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Research Article

Evaluation of Supplier Selection Criteria with Fuzzy DEMATEL Method: An Application on the Pharmacy Industry

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Abstract

Efforts to improve supply chain management processes, which have gained importance since the '90s, have become an increasingly important phenomenon in today's competitive business life. Particularly due to recent developments, attention has turned to the health sector and improvement efforts in this sector. Supplier selection, which is the basic criterion of supply chain management, and the criteria that determine these choices are among the important issues that draw attention. In today's world where costs are reflected in prices and quality and service performance affect competition, knowing the primary criteria of pharmacies in the selection of suppliers in the health sector will guide both the actors who play a role in the sectoral dynamics and the companies. For this reason, by drawing attention to the issue of supplier selection of pharmacies, Fuzzy DEMATEL was used as a research method and supplier selection criteria of pharmacies were evaluated.

Keywords: Supplier selection, Fuzzy DEMATEL, Pharmacy Industry.

Bulanık DEMATEL Yöntemi ile Tedarikçi Seçim Kriterlerinin Değerlendirilmesi: Eczacılık Sektörü Üzerine Bir Uygulama

Öz

90'lı yıllardan bu yana önem kazanan tedarik zinciri yönetimine ilişkin süreçlerin iyileştirilme çabası günümüz rekabete dayalı iş yaşamında giderek daha da önemli bir olgu haline gelmiştir. Özellikle son zamanlardaki gelişmelere bağlı olarak dikkatler sağlık sektörüne ve bu sektördeki iyileştirme çabalarına dönmüştür. Tedarik zinciri yönetiminin temel kriteri olan tedarikçi seçimi ve bu seçimleri belirleyen kriterlerin neler olduğu dikkat çeken önemli konular arasındadır. Maliyetlerin fiyatlara yansıdığı, kalite ve hizmet performansının rekabeti etkilediği günümüz dünyasında, sağlık sektöründe eczanelerin tedarikçi seçimindeki öncelikli kriterlerini bilmek hem sektörel dinamiklerde rol oynayan aktörlere, hem de firmalara yol gösterici olacaktır. Bu nedenle eczanelerin tedarikçi seçimi konusuna dikkat çekilerek araştırma metodu olarak Bulanık DEMATEL kullanılmış ve eczanelerin tedarikçi seçim kriterleri değerlendirilmiştir.

Anahtar Kelimeler: Tedarikçi seçimi, Bulanık DEMATEL, Eczacılık sektörü.

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1. Introduction

Supply chain applications, which have developed considerably since the 1990s, are among the issues that have become very important for businesses. The most appropriate selection of the supplier affects corporate performance by contributing to finding the right supply chain partners. (Chang, 2011:1850). Especially in the health sector, the increase in costs compared to the consumer price index in recent years has increased the efforts to reduce costs in this sector. However, some concerns reducing costs in this sector will also decrease the quality and service performance (Lambert et al., 1997:17). Especially with the recent Covid 19 pandemic, cost problems related to this sector have started to attract attention again.

In today's competitive business life, it is difficult to achieve low cost and high-quality output without satisfactory suppliers. For this reason, one of the most important purchasing decisions is the selection of a competent supplier group and the maintenance of supply chain relations. The supplier selection decision is a difficult and complex process due to the necessity of considering many criteria in the decision-making process (Weber et al., 1991: 3). Suppliers are becoming a barrier for businesses due to rising costs. But essentially the success of the right supply chain management depends on the choice of an appropriate supplier. Experts agree that the selection of suppliers is one of the most important steps in the purchasing process, as it will reduce costs and provide a competitive advantage (Saen, 2007: 84). Therefore, businesses should transform their attitude towards suppliers from an enemy to a partner and become a source of competitive superiority today (Cousins & Menguc, 2006:605). Therefore, an effective and efficient supply performance evaluation becomes even more critical for supply chain management (Dickson, 1996: 2).

