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Research Article

Evaluation Of The Performance Of Companies Operating In The Pharmaceutical Sector For Reverse Logistics Applications With TOPSIS and MOORA Methods

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Drug Industry, TOPSIS, Reverse Logistics, MOORA

ABSTRACT

Reverse logistics activities, which are the process of taking products back to the supply chain point for disposal and recycling are quite expensive and complex. While the importance of reverse logistics varies according to its sector and its economic contribution, it has reached an important size in the world in recent years. In the pharmaceutical sector, which has a continuously developing economy, the successful continuation of reverse logistics applications is important both economically and in terms of customers. In this study, performance evaluation was performed by 6 pharmaceutical companies operating in Turkey. 8 criteria have been determined in line with the indicators obtained in the literature survey for drug company evaluation. It was analyzed by TOPSIS and MOORA methods, two of the most critical decision making techniques in the evaluation. In this evaluation, it was examined how the companies in the pharmaceutical sector perform in reverse logistics. The study was applied in line with the opinions of 5 experts from the Turkish pharmaceutical and medical device institution and performance ratings of the companies were made according to the results found.

İlaç Sektöründe Ters Lojistik Uygulamaları İçin Faaliyet Gösteren İşletmelerin Performanslarının TOPSIS ve MOORA Yöntemileri İle Değerlendirilmesi

Anahtar Sözcükler :

İlaç sektörü, TOPSIS, Tersine Lojistik, MOORA

ÖZ

İmha ve geri dönüşüm amacıyla ürünlerin geri dönmesi gereken tedarik zinciri noktasına götürülme süreci olan tersine lojistikte faaliyetler oldukça kapsamlı ve karmaşıktır. Tersine lojistiğin önemi sektörüne ve ekonomik katkısına göre değişim gösterirken, son yıllarda dünyada oldukça önemli bir büyüklüğe erişmiştir. Sürekli gelişen bir ekonomiye sahip olan ilaç sektöründe tersine lojistik uygulamalarının başarıyla sürdürülmesi hem ekonomik açıdan hem de müşteri açısından önemlidir. Bu çalışmada Türkiye'de faaliyet gösteren 6 ilaç firmasının performans değerlendirmesi yapılmıştır. İlaç firması değerlendirmesine yönelik literatür taramasında elde edilen göstergeler doğrultusunda 8 kriter belirlenmiştir. Değerlendirmede Çok Kriterli Karar Verme tekniklerinden biri olan TOPSİS ve MOORA yöntemi ile analiz edilmiştir. Bu değerlendirmede, ilaç sektöründe ki firmaların tersine lojistikte nasıl bir performans gösterdiği incelenmektedir. Çalışma Türkiye İlaç ve Tıbbı cihaz Kurumundan 5 ayrı uzman görüşleri doğrultusunda uygulanmış ve bulunan sonuçlara göre şirketlerin performans derecelendirmeleri yapılmıştır.

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1. Introduction

With the development of technology in recent years, the increasing understanding of competitive management has made it compulsory to consider the environmental problems and problems of consuming natural resources while managing production activities. Although environmental protection is protected by legal regulations, environmental service understanding is often perceived as an extra-cost element. However, thanks to it's successful reverse logistics activities, companies fulfill their responsibilities towards the environment and provide competitive advantage in compliance with customer-oriented working principles. In addition, in the global competition environment, companies realized the cost advantages of reverse logistics applications, product returns, less use of resources and the advantages obtained from recycling, especially the electronic component producing sectors, and all sectors began to gain widespread. While maximizing the benefits provided by the developing technology, the desire to develop environmentally focused production and supply system has gained importance. Reverse logistics is one of the important activities in the management of returns, and reverse logistics activities and return products can be disposed of safely from the environment. Manufacturers are aware of the fact that logistics is the most important and strategic activity for this cycle, while directing the product's movements from producer to customer and from customer to producer through a Closed Cycle Supply Chain. By returning the products from the customer to the manufacturer, the use of the entire product or part of its components will reduce costs.

Reverse logistics will increase the competitive power of the market because the company will provide more confidence to the customer. Since contact with customer continues, many feedbacks on the product can be received accordingly, product design research, development etc. processes can be revised. In particular, the energy and advantages to be obtained by recycling the packaging materials belonging to the products and the damage to the environment can be minimized. Selection of reusable materials will important when designing the product. The progress of sectors related to this can also be considered as a separate advantage.

The pharmaceutical sector is one of the leading sectors that continues to develop and grow and supports economic development. Although R & D costs are quite high, the resulting products are protected by patents and all activities related to drug production are controlled by government regulations. Competition in the pharmaceutical market is very intense and new products to be developed can bring companies to higher levels in this market. The pharmaceutical supply chain needs to be examined specifically because the products are of the same type. Main actors are producers, pharmaceutical wholesalers, retailers (pharmacies), customers (hospital or patients) in the pharmaceutical supply process. Production in the pharmaceutical industry is usually managed by demand. Manufacturers rarely deliver products to pharmacies or patients, instead they deliver their products to consumers via wholesalers (pharmaceutical wholesalers). In this stage, the responsibility for extermination belongs to the pharmacies. However, within the legal return period, products that cannot be sold in pharmacies are sent to pharmaceutical wholesalers, and products that cannot be sold until they are filled in pharmaceutical wholesalers are returned to the manufacturer. Manufacturers send their returned products back

to disposal companies and bear all the costs incurred in this process. The management of returned products is a critical part of the logistics activities. In some cases, the ministry may make decisions such as stopping drug use, withdrawal from the market, and in this case the products those are decided to be collected are collected by the producer company and the manufacturer takes over the extermination processes. It is clear that the reverse logistics activities of the drug tracking system contribute to monitoring. Thanks to the QR code printed on pharmaceutical packages during the production process, all information from which stage the drug is in throughout the supply chain to the latest customer information can be observed by the Ministry of Health. This prevents forgery (Candan, 2018).

