5	A6	A7	A8
5	A1	0.00	11.49	5.92	6.90	11.07	22.03	10.60	10.41
6	A2	-11.49	0.00	-5.57	-4.59	-0.42	10.54	-0.89	-1.08

7	A3	-5.92	5.57	0.00	0.98	5.14	16.11	4.68	4.49
8	A4	-6.90	4.59	-0.98	0.00	4.17	15.14	3.71	3.52
9	A5	-11.07	0.42	-5.14	-4.17	0.00	10.97	-0.46	-0.65
10	A6	-22.03	-10.54	-16.11	-15.14	-10.97	0.00	-11.43	-11.62
11	A7	-10.60	0.89	-4.68	-3.71	0.46	11.43	0.00	-0.19
12	A8	-10.41	1.08	-4.49	-3.52	0.65	11.62	0.19	0.00

For this calculation, in AM5 cell, =$F4-INDEX($F$4:$F$11;AM$3;1) formula has been written.

Table 10: Obtaining Pj(Ai,Aj) Values as per C4 Criterion

AK	**AL**	**AM**	**AN**	**AO**	**AP**	**AQ**	**AR**	**AS**	**AT**
17	**C4**	1	2	3	4	5	6	7	8
18	$P_j(A_i.A_j)$	A1	A2	A3	A4	A5	A6	A7	A8
19	A1	0.47	0.99	0.73	0.78	0.97	1.00	0.95	0.94
20	A2	0.00	0.47	0.21	0.26	0.45	0.94	0.43	0.42
21	A3	0.20	0.72	0.47	0.51	0.70	1.00	0.68	0.67
22	A4	0.15	0.67	0.42	0.47	0.66	1.00	0.63	0.63
23	A5	0.00	0.49	0.23	0.28	0.47	0.96	0.45	0.44
24	A6	0.00	0.00	0.00	0.00	0.00	0.47	0.00	0.00
25	A7	0.00	0.51	0.25	0.30	0.49	0.98	0.47	0.46
26	A8	0.00	0.52	0.26	0.31	0.50	0.99	0.47	0.47

For this calculation, in AM19 cell, =IF (AM5<=$F$12;0; IF (AND($F$12<AM5; AM5<=$F$13);((AM5 $F$12)/($F$13-$F$12));1)) formula has been written.

Step 4. Calculation of Values of Positive and Negative Superiorities

Positive superiority ø + (a) and negative superiority ø- (a) values have been calculated using equality (5) and equality (6).

Table 11: Positive and Negative Superiorities

30	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**
31	CT	1	2	3	4	5	6	7	8		
32	$P_j(A_i.A_j)$	A1	A2	A3	A4	A5	A6	A7	A8	ø+	Rank
33	A1	0.12	0.25	0.20	0.19	0.24	0.25	0.24	0.23	0.25	1
34	A2	0.17	0.12	0.26	0.20	0.11	0.39	0.13	0.14	0.22	4
35	A3	0.05	0.18	0.12	0.13	0.17	0.25	0.17	0.17	0.18	7
36	A4	0.06	0.17	0.16	0.12	0.16	0.26	0.16	0.16	0.18	6
37	A5	0.19	0.13	0.29	0.23	0.12	0.42	0.16	0.17	0.24	2
38	A6	0.00	0.00	0.03	0.00	0.00	0.12	0.00	0.00	0.02	8
39	A7	0.12	0.14	0.31	0.21	0.12	0.41	0.12	0.15	0.23	3
40	A8	0.11	0.13	0.22	0.16	0.12	0.35	0.12	0.12	0.19	5
41	ø-	0.12	0.16	0.23	0.18	0.15	0.35	0.16	0.16		
42	Rank	1	4	7	6	2	8	3	5		

For this calculation, in B33 cell, =I19*$C$2+S19*$D$2+AC19*$E$2+AM19*$F$2 formula has been written.

For this calculation, in J33 cell, =SUM(B33:I33)/(8-1) formula has been written.

For this calculation, in B41 cell, =SUM(B33:B40)/(8-1) formula has been written.

For ranking as per the positive and negative superiorities, in K33 cell, =RANK(J33;$J$33:$J$40;0) formula has been written.

In B42 cell, =RANK(B41;$B$41:$I$41;1) formula has been written.

Step 5. Obtaining PROMETHEE I Partial Rankings

For this purpose, the negative superiorities obtained from Step 4 are listed from small to large and positive superiorities from large to small. Table 12 shows these calculations.

Table 12: PROMETHEE I Partial Rankings

PROMETHEE I				
	Rank	**$ø^-$**	**Rank**	**$ø^+$**
A1	0.12	1	0.25	1
A2	0.16	4	0.22	4
A3	0.23	7	0.18	7
A4	0.18	6	0.18	6
A5	0.15	2	0.24	2
A6	0.35	8	0.02	8
A7	0.16	3	0.23	3
A8	0.16	5	0.19	5

Step 6. Calculation of Net Priority Value

ønet value must be calculated for the obtained rankings to be expressed with a single number. For this, equation (7) is used.

Step 7. Obtaining PROMETHEE II Full Ranking

The ranking made according to the net values obtained using the equation (7) shows the results of the PROMETHEE II analysis. Table 13 shows the exact sorting values obtained by the PROMETHEE II method.

Table 13: PROMETHEE II Full Ranking

PROMETHEE II		
	Rank	$ø^{net}$
Manufacturing	1	0.13
Transportation and Storage	2	0.09
Information and Communications	3	0.07
Electricity, Gas, Steam	4	0.06
Human Health and Social Work	5	0.03
Wholesale and Retail Trade	6	0.00
Construction	7	-0.05
Accommodation and Food	8	-0.33

According to the PROMETHEE II method, the sectors showing the best performance in 2014-2016 in Turkish markets were Manufacturing, Transportation and Storage, Information and Communications, Electricity, Gas, Steam, Human Health and Social Work, Wholesale and Retail Trade, Construction, and Accommodation and Food, respectively.

While it was anticipated that Manufacturing, Transportation and Storage, and Information and Communications would perform well, that the Construction sector performed poorly was contrary to our sectoral expectations.

5. CONCLUSION

This study has two main objectives. The first is to describe the solutions possible with the PROMETHEE method. The second involves an analysis of sectoral performance in Turkish markets using the PROMETHEE method.

Solutions using the PROMETHEE method comprise seven steps. These are Alternative Decision Maker and Criterion Weights, Determination of Preference Functions, Determination of Common Preference Functions and Preference Indices, Calculation of Positive and Negative Advantages, Calculation of PROMETHEE I Partial Rankings, Calculation of Net Priority Values, and Obtaining PROMETHEE II Full Ranking, respectively.

According to the PROMETHEE II method, the sectors revealing the best performance in the years 2014-2016 in Turkish markets were Manufacturing, Transportation and Storage, Information and Communications, Electricity, Gas, Steam and Airconditioning Supply, Human Health and Social Work, Wholesale and Retail Trade, Construction, and Accommodation and Food, respectively.

While Manufacturing, Transportation and Storage, and Information and Communications ranked in the first tiers of sectoral performance as expected, that the Construction sector showed poor performance was contrary to our expectations.

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