Choosing the right supplier is essentially a tool for an efficient supply chain management goal. In other words, while supplier selection affects the supply chain process, wrong supplier selection is a factor that directly affects supply chain management (Chang, 2011: 1851). Supply chain management is a process and tool that organizes suppliers, producers, warehouses, distribution centers, and distributors to minimize the costs of the entire supply chain system (Xiong Dong, & Wang, 2020: 4199). Supply chain management begins at the source of supply and extends to the point of consumption. It covers the entire value chain and represents a process that includes the relationship between material, information, money flow, and actors (Werner, 2020: 3). Mismanagement of the supply chain causes uncertainty and unexpected problems. For example, manufacturers in the wholesale and retail market face many uncertain situations and different costs. In this case, it chooses the maximum profit by taking a strategic decision instead of the optimum profit. This means that the price increases and therefore, reaching fewer quantities and fewer customers (Choi & Krause, 2006: 637).

As in some other sectors, the supply management of medical equipment and consumer goods in the health sector is full of uncertainty. One of the biggest challenges in the health sector is the evaluation and selection of suppliers (Bahadori, 2017: 1). The supplier selection process is the process of selecting the most suitable supplier in terms of the company's goals and strategies and marketing activities. Criteria for supplier selection may differ in every geography, culture, and process. Many criteria such as customer expectations, product structure, price, socio-cultural characteristics of the market, technological requirements, the status of the enterprise, and the requirements of marketing activities are effective in supplier selection.

The selection criteria used by decision-makers for supplier selection in organizational life and the relative importance of these selection criteria have been examined in many studies to date. Weber revealed 23 criteria that played a role in the selection of suppliers by examining 74 articles that emerged in the period from 1976 to the date of employment in his study in 1991 (Weber, 1991: 3).

In many subsequent studies, supplier selection criteria were examined and many different criteria were tried to be put forward (Chang, 2011; Dargi et al., 2014; Golmohammadi et al., 2009; Lima Junior et al., 2014; Rajesh & Malliga, 2013; Shemsadi et al., 2011; Wan et al., 2017). In this study, the attributes used in supplier selection were examined in line with the preliminary interviews with purchasing managers in the health sector, and 10 criteria for supplier selection were determined as a result of literature review and interviews. This criterion and research method is parallel to Chang's study in 2011, and the criteria in Table 1 were determined.

Table 1: Supplier Selection Criteria

Product Quality (A1)
Product Price (A2)
Technology Ability of the Supplier (A3)
Supplier Service (A4)
Delivery Performance of the Supplier (A5)
Safe Delivery of the Products (A6)
Delivery time (A7)
Reaction to Demand Change in Time (A8)
Production Ability of the Supplier (A9)
Financial Situation of the Supplier (A10)

With the recent turn of attention to the health sector, sectoral improvement efforts in this sector have increased. Considering the contributions of pharmacists to healthcare (quality drug supply, health promotion, and disease prevention, disease screening, improvement of drug compliance, monitoring of chronic diseases, etc.) (Bağcı & Atasever, 2020:14), choosing the right supplier is vital for pharmacies In this context, it has become very important to develop an idea about the supplier selection criteria, which is one of the first conditions of efficient supply chain management for pharmacies. Choosing the wrong supplier can cause many consequences, from increasing prices to decreasing service quality, from quality problems to distrust in the sector. The appropriateness and reliability of pharmacies as an institution where people shop from prescription medicines to supplements, personal care products to many supplements are issues that have become more important recently. Since the subject of the study is, the subject of the study was designed on the supplier selection criteria, which is one of the indirect factors of the pharmacies' price, quality, and service performance. Therefore, the purpose of this study is to reveal the supplier selection criteria for the pharmacy sector using the Fuzzy DEMATEL method and to contribute to the relevant field.

2. Material and Method

2.1. Multi-Criteria Decision Making Methods

Multi-criteria decision-making methods are used in problems that have more than one criteria and need to be decided. The decision-making process involves choosing an alternative and listing the alternatives under the available data, decision-makers' opinions, and the purpose of the decision (Zopounidis, 2002: 227).

Many different methods have been developed to make the most appropriate decisions regarding the nature of the problems. Using the Fuzzy DEMATEL method was considered more appropriate in terms of the criteria in this study.