The assessment at the firm level is important for managers as well as for investors. As a result of the performance analysis, managers who are in decision-making position in enterprises will be able to make plans in an even more conscious way in the effective use of related resources and increasing efficiency in general. Investors will be more rational and conscious about their investment decisions and their portfolio in the light of the analysis and evaluations made.

With the globalization process, competition and uncertainty are among the factors which affect business activities most. Decision making is briefly defined as the process of choice among alternatives. In today's decision-making process, the excess of alternatives and the fact that the criteria which effects the decision will be taken both to make the decision complicated. Under these circumstances, it is recommended to use multi-criteria decision making techniques instead of traditional techniques in the process.

If there are multiple criteria and objectives in a decision-making problem, such a decision-making problem can be solved through multi-criteria methods. Performance appraisal of companies requires a very critical decision. In this study, performance evaluation of companies was performed with TOPSIS and MOORA methods which are two of the most critical decision making methods. In this study, the ratios obtained from six pharmaceutical companies are used as the criteria for performance analysis. Each of six pharmaceutical companies are superior to each other in terms of different performance indicators. However, in order to make a holistic assessment, TOPSIS and MOORA methods were used in multi-criteria decision making process. TOPSIS and Moora methods which have been preferred since all the criteria which are essential for valuation can be evaluated together. The most important factor in the use of these methods in the selection process is the evaluation of multiple quantitative and qualitative criteria. The problems appear to be complex in these two methods are shown in the form of formulations within the structure.

As an alternative, the decision-making problem to be modelled is examined as a ÇKKV (Multı-Crıterıa Decısıon Makıng Methods) problem. For this purpose, the performance of pharmaceutical companies in the pharmaceutical industry was modelled as a ÇKKV problem and analyzed with TOPSIS and Moora methods. In this study, performance criteria for pharmaceutical companies were examined and decision model was analyzed according to the criteria set and weights determined from the literature survey and the results obtained were evaluated comparatively.

2. An Overview of the Pharmaceutical Sector in the World and Turkey

The sector also keeps the change process coming with Industry 4.0 on its agenda. Pharmaceutical industry began to transform into industrial 4.0 at the same pace as automotive, aviation and defense industries. Digitalization, the development of production processes with smarter and efficient models, R & D, pharmaceutical representatives to follow field work is among the plans of the sector, and of course, the prerequisite of digital transformation, innovation culture, pharmaceutical companies corporate culture is the unchanging part. With the impact of strong factors such as human life responsibility, competitive challenges and reputation, the capacity to create speed-winning change has a power that affects other sectors. Many innovations within the health system also concern the pharmaceutical sector. Even operations with robotic systems today and giving positive results affect drug use dynamics in the health sector. In addition to treatment, important steps are taken in the field of Preventive Medicine. The sector is also at the center of these studies. However, the responsibility of pharmaceutical companies in the health sector is not limited to R & D and production. All health sectors, especially health workers, tend to benefit from the guidance of pharmaceutical companies. The pharmaceutical sector should also see to produce more information as the opinion leader of the total health sector.

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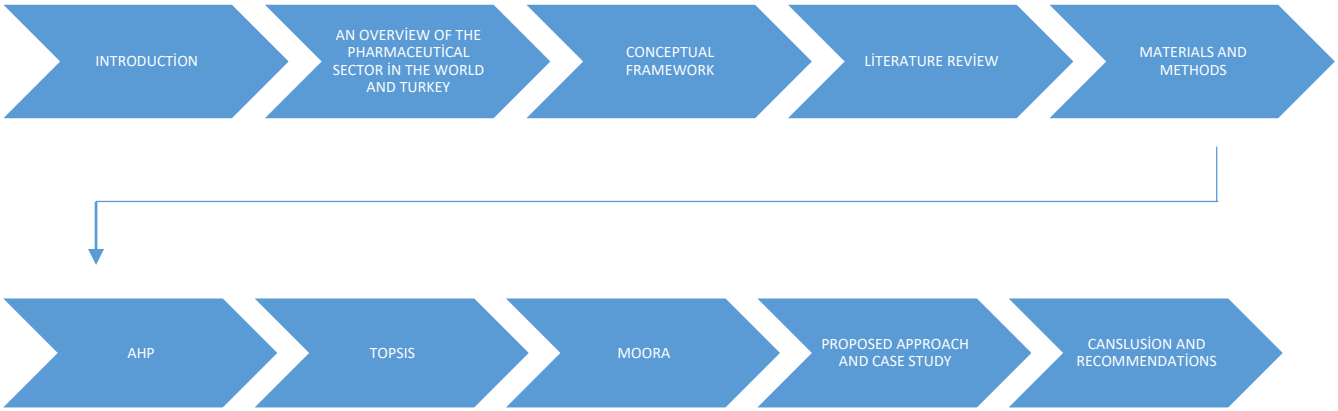

Figure 1. Selected Methods Solution Flow Chart

3. Conceptual Framework

3.1. Reverse Logistics İn Pharmaceutical İndustry

Reverse logistics is a process that covers all logistics activities from the product which is no longer needed or can not be used, to the product which will be subject to return or recycling, to the product which can be reused in the market. In this context, reverse logistics involves physical transportation of the final product from the end user to the first manufacturer. At the next stage, the product is recycled and destroyed or recycled. Returned products can be taken back from the point of sale or consumption point. Return of the product to the point of sale or the consumer to reach the

expenses of the product waiting on the shelf, preparation for the return, transportation, storage, return to the manufacturer and as a result of the destruction of the expenses for the addition of logistics costs of the product in question increases. Increasing costs reduce profit margins and reduce market share.

