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Acta Infologica
acin 2024, 8 (2), 157–175
DOI: 10.26650/acin.1462978

Research Article

Evaluation of the Quality of Second-Hand Clothes Trading Websites using the VIKOR and MOORA Methods

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ABSTRACT

Along with technology, people's living standards have also improved in the same direction. Long-distance shopping trips are no longer preferred by people. Many consumers now find it more appealing to shop while sitting at home and avoiding the crowds while also finding what they are looking for more quickly. However, this impressive opportunity provided by technology can sometimes create difficulties for customers. In the online realm, there are various alternative e-commerce websites. This led to frequent consideration of the query, "Which website is better for me to shop from?". Here convenience means price, security, product variety, etc. such criteria. This rightful consideration of consumers has led many researchers to enter this field and have enabled them to use decision-making methods during the selection of e-commerce sites. From the 2000s to the present, second-hand goods have gained popularity again. The fact that second-hand goods are generally cheaper than new ones encourages thrifty consumers to buy second-hand goods because of their price advantages. In addition, many consumers may turn to second-hand sources because they are concerned about the scarcity of natural resources and the volume of waste generated. The trend toward buying second-hand products is driven by the issue of sustainability, which has recently received significant attention. In this study, the quality of three e-commerce sites selling second-hand clothes in Turkey was evaluated using various multi-criteria decision-making methods. The criteria taken into consideration while shopping on the e-commerce sites in question were determined from studies in the literature and from a website called "Şikayetvar" that is frequently visited by internet users. The weights of the determined criteria were then calculated using the AHP method. The sites were then compared using the VIKOR and MOORA methods.

Keywords: Second Hand Clothes, Sustainability, VIKOR, MOORA

Submitted	: 01.04.2024
Revision Requested	: 03.09.2024
Last Revision Received	: 03.10.2024
Accepted	: 20.10.2024
Published Online	: 31.10.2024

1. INTRODUCTION

"The acquisition of second-hand objects through methods and venues of exchange that are often different from new products" is the definition of second-hand shopping. Digital channels have witnessed a surge in the popularity and reach of second-hand shopping, particularly in consumer-to-consumer e-commerce.

In fact, buying second-hand has existed as a form of purchasing alternative since the mid-fourteenth century. People's poverty levels gradually increased due to the deep economic depression caused by the plague in Europe in the 16th century, increasing population, political and social uprisings, and severe famine. The deterioration of the economy has led people to give the clothes they use to each other, expecting something in return and exchanging them. The development of second-hand product trade continued until the 18th century, during which time the Industrial Revolution occurred. From the 2000s to the present, second-hand goods have regained popularity, and the used product market has begun to grow and attract much attention. (Borusiak et al., 2020).

Although the second-hand market has many features and benefits compared to traditional sales, it can be more complex in some respects. For example, a second-hand store can compete in three different markets at the same time. These include rivalry from consignors, buyers, and dealings with the waste industry. Furthermore, many customers anticipate that second-hand shops will be of a quality comparable to chain stores or retail establishments that offer brand-new merchandise. What is expected from a decent-quality store is that it is well organized and that the goods and shopping experience are provided with the help of a friendly staff. Therefore, offline channels offer the chance to browse the store, examine products, and engage in social interaction while shopping. When using online channels, it cannot be adjusted in this way for reasons closely related to physical stores. When evaluating product condition during second-hand online shopping, customers should benefit from images and product descriptions rather than touching the actual product. Therefore, when assessing products in online channels, additional factors such as brand name, price, store, and country of origin are taken into consideration. In addition, online stores enable you to reach a wider audience geographically. Although it is claimed that some geographical restrictions may still exist in e-commerce, in theory, any seller can sell their products to users anywhere in the world. Additionally, online stores do not restrict the time a customer can shop (Kassinen and Koivumäki, 2019).

Consumers and site users make purchases when purchasing second-hand products for various reasons. According to Kassinen and Koivumäki (2019), these are known as economic and critical motivations. Many researchers have emphasized economic reasoning when purchasing second-hand products. It is observed that in most cases, second-hand goods are not purchased as the first choice; instead, consumers are forced to buy second-hand goods due to economic constraints. Saving money is an important factor for people in general. Second-hand markets are important for people with very little income (Napompech and Kuawiriyapan, 2011). In a study investigating the main reasons for buying second-hand goods, it was concluded that the main reasons for the group between the ages of 18 and 24 were saving money (Nieminen, 2016).

There are three main categories of critical reasons for purchasing second-hand goods. These are listed as avoiding traditional methods, ethical and ecological motivations, and anti-vanity. The inclination of people to distance themselves from the current consumption system is linked to their avoidance of traditional methods. Due to the rapid phase of consumption, many people are unusually turning to second-hand goods as they realize that second-hand items are generally relatively less used and are therefore still usable and often in good condition.