2.2. Fuzzy DEMATEL Method

DEMATEL (Decision Making Trial And Evaluation Laboratory) method was first introduced by Gabus and Fontela in 1972 (Gabus & Fontella, 1972: 3). The method is an effective method that analyzes cause-effect relationships between factors in complex problems with the help of matrices (Si et al., 2018: 20; Bakir et al.2018: 326). The DEMATEL method is a multi-criteria decision-making method developed to determine the causal relationships between criteria. Thanks to the DEMATEL method, the strength, and level of the relationships between the criteria can be determined. In the DEMATEL method, as in other multi-criteria decision-making methods, the evaluation of the criteria is based on expert opinions and experiences. In the DEMATEL method, complex relationships between criteria are visualized in the relationship diagram. The relationship diagram allows decision-makers to visually see the direction and intensity of the relationships between the criteria, allowing for easier interpretation of complex relationships between criteria. In this way, decision-makers can analyze how they can develop the criteria in the affected criteria group to make changes to other criteria. Also, the method allows decision-makers to focus on fewer criteria by determining criteria with a high degree of influence on the solution (Chang et al., 2011; Lin, 2013; Tsai et al., 2015)

The DEMATEL method was first applied by Lotfi A. Zadeh (Zadeh, 1965), who was shown as the founder of fuzzy logic in integration with fuzzy logic. With the application of fuzzy logic to the DEMATEL method, the decision-making group can make their evaluations more applicable and compatible with the real world by using linguistic variables in expressing uncertainty, as is the basis of this logic (Özdemir, 2016:236).

In the Fuzzy DEMATEL method, the steps in the DEMATEL method are handled within the framework of fuzzy logic.

2.1.1. Fuzzy DEMATEL Method Steps

Step 1: After the problem is detected, it should be clearly defined. The criteria should be clear and ensure that all-important criteria that will affect the problem are included in the model.

Step 2: In this step, the first calculation data of the DEMATEL method, the direct relationship matrix is created. At this stage, the relationships between the criteria are evaluated by decision-makers.

Step 3: At this stage, the bilateral relations between the criteria are evaluated by decision-makers to measure the relationship between the criteria. Subsequently, the fuzzy matrix (Ž) is calculated. Fuzzy linguistic expressions are shown in Table 2. In this process, equality (1) and (2) are used. The evaluations were made by 3 different experts. These experts give their opinions using the five-point rating scale mentioned above. Also, 3 different matrices are obtained as a result of the evaluation.

Table 2: Fuzzy Linguistic Scale

Linguistic Scale	Triangular fuzzy number values		
No Influence	0	0	0.25
Low Influence	0	0.25	0.5
Medium Influence	0.25	0.5	0.75
High Influence	0.5	0.75	1
Very High Influence	0.75	1	1

$$\left(\check{Z}\right)=\frac{\check{Z}\otimes\check{Z}^{2}\otimes\cdots\otimes\check{Z}^{p}}{p} \quad (1)$$

$$\check{Z}=\begin{pmatrix}0 & \cdots & \check{Z}_{1n}\\ \vdots & \ddots & \vdots\\ \check{Z}_{n1} & & 0\end{pmatrix} \quad (2)$$

As can be seen from Equation 1, the values are divided by the number of experts in the average fuzzy matrix calculation. Also, in the above equations, the value of Žij consists of triangular fuzzy numbers in the form of Žij = (lij, mij, uij).

Step 4: The fourth stage of the analysis is about the normalization process. In this framework, the normalized direct relationship matrix ($\bar{X}$) is obtained. In this process, the equation is calculated with the help of (3) - (5).

$$\bar{X}=\begin{pmatrix}\bar{X}_{11} & \cdots & \bar{X}_{1n}\\ \vdots & \ddots & \vdots\\ \bar{X}_{1n} & & \bar{X}_{nn}\end{pmatrix} \quad (3)$$

$$\bar{X}_{ij}=\frac{\check{Z}_{ij}}{r}\left(\frac{I_{ij}}{r},\frac{m_{ij}}{r}\frac{u_{ij}}{r}\right) \quad (4)$$

$$r=\max_{1\le i\le n}\left(\sum_{j=i}^{n}u_{ij}\right) \quad (5)$$

As can be understood from the above equations, the largest number in the rows in the mean fuzzy matrix is determined and all values in the matrix are divided by this number.