Looking at the pharmaceutical industry, reverse logistics needs can be grouped under four headings. First, the most important in the sector, the product of any hidden or obvious defect arising from the occurrence of the case of refunds. This process, also called "withdrawal", is that manufacturers have to collect the drugs they have introduced to the market due to the health threat and security measures. For pharmaceutical companies, they need a well-planned reverse logistics procedure in order to complete the collection activities as quickly as possible in such incidents which cause both respect and monetary losses. The second reason for refunds is due to incompatibility or disagreement with commercial agreements. The other two types of return are shipment errors that occur during shipment and returns that occur to be shipped to a different customer or to a new value-added service application on the product in accordance with a specific agreement. Recall all commercial concerns aside, ethical reverse logistics activity should be carefully evaluated and planned by pharmaceutical companies, pharmaceutical wholesalers and pharmacies (Ay, 2018).

3.2. Performance Measurement İn Enterprises

In today's increasingly competitive environment, businesses must determine their level of success or failure in order to maintain their assets. A comparison between the planned and actual results will reveal the extent to which the enterprise has achieved its objectives. Therefore, performance evaluation studies are required for such a work or in other words to determine the performance of the enterprise.

In other words, business performance is a qualitative and quantitative study that reaches its goal through analysis, measurement, evaluation and comments that answer questions in a wide range of dimensions related to business structure, financial structure and capital structure. Performance measurement represents a must for an enterprise. Because, what can be improved in an enterprise, profitability level increases and decreases, cost reduction efforts positive developments in the performance of measurement and evaluation can be understood by the performance evaluation.

Another issue that needs to be considered when defining performance is the time dimension and reference point of performance. It is possible to distinguish between past and future performance, but past excellent performance does not guarantee future performance. Another issue about time is which time zone will be taken into account. (Short, medium or long term). The reference dimension of performance is a separate complexity. Which reference will be the subject of performance? The industry average, the financial indicators of the main competitors, a set of targets or past period indicators. Each of these reference points is related to business performance (İlarslan & Bıyıklı, 2018).

4. Literature Review

Performance evaluation was carried out by TOPSIS and MOORA, two of the multi-criteria decision making methods. These methods are widely used in different areas

from past to present in order to solve multi-criteria decision making problems. Examples of these studies;

Table 1: Literature Review

Author / s	Year	Subject	Method
Cheng-Ru Wu	2008	Assessment Of Organizational Performance İn Capital Management Of Banks	AHP VE TOPSIS
Ching-Shih Tsou	2008	Multi-Purpose İnventory Planning	MOPSO and TOPSIS
Hui Yin Tasai	2008	Evaluation Of The Performance Of İnsurance Companies	AHP and TOPSIS
Cheng-Min Feng	2001	Evaluation Of Financial Performance Of Bus Operators	TOPSIS
Manabendra	2009	In Evaluating The Service Quality Of The Banking Sector	TOPSIS
Wang, Elhag	2006	Risk Assessment	TOPSIS
Benitez	2007	In Evaluating The Service Quality Of Hotel Enterprises	TOPSIS
Dasthti	2010	2010 İn Data Mining	TOPSIS
Chu	2002	Facility Location Selection	TOPSIS
Ertuğrul	2009	İn The Evaluation Of Financial Performances Of Cement Plants	AHP and TOPSIS
Şeçme	2009	In The Evaluation Of Financial Performance İn Banking Sector	AHP and TOPSIS
İç	2010	In Evaluating The Credibility Of Banks' Manufacturing Companies	TOPSIS
Tolga	2008	Financial Evaluation Of İnvestments	TOPSIS
Dumaoğlu	2010	Evaluates The Financial Performance Of 2010 Technology Companies	TOPSIS and AHP
Yurdakul	2003	Performance Measurement Of Automotive Companies	TOPSIS
Akkaya	2004	İn The Evaluation Of The Performance Of The Airline Companies	TOPSIS
Demireli	2010	Evaluation Of The Performance Of State Banks	TOPSIS
Bülbül	2009	Evaluation Of Financial Performance Of Food Companies	TOPSIS and AHP

In the literature, there was no study evaluating the performance of the companies operating in reverse logistics applications in the pharmaceutical sector using TOPSIS and Moora method. It is thought that this study will contribute to the literature. When the relevant literature is examined, it is observed that the topsis method is used more frequently than the Moora method, which is considered to be the most reliable and which requires at least mathematical processing. The study is expected to contribute to the literature on which CSFP is stronger in terms of reverse logistics.

5. Materıals And Methods

5.1. Criteria For Reverse Logistics Applications

In this study, it is aimed to evaluate the factors related to logistics activities in the pharmaceutical sector. First of all, the factors related to reverse logistics activities in the pharmaceutical sector were determined by reference to the literature survey. The eight criteria discussed are shown in Table 2.

Table 2: Criteria (Candan, 2018)

K1 Legal Procedures
K2 Transportation Costs
K3 QR Code Applications
K4 Disposal Costs
K5 Storage Conditions
K6 Ecofriendly
K7 Communication Performance
K8 Product Design

Legal procedures: the pharmaceutical manufacturer is subjected to many legal procedures since the supply of the raw materials belonging to the product. For example, the stock information of the raw materials subject to special control determined by the ministry is communicated to the ministry by the manufacturer periodically. After the product is produced and distributed, the legal responsibilities of the warehouses and pharmacies are continued and the product is monitored until it reaches the end user. For any reason, the monitoring of products which will return to the top supplier anywhere in the supply chain is also carried out by legal procedures.

Transportation costs: if the product is returned to a top supplier for any reason, the transportation costs will be reversed logistics performance is a factor affecting.

QR Code applications: there is a chance of monitoring the products produced by the drug tracking system with karekod. This system enables you to see the current stage of the product in the supply chain and its past movements through the Datamatrix printed on the product during production. This makes it easier to monitor the returned products while preventing counterfeiting.