According to ethical and ecological motivations, many people may turn to second-hand resources because they are concerned about the scarcity of natural resources and the amount of waste produced. Waste is considered a negative factor. When a used product is purchased instead of a new one, there is no waste, thus allowing the balanced use of production resources (Dengin, 2012). Research has shown that students who purchase items from second-hand stores are more aware of environmental issues (Borusiak et al., 2020). According to anti-vanity motivation, many people are not interested in the latest trends in their purchases. It has been observed that many people with this view tend to purchase functional products that add value to the person rather than show off.

Secondhand markets provide a focused solution to the issues raised by fast fashion. Clothes are frequently destroyed before they reach the end of their life cycle because people consume fashion so quickly. Many people believe they can act environmentally responsibly without sacrificing the satisfaction of their true needs and desires when buying used clothing. Regardless of the item's age, second-hand clothing is defined as clothing that has been worn previously. Nonetheless, whether or not an item of clothing determines whether it qualifies as vintage. Unlike many other second-hand goods, used clothing is made of a unique material or size.

Although the use of second-hand clothes was seen as a style of clothing inspired by poverty in previous periods, this idea gained a different meaning in the 90s. In the 90s, fashion became a popular way to recreate the 1970s. The

fashion trend has shifted people to second-hand shopping markets. Over time, consumers have begun to realize the benefits of second-hand clothing and have turned to sustainability issues. The fact that second-hand goods are generally cheaper than new goods encourages frugal consumers to buy second-hand goods because of their price advantages. However, consumers who buy second-hand clothes with low budgets have adopted this situation as a sociological conflict avoidance strategy and a means of escaping the burden of poverty (Tóta, 2016).

The sale of second-hand clothes on e-commerce sites has increased considerably. The increase in the number of such sites leads users to confusion about which sites to shop from. In this study, it is aimed to evaluate the quality of three e-commerce sites operating for the sale of second-hand clothing in Turkey using various multi-criteria decision-making methods. The weights of the criteria were calculated using the AHP method. Subsequently, an evaluation was performed between the sites using the VIKOR and MOORA methods. It has been observed that e-commerce sites operating in different fields, such as Limango, Markofoni, Trendyol, Morhipo, D & R, Hepsiburada, and LCWaikiki, are frequently discussed in the literature. Only one study has been found to evaluate sites where second-hand clothes are sold (Karadayı Usta and Kadaifci, 2022). However, this study differs from the aforementioned study in terms of the criteria used, method for obtaining criteria, and methods used for ranking alternatives.

This paper is organized as follows. Section 2 discusses the methods used. Section 3 presents the application in detail. The obtained findings are also reported at the end of each relevant step in this section. Section 4 concludes the paper with recommendations for further research.

2. METHODOLOGY

2.1. Analytical Hierarchy Process (AHP)

The AHP is a multi-criteria decision-making tool that can make pairwise comparisons between criteria using the eigenvalue approach and calibrate the numerical scale used in quantitative and qualitative performance measurements. According to the definition in the Operations Management book written by Russell and Taylor (2003), it is a quantitative method used to rank decision alternatives and make selections according to multiple criteria (Çelikbilek, 2018).

Myers and Alpert first presented the AHP idea in 1968. Saaty then developed the model and found it useful for solving decision-making problems in 1977. When the decision hierarchy can be identified, the Analytic Hierarchy Process (AHP) is utilized as a decision-making and estimation technique that provides the percentage distribution of decision points in terms of the criteria influencing the decision (Yaralıoğlu and Köksal, 2003).

The steps of the AHP Method are presented below:

STEP 1. Defining the Problem: As in every problem, the first stage of the AHP method defines the problem. It is very important that this step is performed well. Any mistake made at this point will directly affect the course of the transaction.

STEP 2. Determination of Criteria/Alternatives: After a clear definition of the problem, it will be much easier to determine the criteria to be used for the solution and alternatives to be evaluated.

STEP 3. Creating the Hierarchical Structure: The hierarchical structure of the target problem is created at this stage, as shown as an example in Fig. 1.