Step 5: In the fifth stage, the total relation fuzzy matrix (Ť) is formed with the help of equation (6) - (10).

$$X_1=\begin{pmatrix}0 & \cdots & I'_{1n}\\ \vdots & \ddots & \vdots\\ I'_{n1} & & 0\end{pmatrix}X_m=\begin{pmatrix}0 & \cdots & m'_{1n}\\ \vdots & \ddots & \vdots\\ m'_{n1} & & 0\end{pmatrix}X_u=\begin{pmatrix}0 & \cdots & u'_{1n}\\ \vdots & \ddots & \vdots\\ u'_{n1} & & 0\end{pmatrix} \quad (6)$$

$$\check{T}=\begin{pmatrix}\breve{t}_1 & \cdots & \breve{t}_{1n}\\ \vdots & \ddots & \vdots\\ \breve{t}_{n1} & & \breve{t}\end{pmatrix} \quad (7)$$

$$\iota''_{ij}=X(1-X_l)^{-1} \quad (8)$$

$$m''_{ij}=X(1-X_m)^{-1} \quad (9)$$

$$u_{ij} = X(1-X_u)^{-1} \quad 10$$

The steps of the CFCS (Converting Fuzzy Data into Crisp Scores) method developed by Opricovic and Tzeng (2003: 643), which is the process of converting fuzzy numbers to clear values, are as follows:

$$\breve{T} = (l_{ij}, m_{ij}, u_{ij})\ R = \max u_{ij}\ L = \min = \min l_{ij}\ and\ \ \Delta = R - L \quad 11$$

$$t_{ij} = (l_{ij} - L)/\Delta,\ \ \mathrm{t}_{mj} = (m_{ij} - L)\Delta,\ \ \ t_{uj} = (u_{ij} - L)\Delta \quad 12$$

$$t_{lj}{}^{ls} = t_{mj}/(1 + t_{mj} - t_{lj}),\ \ t_{uj}{}^{rs} = t_{uj}/(1 + t_{uj} - t_{mj}) \quad 13$$

$$t_j{}^{crisp} = [t_{lj}{}^{ls} x(1 - t_{lj}{}^{ls}) + t_{uj}{}^{rs} x\, t_{uj}]/[1 - t_{lj}{}^{ls} + t_{uj}{}^{rs}] \quad 14$$

$$\breve{f}_{ij}{}^{crisp} = L + t_j{}^{crisp} x\, \Delta \quad 15$$

Step 6: In the last stage of the analysis, $(\breve{D}_l + \breve{R}_l)^{def}$ and $(\breve{D}_l - \breve{R}_l)^{def}$ values are obtained. $\tilde{R}_i{}^{def}$ represents the sum of all vector columns while $\tilde{D}_i{}^{def}$ represents the sum of all vector rows. $(\tilde{D}_i + \tilde{R}_i)^{def}$, indicates the overall degree of influence between criteria. In other words, when this value is higher, it means that the criterion is much closer to the center point. On the other hand, the value $(\tilde{D}_i - \tilde{R}_i)^{def}$ of explains the degree of causality between criteria. Hence, when this value is positive, it means that the criterion affects other criteria.

At the last stage of the study, the importance weights of the variables are calculated. First, the sum of $(\breve{D}_l + \breve{R}_l)^{def}$ values of all criteria is taken. After that, the $(\breve{D}_l - \breve{R}_l)^{def}$ value of each criterion is divided by the calculated sum to obtain the importance weights of the criteria. The sum of all the obtained criterion weights gives a value of 1.

Step 7: At this stage, the network structure is created. To create the network structure using the total relationship matrix, the threshold value must first be calculated. The threshold value can be a value determined by decision-makers. If there is no such value, this value can be determined by taking the average of the total relationship matrix.

3. Results and Discussion

To determine the importance of the supplier selection criteria of pharmacies, the Fuzzy DEMATEL method was applied. Ten criteria determined as a result of literature research and expert opinions were subjected to linguistic evaluations of three pharmacists who have been engaged in pharmacy for a long time and calculations were made with the help of the Microsoft Excel program.

The analysis results obtained from the experts are shown in the fuzzy effect matrix in Table 3. The "A" values in Table 3 express the supplier selection criteria (see Table 1) and show the triangular fuzzy number values of the opinions of 3 specialist pharmacists.