Destruction costs: one of the factors leading to disruption of reverse logistics activities is destruction costs. During the destruction of the chemical product of the drug, the destruction costs are very difficult. In addition, transportation costs due to the fact that disposal companies are not very common are added and destruction costs are quite burdened. In this situation, the producers who take over the destruction are forcing them financially.

Storage conditions: each drug has its own storage conditions. In particular, it is important that the products that need to be stored in cold storage are delivered from the manufacturer to the consumer. In contrast, the return that will arise from the lack of storage conditions can be considered as the factors that affect logistics.

Environmental sensitivity: disposal of drug products with chemical content by disposal activities is extremely important in terms of Environment. Although packaging materials belonging to the products can be recycled, there is no question of the reuse of chemical raw materials.

Communication performance: contrary to the power of communication between manufacturers and warehouses and pharmacies, it has an impact on successful implementation of logistics activities. The return of the product to be returned on time affects the satisfaction of the customer directly, and the reasons for the return must be recorded.

Product design: due to the packaging of some products in the pharmaceutical sector, deformations such as breaking, bending can occur in the products, which increases

the return from the user. The fact that the packaging material (glass, cardboard, PVC) and related auxiliary materials (spoons, covers, scales) to be selected in the product design are useful in order to reduce product returns is also a factor affecting customer satisfaction (Candan, 2018).

In this study, TOPSIS method was used frequently in the performance evaluation of pharmaceutical companies. This method will be studied in the following topics.

5.2. TOPSIS

The TOPSİS method is a MCDM (Multi-Criteria Decision Making Method) method that is expressed as an acronym for technique for order Preference by Similarity to Ideal solution. The method was developed by Hwang and Yoon (1981) and has been applied successfully in the solution of many MCDM problems to date.

Many kinds of simple mathematical model easily apply the requirements of the operation and to the problem of fuzzy system Theory, Grey system theory and hybrid system theory integrated with other methods such as the method to be used often to be preferred MCDM lead.

The analysis of the problem consists of 6 steps based on the principle of convergence of alternatives to ideal solutions in decision-making problems. :

Step 1. As with all CPC problems, the analysis process starts with the formation of a decision matrix in which the performance scores of alternatives are expressed together according to criteria. The Matrix D generated by the decision maker is shown as follows.

$$D = \begin{bmatrix} y11 & y12 \dots & y1k \\ \dots & \dots & \dots \\ yn1 & yn2 \dots & ynk \end{bmatrix} \quad (1)$$

Step 2. The decision matrix is defined as the number of units or units that are different from each other according to different criteria, so the evaluation process is continued by standardizing the decision matrix. Standardized decision matrix decision matrix R rij to be presented with standardized performance scores to be standardized by taking advantage of the equality is achieved.

$$rij = \frac{yij}{\sqrt{\sum_{i=1}^{n} y_{ij}^2}} \quad i= 1,2,\dots,n \quad j= 1,2,\dots,k \quad (2)$$

Step 3. The degree of severity used to express the extent to which the criteria of the ÇKKV will influence the decision process, in other words, the weight of the criteria wi, is multiplied by each relevant value in the R matrix and the V weighted standardized decision matrix is obtained.

$$W = \begin{bmatrix} w11 & w12 \dots . & w1k \\ \dots . & \dots . & \dots . \\ wn1 & wn2 \dots . & wnk \end{bmatrix} \quad (3)$$

$$V = \begin{bmatrix} v11 & v12 \ldots . & v1k \\ \ldots . & \ldots . & \ldots . \\ vn1 & vn2 \ldots . & vnk \end{bmatrix}$$

Step 4. As mentioned in the definition of topsis method, ideal solutions are based on the principle of proximity calculation. In this step of the TOPSIS method, where the ideal solution is handled in two way, the ideal positive solution and ideal negative solution sets are created and the processing is continued. When creating ideal sets of solutions, the process is performed taking into account the benefits and cost conditions that are considered the attributes of the criteria in the decision-making problem. In the topsis method, the positive ideal solution set is calculated with the help of the negative ideal solution set.

$$A^* = \{\{\max Vij \,|j \in I\}, \{\min Vij \,|j \in J\}\} \quad (4)$$

$$A^- = \{\{min\, Vij \,|\, j \in I\}, \{max\, Vij \,|\, j \in J\}\}$$

Step 5. In the TOPSİS method, the Euclidian distance approach is used to calculate deviations from ideal solution sets. The ideal separation values are calculated for each set of solutions. A positive ideal separation measure is calculated using S*, and a negative ideal separation measure is calculated using S⁻.

$$S_i^* = \sqrt{\sum_{j=1}^{n} (Vij - V"j)^2} \quad (5)$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} (Vij - V^-j)^2}$$

Step 6. The ideal separation criteria are used in the calculation of the C* value, which expresses the relative proximity of each alternative to the ideal solution.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*} \qquad 0 \le C_i^* \le 1 \quad (6)$$

As the C* values that are in the range 0 to 1 grow, we express absolute closeness to the positive ideal solution. As a result of the analysis steps, the C* value obtained is sorted from larger to smaller and an alternative order based on its proximity to the ideal is obtained (Yıldırım & Önder, 2018).

5.3. MOORA (the multi-Objective optimization by Ratio Analysis Method)

The multi-objective optimization by Ratio Analysis method (Moora), based on the ratio analysis method (Zavadskas, 2006), has been written in the literature. The Moora method is based on the grouping of different predictions. The Moora method begins with a matrix with answers to all alternative and criteria. The Matrix is shown in the form of "xij". xij expression, I. your nature or purpose, J. alternative response/response is defined as (Brauners and Ginevicius, 2009: 123). The Moora method consists of two main parts: the ratio system and the reference point approach.

Ratio System Approach

The ratio system approach is defined as the benefit (benefit: representation of all the alternatives related to this purpose) in a situation in which the response of the alternatives related to any purpose is compared. In order to solve the ratio system approach, the xij value needs to be calculated first. The xij value is calculated using the following formula.

$$Xİ J = \frac{X_{ij}}{\sqrt{\sum_{j=1}^{m} x_{ij}^2}} \quad (7)$$

Mathematical expressions used in the calculation of Xij; , Xij, i. j. response / response of an alternative; j = 1, 2... m; m the number of alternatives; i = 1, 2...n; n the number of purposes; Xij, i. j. it is defined as a dimensionless number representing the nomalization of the response / response of the alternative. Dimensionless numbers are obtained from operations such as division or multiplication with a special unit of measure. The response / response (0; 1) of the alternatives related to the objectives is normalized according to the range. Sometimes it is between (-1; 1) and it is normalized according to this interval. For example, in some sectors, regions and countries where it is expected to increase productivity, a decrease may be observed instead of an increase in productivity (Negative Sizeless Number). For optimization, the sum of those responses / responses in minimization of the sum of those in maximization is subtracted. The formula used for optimization (Y_j^*)is shown below.

$$Yj^* = \sum_{i=1}^{i=g} x_{ij} - \sum_{i=g+1}^{i=n} x_{ij} \quad (8)$$

Mathematical expressions in the formula used for optimization; i = 1, 2 sim g maximizing objectives; i = g + 1, g + 2 minimizing the objectives; yj * = normalized for all purposes. Evaluation of the alternative yj * value may be positive or negative depending on the sum of the maximum and the minimum value. Once the optimization values have been calculated, the optimization values will be sorted sequentially to obtain the final choice.

Reference Point Approach

The formula used in reference point approach and ratio system approach is normalized. values are extracted from the formula and "maximal tool reference point" is obtained. Maximal vehicle reference point is called realistic and non - subjective coordinates. The coordinates (ri) are used in the selection of the reference point and in the selection of one of the candidate alternatives. I given as dimensionally numbered. j related to purpose. the normalized response of alternative/answers once the formula is found, the value of calculated coordinates) is calculated with the formula. Mathematical expressions used in the formula; i=1, 2, ..., N as attributes, J=1, 2, ..., m as alternatives, ri= i. coordinate of the Pearl reference point and = normalize J. i about the alternative. it is described as attribute. The Matrix created with the obtained values is the final ranking using the formula "Tchebycheff Min-Max metric". The formula used for the Min-Max metric operation of tchebycheffe is shown below.

$$min\left\{max\left|r_{i-X_{ij}}\right.\right\} \quad (9)$$

$\left|r_{i-X_{ij}^*}\right|$if the value of R is greater than Ri, the absolute value mathematical expression is used.

Where Objectives Are Important

In the ratio system and reference point approach, transactions are performed considering that the objectives have equal importance value. However, in some cases, the significance values of some of the purposes may have different significance than others. In such cases, alternatives for the purposes of the first (0; 1) range are normalized using the Xij * formula. The normalized alternative values obtained are multiplied by the values given for each purpose. This process is called gösteril Significance Factor ı and is shown as y *.

$$Yj^* = \sum_{i=1}^{i=g} x_{ij} - \sum_{i=g+1}^{i=n} x_{ij} \quad (10)$$

Mathematical expressions used in the calculation of the significance coefficient; maximizing the objectives; minimizing the objectives; I=G+1, g+2... n; si=i. the importance factor of the goal: j normalized according to all goals. the evaluation of the alternative is defined as important coefficients. Whichever approach is chosen in the Moora method, subsequent operations continue the same as those in the chosen approach (Şimşek, Çatır, & Ömürbek, 2015).

5.4. AHP

The analytical hierarchy process was first introduced by Myers and the Alpert duo in 1968 and in 1977, Professor Thomas Lorie developed it as a model for solving decision-making problems (Yaralıoğlu, 2001). AHP allows decision makers to model complex problems in a hierarchical structure that shows the relationship between the main goal of the problem, criteria, sub-criteria and alternatives. The most important feature of the AHP is that the decision maker can be involved both objectively and subjectively in the decision process. In other words, AHP is a method where knowledge, experience, individual's thoughts and hunch are logically combined. (Kuruüzüm and Atsan, 2001) when starting AHP implementation, the hierarchy model is first set up. In the analytical hierarchy process, the aim of the problem is to establish the hierarchy at the top step. In the lower stage, the main criteria for the problem and the sub-criteria for the related criterion are in the lower stage of the main criteria. At the bottom of the generated hierarchy, there are options related to the problem. The next step after the decision-making problem is to determine the weights of the criteria with the same importance level. At this stage, the weight according to each other is used in the selection scale of the clock with 1-9 points. The effectiveness of this scale was determined as a result of the applications made in different areas and theoretical comparisons made with other scales. (Kuruüzüm, Atsan, 2001)

Tablo 3: 1-9 Points Preference Scale (Uzun, Kazan, 2016)

Degree Of Importance	Definition	Description
1	Equally Important	Both factors are of the same importance.
3	Moderately Important	One factor is a little more important than the other.
5	Strongly Important	One factor is more important than the other.
7	Very Strong Importance	One factor should be preferred with a high degree of strength compared to the other.
9	Absolute Importance	One factor is very important compared to the other.
2, 4, 6, 8	Intermediate Values	It is used when there are small differences between the two factors.
Mutual Values.	if I is assigned a value x while J is being compared, J must be 1/x when I is being compared.	

The term Wi/wj in the binary comparison matrix means i to achieve the goal. criterion j. It refers to how much more important the criteria are. The scale shown in Table 1 is used in this evaluation. For example, if this value is 5, I. criterion j. according to the criterion, it is understood that it is very important. Similar figure J in this case. I criterion. according to the criteria, it is important at Level 1/5.