The fuzzy effect matrix given in Table 3 should be normalized for later calculations. Table 4 shows the normalized fuzzy effect matrix.

In the next step of the analysis, the total values of the normalized fuzzy effect matrix need to be calculated. Table 5 shows the total fuzzy effect matrix according to the Fuzzy DEMATEL method.

In the next step, the total fuzzy effect matrix has to be transformed into an effect matrix. In Table 6, the fuzzy numbers are transformed into a non-fuzzy number set, that is, the total relationship matrix.

In the next step, the total effect values are obtained from the total relationship matrix. Table 7 shows the degree of impact-relationship and the weights of the criteria. When the values in Table 7 of the criteria that affect the selection of the supplier are examined, the technical ability (A3) criterion of the supplier has been determined as the most important supplier selection criterion. It can be said that the delivery performance of the supplier (A5), the safe delivery of the products (A6), the price of the products (A2), the quality of the products (A1), and the service provided by the supplier (A4) are also more important than the remaining criteria in the selection of the pharmacies. Although the weights of the criteria are close to each other, it is seen that the lead time (A7) is the criterion with the least weight. Accordingly, the importance value ranking of the criteria is technology ability (A3), delivery performance (A5), safe delivery of products (A6), price of products (A2), service provided by the supplier (A4), production ability (A9), the financial status of the supplier (A9), its ability to react to changes in demand promptly (A8) and delivery time (A7).

In the last step of the analysis, a "threshold value" is created by taking the average (0.1525) of the total relationship matrix values shown in Table 6. Values above this threshold value are indicated in bold in Table 6. Based on these values, Figure 1 shows how supplier selection criteria affect each other.

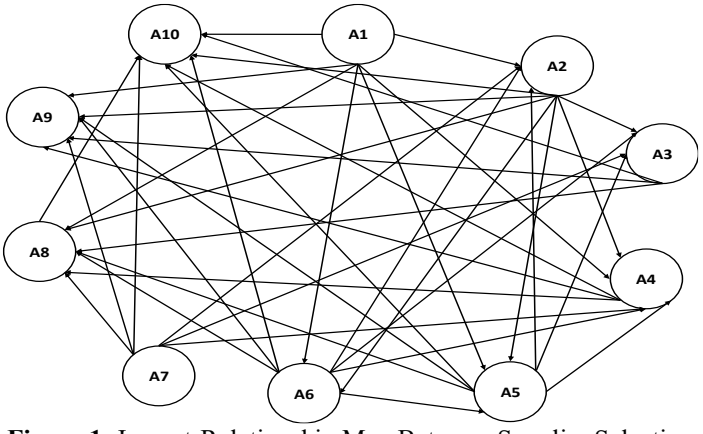

Figure 1: Impact-Relationship Map Between Supplier Selection Criteria

As seen in Figure 1, delivery time (A7) is not affected by any criteria. On the other hand, the product quality (A1) criterion is effective on all criteria except for the delivery time and is not affected by any other criteria. Similarly, the price of the products (A1), delivery performance (A5), and the safe delivery of the products (A6) are effective on many criteria.