Matrix consistency is calculated by finding relative importance of criteria. In order for a comparison matrix to be consistent, the largest value (λmax) must be equal to The Matrix size (n). So λmax is calculated briefly as follows. The elements of each column in the comparison matrix are divided into the total value of the column and The Matrix is normalized. The average of each row is taken for the priorities vector account. Then, the initial comparison matrix is multiplied by the vectors of the priorities and the "All priorities Matrix" is calculated. Matrix elements obtained are divided into priority vectors. to calculate the λmax, the mean of these values is found. This average gives us λmax (Timor, 2011).

After we find the λmax, we need to calculate the amount of the transaction. Calculate the degree of consistency by calculating the consistency ratio of the hierarchy that is created we'll be able to. In fact, the consistency of the entire decision-making process is calculated in this way. This measure, which we call the parity ratio, also determines the wrong comparison of the decision maker if there is a binary comparison. If there is an incorrect comparison, the results of a more healthy decision will be made by making an appropriate change. The upper limit for the consistency ratio is 0.10.If the amount is above this value, the binary comparison should be reviewed again. In order to calculate the consistency ratio, we must first calculate the consistency index(ci) :

$$CI=(\lambda max-n) / (n-1)$$

It is found in the form. After the CI is found, the consistency rate(CR) is calculated as follows:

$$CR=CI/RI$$

Ri represents the random value index. Random value index table by selecting the appropriate value is done.

If the amount is less than 0.10, the decision-making process is consistent. The decision is applied in a way that is appropriate to the purpose.

6. Proposed Approach and Case Study

In the analysis and findings section of the study, it is aimed to evaluate the performance of companies that are applying reverse logistics in the pharmaceutical sector in Turkey. For this purpose, a performance evaluation was made by modeling as a ratio criteria set for firms and an alternative set for firms. Firstly, the criteria for reverse logistics activities in the pharmaceutical sector have been determined by reference to the literature research and expert knowledge. According to Expert Opinions, the weights of the criteria were calculated using AHP. In order to determine the relationship between the criteria and to question the importance of the score, the method of TOPSIS and MOORA was applied with a CISC-based approach. For this

purpose, the performances of 6 firms were evaluated according to the criteria set. The weights of the criteria and the criteria set for this study Table 3. Shows

Figure 2. Applied Methods

Table 4: Criteria and Weights Used in the Study

Ratios	Weight
Legal Procedures	1
Transportation Costs	9
Data Matrix Applications	5
Costs of destruction	5
Storage Conditions	7
Ecofriendly	3
Communication Performance	8
Product Design	6

A set of company alternatives to be used in the ÇKKV problem model and performance evaluation was formed from 6 companies.

Table 5: Alternative Drug Companies Applying Reverse Logistics Performance Evaluated In The Study

Alternative
A1
A2
A3
A4
A5
A6

6.1. Application of Topsis Method

Microsoft Excel package program was used to compile data. The method was performed in 6 steps as shown below.

Step 1: Create The Decision Matrix

In this step, the comparison matrix was formed by 5 different experts from Turkish pharmaceutical and medical device institution.

According to TOPSİS method;

Table 6: Creation Of Decision Matrix

	YS	TM	KU	İM	SK	CD	İP	ÜT
A1	1	5	2	3	4	6	4	5
A2	3	6	4	2	1	5	3	6
A3	4	3	5	1	6	2	4	3
A4	2	4	4	6	3	5	2	4
A5	5	2	1	4	5	3	5	2
A6	6	1	3	5	2	4	6	1

Table is created with the data given in the problem. After the decision matrix is created 2. The step is to obtain the normalized Matrix.

Step 2: Obtain The Normalized Matrix

The values of the decision criteria corresponding to each alternative are taken and then the values of each column are collected and the following table is obtained by taking the square root.

Table 7: The Normalization Process

	YS	TM	KU	İM	SK	CD	İP	ÜT
A1	1	25	4	9	16	36	16	25
A2	9	36	16	4	1	25	9	36
A3	16	9	25	1	36	4	16	9
A4	4	16	16	36	9	25	4	16
A5	25	4	1	16	25	9	25	4
A6	36	1	9	25	4	16	36	1
	9,539392014	9,539392	8,42615	9,539392	9,539392014	10,72381	10,29563	9,539392

Step 3: Obtain A Weighted Normalized Matrix

Table 8: Obtaining Weighted Normalized Matrix

AHP	**1**	**9**	**5**	**5**	**7**	**3**	**8**	**6**
	YS	**TM**	**KU**	**İM**	**SK**	**CD**	**İP**	**ÜT**
A1	0,104828484	1,8	1,186782	1,572427	2,935197543	1,678509	3,108115	3,144855
A2	0,314485451	5,660738	2,373563	1,048285	0,733799386	1,398757	2,331086	3,773825
A3	0,419313935	2,830369	2,966954	0,524142	4,402796314	0,559503	3,108115	1,886913
A4	0,209656967	3,773825	2,373563	3,144855	2,201398157	1,398757	1,554057	2,515884
A5	0,524142418	1,886913	0,593391	2,09657	3,668996929	0,839254	3,885143	1,257942
A6	0,628970902	0,943456	1,780172	2,620712	1,467598771	1,119006	4,662172	0,628971

Step 4: Obtain The Ideal and Negative Ideal Solution Values

Point to note here is that since each decision criterion as an element of a return is planned, the ideal solution for the values for each column the maximum value is taken into consideration when negative ideal solution for each column the minimum value of the values is taken into account.

Table 9: Obtaining The Ideal Solution Values

IDEAL SOLUTION	**0,628970902**	**5,660738**	**2,966954**	**3,144855**	**4,402796314**	**1,678509**	**4,662172**	**3,773825**

Ideal solution A values* =(0.62,5.66,2.96,3.14,4.402,1.67,4.66,3.77) it will be obtained in the form.

Table 10: Obtaining Negative Ideal Solution Solutions

NEGATIVE IDEAL SOLUTION VALUES	**0,104828484**	**0,943456**	**0,593391**	**0,524142**	**0,733799386**	**0,559503**	**1,554057**	**0,628971**

The negative ideal solution values A are-= (0.104, 0.94, 0.59, 0.52, 0.73, 0.55, 1.55,0.62) it will be obtained in the form.

Step5: Obtaining Distance Values For Ideal And Non-Ideal Points

Table 11: Calculation Of Ideal Distances

	YS	TM	KU	İM	SK	CD	İP	ÜT	TOTAL	S^-
A1	0	0,856544	0,593391	1,048285	2,201398157	1,119006	1,554057	2,515884	9,888564	3,144609
A2	0,209656967	4,717282	1,780172	0,524142	0	0,839254	0,777029	3,144855	11,99239	3,463003

A3	0,314485454	1,886913	2,373563	0	3,668996929	0	1,554057	1,257942	11,05596	3,32505
A4	0,104828484	2,830369	1,780172	2,620712	1,467598771	0,839254	0	1,886913	11,52985	3,395563
A5	0,419313935	0,943456	0	1,572427	2,935197543	0,279751	2,331086	0,628971	9,110203	3,018311
A6	0,524142418	0	1,186782	2,09657	0,733799386	0,559503	3,108115	0	8,209811	2,86512

$S_i^* = \sqrt{\sum_{i=0}^{n}(v_{ij-v_j})^2}$ formula is used to calculate the ideal distance. In this case, the ideal distances for each decision criterion are calculated as follows.

Table 12: Obtaining Negative Ideal Distances

	YS	TM	KU	İM	SK	CD	İP	ÜT	TOTAL	S^-
A1	0	0,856544	0,593391	1,048285	2,201398157	1,119006	1,554057	2,515884	9,888564	3,144609
A2	0,209656967	4,717282	1,780172	0,524142	0	0,839254	0,777029	3,144855	11,99239	3,463003
A3	0,314485451	1,886913	2,373563	0	3,668996929	0	1,554057	1,257942	11,05596	3,32505
A4	0,104828484	2,830369	1,780172	2,620712	1,467598771	0,839254	0	1,886913	11,52985	3,395563
A5	0,419313935	0,943456	0	1,572427	2,935197543	0,279751	2,331086	0,628971	9,110203	3,018311
A6	0,524142418	0	1,186782	2,09657	0,733799386	0,559503	3,108115	0	8,208911	2,83512

$S_i^- = \sqrt{\sum_{i=0}^{n}(v_{ij-v_j})^2}$ formula is used to calculate the negative ideal distance. In this case, negative distances for each decision criterion are calculated as follows.

Step 6: Calculating Relative Proximity To The Ideal Solution

Table 13: Result Table

	S*	S^-	C*	RANKING
A1	0,628970902	3,144609	0,833322	2
A2	0	3,463003	1	1
A3	1,886912706	3,32505	0,637965	4
A4	1,257941804	3,395563	0,729679	3
A5	2,515883608	3,018311	0,545393	5
A6	3,14485451	2,86512	0,476727	6

$C_i^* = \frac{S_i^-}{S_i^- + S_i^*}$ formula is used to calculate the relative proximity to the ideal solution.

When the results were examined, it was concluded that the company "A2" was first preferred in the selection of reverse logistics performance in the pharmaceutical sector. Other companies; A1>A4>A3>A5>A6 in the form of. The biggest reason why it performs best is because it is within the overall accepted limits in product design, including legal procedures, transportation costs, landslide applications, disposal costs, storage conditions, environmental sensitivity, communication performance, and product design.

6.2. Implementation of MOORA Method

In the application of MOORA method, The Decision Matrix (Table 5), normalized Decision Matrix (Table 6) and weighted Standard Decision Matrix (Table 7) are the same as TOPSIS method. The two approaches of the MOORA method are the ratio system and the first steps of the reference point approach are the same. Therefore, the transactions in the weighted Standard decision matrix were not shown separately.

Table 14: Results And Ranking Of Alternatives According To Rate System Approach

	MİN	MİN	MAKS	MİN	MAKS	MAKS	MAKS	MAKS		
	K1	K2	K3	K4	K5	K6	K7	K8	Yİ*	RANKING METHOD
A1	0,104828	0,524142	0,237356	0,314485	0,419314	0,559503	0,388514	0,524142	0,137089	2
A2	0,314485	0,628971	0,474713	0,209657	0,104828	0,466252	0,291386	0,6289671	-0,4449	6
A3	0,419314	0,314485	0,593391	0,104828	0,628971	0,186501	0,388514	0,314485	0,644264	4
A4	0,209657	0,419314	0,474713	0,628971	0,314485	0,466252	0,194257	0,419314	-0,22755	5
A5	0,524142	0,209657	0,118678	0,419314	0,524142	0,279751	0,485643	0,209657	0,045445	3
A6	0,628971	0,104828	0,35604	0,524142	0,209657	0,373002	0,582772	0,104828	0,158695	1

According to the ratio system approach, the most appropriate company is "A6" and "A2" when the performance of the companies operating in the pharmaceutical sector for reverse logistics applications is evaluated. The ranking of other firms is in the form of A1,A5,A3,A4.

For the reference point approach, reference point selection is made first according to the minimum and maximum values obtained from the weighted standard decision matrix in Table 7.

In determining the reference point (calculation of ri values), the criteria are performed according to whether the criteria are the minimum (the smallest numerical expression in the column belonging to the K1 criteria) or the maximum (the largest numerical expression in the column belonging to the K3 criteria). These operations are shown in Table 15.