Table 3: Fuzzy Impact Matrix for Supplier Selection Criteria

	A1			A2			A3			A4			A5			A6			A7			A8			A9			A10		
A1	0.00	0.00	0.25	0.58	0.83	1.00	0.50	0.75	1.00	0.33	0.50	0.75	0.33	0.58	0.83	0.33	0.58	0.83	0.17	0.33	0.58	0.42	0.67	0.92	0.33	0.58	0.83	0.33	0.58	0.83
A2	0.08	0.17	0.42	0.00	0.00	0.25	0.50	0.75	1.00	0.25	0.50	0.75	0.33	0.58	0.83	0.33	0.58	0.83	0.08	0.25	0.50	0.25	0.50	0.75	0.33	0.58	0.83	0.67	0.92	1.00
A3	0.17	0.42	0.67	0.17	0.42	0.67	0.00	0.00	0.25	0.17	0.42	0.67	0.08	0.33	0.58	0.08	0.33	0.58	0.08	0.33	0.58	0.17	0.42	0.67	0.25	0.50	0.75	0.25	0.50	0.75
A4	0.17	0.33	0.58	0.08	0.17	0.42	0.50	0.75	0.92	0.00	0.00	0.25	0.17	0.42	0.67	0.17	0.42	0.67	0.08	0.33	0.58	0.25	0.42	0.67	0.50	0.75	1.00	0.17	0.42	0.67
A5	0.08	0.25	0.50	0.33	0.50	0.75	0.50	0.75	1.00	0.42	0.67	0.92	0.00	0.00	0.25	0.25	0.50	0.75	0.17	0.25	0.50	0.42	0.67	0.92	0.33	0.58	0.83	0.33	0.58	0.83
A6	0.25	0.42	0.67	0.42	0.67	0.92	0.42	0.67	0.92	0.33	0.58	0.83	0.33	0.58	0.83	0.00	0.00	0.25	0.08	0.17	0.42	0.33	0.58	0.83	0.42	0.67	0.92	0.25	0.50	0.75
A7	0.17	0.33	0.58	0.17	0.42	0.67	0.42	0.67	0.92	0.33	0.58	0.83	0.17	0.33	0.58	0.17	0.25	0.50	0.00	0.00	0.25	0.33	0.58	0.83	0.42	0.67	0.92	0.42	0.67	0.92
A8	0.00	0.25	0.50	0.00	0.25	0.50	0.08	0.33	0.58	0.08	0.33	0.58	0.00	0.25	0.50	0.00	0.25	0.50	0.08	0.33	0.58	0.00	0.00	0.25	0.17	0.42	0.67	0.25	0.50	0.75
A9	0.00	0.25	0.50	0.00	0.25	0.50	0.00	0.17	0.42	0.00	0.25	0.50	0.00	0.25	0.50	0.00	0.25	0.50	0.00	0.25	0.50	0.08	0.33	0.58	0.00	0.00	0.25	0.17	0.42	0.67
A10	0.00	0.25	0.50	0.00	0.25	0.50	0.08	0.33	0.58	0.00	0.25	0.50	0.00	0.25	0.50	0.00	0.25	0.50	0.00	0.25	0.50	0.00	0.25	0.50	0.17	0.42	0.67	0.00	0.00	0.25

Table 4: Normalized Fuzzy Impact Matrix

	A1			A2			A3			A4			A5			A6			A7			A8			A9			A10		
A1	0.00	0.00	0.03	0.07	0.11	0.13	0.06	0.10	0.13	0.04	0.06	0.10	0.04	0.07	0.11	0.04	0.07	0.11	0.02	0.04	0.07	0.05	0.09	0.12	0.04	0.07	0.11	0.04	0.07	0.11
A2	0.01	0.02	0.05	0.00	0.00	0.03	0.06	0.10	0.13	0.03	0.06	0.10	0.04	0.07	0.11	0.04	0.07	0.11	0.01	0.03	0.06	0.03	0.06	0.10	0.04	0.07	0.11	0.09	0.12	0.13
A3	0.02	0.05	0.09	0.02	0.05	0.09	0.00	0.00	0.03	0.02	0.05	0.09	0.01	0.04	0.07	0.01	0.04	0.07	0.01	0.04	0.07	0.02	0.05	0.09	0.03	0.06	0.10	0.03	0.06	0.10
A4	0.02	0.04	0.07	0.01	0.02	0.05	0.06	0.10	0.12	0.00	0.00	0.03	0.02	0.05	0.09	0.02	0.05	0.09	0.01	0.04	0.07	0.03	0.05	0.09	0.06	0.10	0.13	0.02	0.05	0.09
A5	0.01	0.03	0.06	0.04	0.06	0.10	0.06	0.10	0.13	0.05	0.09	0.12	0.00	0.00	0.03	0.03	0.06	0.10	0.02	0.03	0.06	0.05	0.09	0.12	0.04	0.07	0.11	0.04	0.07	0.11
A6	0.03	0.05	0.09	0.05	0.09	0.12	0.05	0.09	0.12	0.04	0.07	0.11	0.04	0.07	0.11	0.00	0.00	0.03	0.01	0.02	0.05	0.04	0.07	0.11	0.05	0.09	0.12	0.03	0.06	0.10
A7	0.02	0.04	0.07	0.02	0.05	0.09	0.05	0.09	0.12	0.04	0.07	0.11	0.02	0.04	0.07	0.02	0.03	0.06	0.00	0.00	0.03	0.04	0.07	0.11	0.05	0.09	0.12	0.05	0.09	0.12
A8	0.00	0.03	0.06	0.00	0.03	0.06	0.01	0.04	0.07	0.01	0.04	0.07	0.00	0.03	0.06	0.00	0.03	0.06	0.01	0.04	0.07	0.00	0.00	0.03	0.02	0.05	0.09	0.03	0.06	0.10
A9	0.00	0.03	0.06	0.00	0.03	0.06	0.00	0.02	0.05	0.00	0.03	0.06	0.00	0.03	0.06	0.00	0.03	0.06	0.00	0.03	0.06	0.01	0.04	0.07	0.00	0.00	0.03	0.02	0.05	0.09
A10	0.00	0.03	0.06	0.00	0.03	0.06	0.01	0.04	0.07	0.00	0.03	0.06	0.00	0.03	0.06	0.00	0.03	0.06	0.00	0.03	0.06	0.00	0.03	0.06	0.02	0.05	0.09	0.00	0.00	0.03