Based on the values in Table 6 after the reference points are determined, the results obtained by Tchebycheff's Min-Max Metric process $\left|r_{i-X_{ij}^{*}}\right|$ are sorted from small to large and the most suitable alternative is selected. These operations are shown in Table 15.

According to the point-of-reference approach, the most appropriate company for the performance evaluation of pharmaceutical companies is Firm A1 and the last one is A2. Other companies are A3,A5, A6,A3 and there are differences in the ranking of alternatives according to TOPSIS method and rate system approach.

Table 15: Determination of reference point (Ri)

	MİN	MİN	MAKS	MİN	MAKS	MAKS	MAKS	MAKS
	K1	K2	K3	K4	K5	K6	K7	K8
A1	0,104828	0,524142	0,237356	0,314485	0,419314	0,559503	0,388514	0,524142
A2	0,314485	0,628971	0,474713	0,209657	0,104828	0,466252	0,291386	0,628971
A3	0,419314	0,314485	0,593391	0,104828	0,628971	0,186501	0,388514	0,314485
A4	0,209657	0,419314	0,474713	0,628971	0,314485	0,466252	0,194257	0,419314
A5	0,524142	0,209657	0,118678	0,419314	0,524142	0,279751	0,485643	0,209657
A6	0,628971	0,104828	0,356034	0,524142	0,209657	0,373002	0,582772	0,104828
REFERENCE POINTS	**0,104828**	**0,209657**	**0,593391**	**0,104828**	**0,628971**	**0,559503**	**0,582772**	**0,628971**

Table 16: Final results and order of Tchebycheff according to Min-Max metric

	MİN	MİN	MAKS	MİN	MAKS	MAKS	MAKS	MAKS		
	K1	K2	K3	K4	K5	K6	K7	K8	MAKSS	
A1	0	0,314485	0,356034	0,209657	0,209657	0	0,194257	0,104828	0,356034	1
A2	0,209657	0,419314	0,118678	0,104828	0,524142	0,09325	0,291386	0	0,524142	6
A3	0,314485	0,104828	0	0	0	0,373002	0,194257	0,314485	0,373002	2
A4	0,104828	0,209657	0,118678	0,524142	0,314485	0,09325	0,388514	0,209657	0,474713	5
A5	0,419314	0	0,474713	0,314485	0,104828	0,279751	0,097129	0,419314	0,474713	3
A6	0,524142	0,104828	0,237356	0,419314	0,419314	0,186501	0	0,524142	0,524142	4

The difference between the applied Moora method and the topsis method is that the results are evaluated in a collective manner and the results are compared to a pressure. The results of the topsis method, ratio analysis and reference approach are shown in Table 17.

Table 17: Ranking Of Firms According To Multi-Criteria Decision Making Methods

Companies	TOPSIS	RATE	REFERENCE
A1	2	2	1
A2	1	6	6
A3	4	4	2
A4	3	5	5
A5	5	3	3
A6	6	1	4

According to topsis method, the most appropriate company is “A2” and the last one is “A6”. According to this method, other alternative companies are listed. According to the Moora method, the most appropriate and final alternatives obtained from the ratio and reference approach must be different to make a sort. According to these results, according to the ratio method, the most appropriate company is "A6" and the last one is "A2". the most appropriate company for reference approach is "A2" and the last one is "A6".

7. Conclusion and Recommendations

In this study, 6 companies were compared in terms of 8 criteria to evaluate the performance of pharmaceutical companies in reverse logistics applications. Legal procedures, transportation costs, landslide applications, disposal costs, storage conditions, environmental sensitivity, communication performance, product design were selected from the criteria that enable enterprises to evaluate their past activities and make predictions for the future.

The weights of the criteria were determined using the AHP method in Microsoft Excel. The AHP method was used in the calculation of Criterion weights and the TOPSIS and MOORA methods were used in the ranking of firms. According to the analysis results, topsis and Moora discovered that the rankings for some companies were close to each other and that they were quite distant for some companies. When the results are examined, it can be said that the rankings determined by the topsis and Moore Methods give different results in general. According to the analysis results, performance measurements with topsis and Moora methods can often be interpreted as giving different results. Another finding of the study is that companies performing best and worst in both performance rankings are different.

Performance comparisons with topsis and Moora methods are made under some assumptions. Performance evaluation researchers should be careful when weighing and weighing according to the importance given to the criteria when implementing the TOPSIS method and when deciding which criteria will provide higher benefits in the event of maximization and minimization.

In today's world where production, supply and logistics systems are important, it is important to evaluate the factors related to reverse logistics activities in the pharmaceutical sector, which is an important sector. In order to avoid approaches that consider reverse logistics activities as cost and time loss, approaches that minimize costs related to reverse supply and logistics activities should be accepted and encouraged by companies as well as approaches that minimize costs related to reverse supply and logistics activities.

In later studies, by modeling reverse logistics criteria of pharmaceutical companies in multiple periods, monitoring of their performance in the period can be ensured. In addition, analysis can be taken in a different dimension with the criteria integrated into other system theories such as fuzzy and grey numbers to be calculated with reverse logistics criteria. It is important for investors to use multivariate decision-making methods for pharmaceutical companies and to achieve fast and reliable results, taking into account many variables, especially when evaluating reverse logistics performance. This study provides investors, managers and authorities with a different perspective on the implementation of methods.

It is clear that companies should make plans with objective criteria when making future decisions. TOPSIS, one of the very critical decision-making methods, helps companies take more measured and more stable steps. Further studies can be carried out to evaluate the performance of firms and competitors operating in different sectors as of the years. In addition, the topsis method, electro or Promethees and many other critical decision-making methods can be evaluated and their performance can be measured.

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