Table 5: Total Fuzzy Impact Matrix

	A1			A2			A3			A4			A5			A6			A7			A8			A9			A10		
A1	0.01	0.05	0.38	0.08	0.16	0.53	0.08	0.18	0.61	0.05	0.13	0.53	0.05	0.13	0.51	0.05	0.13	0.50	0.03	0.09	0.41	0.07	0.16	0.57	0.06	0.16	0.61	0.06	0.16	0.59
A2	0.02	0.06	0.37	0.01	0.05	0.40	0.08	0.16	0.57	0.04	0.12	0.49	0.05	0.12	0.47	0.05	0.12	0.46	0.01	0.07	0.37	0.04	0.12	0.50	0.06	0.15	0.56	0.10	0.18	0.57
A3	0.02	0.08	0.36	0.03	0.09	0.41	0.01	0.06	0.42	0.03	0.10	0.43	0.01	0.08	0.39	0.01	0.08	0.39	0.01	0.07	0.34	0.03	0.10	0.44	0.04	0.12	0.49	0.04	0.12	0.48
A4	0.02	0.08	0.36	0.02	0.07	0.39	0.07	0.15	0.51	0.01	0.05	0.39	0.03	0.10	0.41	0.03	0.09	0.40	0.01	0.07	0.35	0.04	0.11	0.45	0.07	0.15	0.53	0.03	0.11	0.48
A5	0.02	0.07	0.38	0.05	0.11	0.46	0.08	0.16	0.57	0.06	0.14	0.51	0.01	0.05	0.40	0.04	0.11	0.45	0.02	0.07	0.38	0.06	0.14	0.53	0.06	0.15	0.57	0.06	0.15	0.55
A6	0.04	0.09	0.41	0.06	0.14	0.49	0.07	0.16	0.57	0.05	0.13	0.51	0.05	0.13	0.48	0.01	0.05	0.40	0.02	0.06	0.37	0.05	0.14	0.53	0.07	0.16	0.58	0.05	0.14	0.55
A7	0.03	0.08	0.38	0.03	0.10	0.44	0.06	0.15	0.55	0.05	0.13	0.48	0.03	0.09	0.43	0.03	0.08	0.41	0.00	0.04	0.33	0.05	0.13	0.50	0.07	0.15	0.56	0.06	0.15	0.54
A8	0.00	0.06	0.31	0.00	0.07	0.35	0.01	0.09	0.42	0.01	0.08	0.37	0.00	0.06	0.34	0.00	0.06	0.34	0.01	0.07	0.31	0.00	0.04	0.35	0.02	0.10	0.43	0.03	0.11	0.43
A9	0.00	0.05	0.29	0.00	0.06	0.32	0.00	0.06	0.37	0.00	0.06	0.34	0.00	0.06	0.32	0.00	0.06	0.31	0.00	0.05	0.28	0.01	0.08	0.36	0.00	0.04	0.35	0.02	0.09	0.40
A10	0.00	0.05	0.29	0.00	0.06	0.33	0.01	0.08	0.39	0.00	0.06	0.34	0.00	0.06	0.32	0.00	0.06	0.32	0.00	0.05	0.28	0.00	0.07	0.36	0.02	0.09	0.41	0.00	0.04	0.35

Table 6: Total Relationship Matrix

FİJ	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
A1	0.1065	**0.2217**	**0.2432**	**0.1964**	**0.19435**	**0.1913**	0.1427	**0.2204**	**0.2283**	**0.2264**
A2	0.1174	0.1147	**0.2246**	**0.1800**	**0.1796**	**0.1769**	0.1223	**0.1858**	**0.2109**	**0.2404**
A3	0.1301	0.1456	0.1218	0.1518	0.1351	0.1327	0.1179	**0.1572**	**0.1789**	**0.1766**
A4	0.1258	0.1233	0.2065	0.1093	0.1479	0.1454	0.1213	**0.1636**	**0.2121**	**0.1726**
A5	0.1270	**0.1728**	**0.2258**	**0.1988**	0.1142	0.1685	0.1240	**0.2048**	**0.2120**	**0.2085**
A6	0.1479	**0.1942**	**0.2212**	**0.1931**	**0.1840**	0.1152	0.1160	**0.1996**	**0.2242**	**0.2039**
A7	0.1322	**0.1569**	**0.2097**	**0.1835**	0.1476	0.1364	0.0891	**0.1896**	**0.2139**	**0.2110**
A8	0.0992	0.1115	0.1389	0.1264	0.1105	0.1085	0.1067	0.0937	0.1507	**0.1574**
A9	0.0920	0.1034	0.1111	0.1081	0.1025	0.1007	0.0901	0.1212	0.0943	0.1376
A10	0.0937	0.1053	0.13055	0.1102	0.1043	0.1025	0.0915	0.1142	0.1419	0.0946

Table 7: Impact-Relationship Degree and Criterion Weight Results

	D	R	D+R	D-R	W
A1	1.97166	1.17228	3.14394	0.79938	0.10286
A2	1.753	1.44994	3.20294	0.30305	0.10479
A3	1.44812	1.83385	3.28197	-0.38573	0.10738
A4	1.52818	1.55799	3.08617	-0.02981	0.10097
A5	1.75699	1.4204	3.17739	0.33659	0.10395
A6	1.79978	1.37852	3.1783	0.42126	0.10398
A7	1.67046	1.12224	2.79269	0.54822	0.09137
A8	1.20399	1.65064	2.85464	-0.44665	0.09339
A9	1.0615	1.86745	2.92895	-0.80596	0.09583
A10	1.08902	1.82938	2.9184	-0.74036	0.09548

4. Conclusion and Recommendations

The performance of the supply chain, as in many sectors, is vital in competitive advantage and sustainability in the pharmacy sector, and supplier selection is one of the factors determining this performance. The selection of suppliers can vary greatly from sector to sector and from business to business, and there are many different criteria to choose the most suitable supplier for the business, the customer, and the market. Therefore, in this study, it was aimed to estimate which criteria are important in choosing suppliers in the pharmacy sector by using the Fuzzy DEMATEL method. The results of the study can help pharmacies predict precisely which suppliers are suitable by focusing on the important factors identified.

In the study, it is seen that the importance weights calculated with the Fuzzy DEMATEL method of ten criteria determined in line with the literature review and expert opinions are not so far from each other. Businesses often pay close attention to product quality, product price, and delivery performance when selecting or evaluating suppliers. However, this study shows that the technical ability of suppliers has the greatest impact among the supplier selection criteria in pharmacies. The results of the research show that the technical ability, delivery performance and the price and quality of the products are also important criteria in supplier selection. It is thought that the reason for this is that the technological ability of suppliers creates trust in pharmacists and this trust directly affects the quality perception of products and services.

It is believed that the pharmacy sector and the Fuzzy DEMATEL method discussed in the study will contribute to the

literature and shed light on similar studies since they were not used in the evaluation of supplier selection criteria before. In future studies, supplier selection criteria can be analyzed using the Fuzzy DEMATEL method on different sectors and sectoral differences or similarities can be revealed. Also, different perspectives can be developed by using different decision-making methods.

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