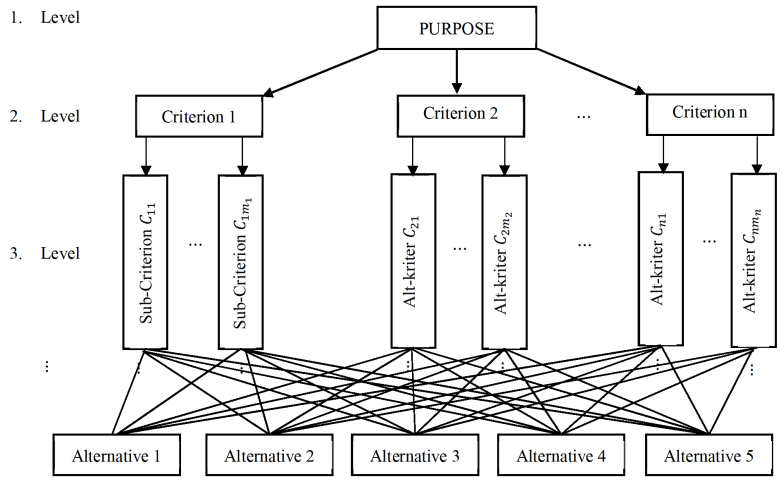

Figure 1. Hierarchical Structure Example

STEP 4. Pairwise Comparisons: In this step, pairwise comparison matrices are prepared for each level, adhering to the hierarchical structure.

When performing pairwise comparisons, the pairwise comparison scale recommended by Wind and Saaty (1980) and given in Table 1 is used. Pairwise comparisons are performed for only one side of the principal diagonal of the comparison matrix. In common use, the upper part of the prime diagonal is filled in by decision-makers, and the values below the prime diagonal are completed accordingly.

Table 1. Fundamental scale for pairwise comparisons (Wind and Saaty, 1980)

Importance intensity	Definition	Explanation
1	Equal Importance	The two activities contribute equally to the objective of
3	Moderate Importance	Experience and judgment slightly favor one activity over another.
5	Strong Importance	Experience and judgment strongly favor one activity over another
7	Very Strong Importance	An activity is very strongly favored over another; its dominance is demonstrated in practice
9	Absolute Importance	The evidence-favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	For compromise between the above values	Sometimes, a compromise judgment must be interpolated numerically. Because there is no good word to describe.
Reciprocals Of the above		If activity i has one of the above nonzero numbers assigned to it when compared with activity j, then j has the reciprocal value compared with i.

STEP 5. Normalization of Pairwise Comparison Matrices: Normalization is done by taking the row totals. A pairwise comparison matrix containing n criteria is denoted by $[x_{ij}]_{n\times n}$, normalization calculations are carried out with the help of Eq. (1), and the normalized matrix $[y_{ij}]_{n\times n}$ is obtained.

$$y_{ij} = \frac{x_{ij}}{\sum_{i=1}^{n} x_{ij}} \tag{1}$$

STEP 6. Calculation of Priority Vectors: Priority vectors are obtained by averaging the rows of the normalized matrix. In a problem with n criteria, the priority vector is denoted by $A = [a_i]_{n\times 1}$. The priority value of the first criterion is calculated with the help of Eq. (2).

$$a_1 = \frac{\sum_{j=1}^{n} y_{1j}}{n} \tag{2}$$

STEP 7. Consistency Tests: These tests are applied to determine whether pairwise comparisons are consistent. Inconsistent test results require a re-comparison. To perform the consistency test, the normalized pairwise comparison matrix must first be multiplied by the priority vector. The Eq. valid for the consistency test of the pairwise comparison of n criteria is given in (3).

$$[t_i]_{n\times 1} = [x_{ij}]_{n\times n}.[a_i]_{n\times 1} \tag{3}$$

Because of Eq. (3), each element of the obtained vector is divided into priority vector elements, respectively.

$$\frac{t_i}{a_i} \quad For\ \forall i \in n \tag{4}$$

After Eq. (4), the largest eigenvalue, , λ_{maks} is calculated by averaging the obtained values.

$$\lambda_{maks} = \frac{\sum_{i=1}^{n} \frac{t_i}{a_i}}{n} \tag{5}$$

The consistency index (CI) is then calculated with the help of λ_{maks}.

$$CI = \frac{\lambda_{maks} - n}{n - 1} \tag{6}$$

After applying Eq. (6), the consistency ratio result (CR) is obtained by dividing the fit index (CI) and random index (RI) values together.

$$CR = \frac{CI}{RI} \tag{7}$$

The random index value to be used during the calculation in Eq. (7) varies according to the number of criteria and is shown in Table 2.

Table 2. RI Values for Consistency Ratio Calculation

n	RI
3	0,58
4	0,90
5	1,12
6	1,24
7	1,32
8	1,41
9	1,45
10	1,49
11	1,51
12	1,53

The consistency ratio obtained because of these calculations is expected to be less than 0.1. If CR<0.1, the discrepancy rate is considered to be at an acceptable level.

2.2. VIKOR Method

The VIKOR method, developed for the optimization of multi-criteria complex systems, is based on choosing and ranking alternatives when there are conflicting criteria. Considering that each alternative is evaluated according to each criterion function, the multi-criteria measure for compromise ranking is developed from the L_p criterion, which is used as the aggregation function in compromise programing. Various j alternatives are shown as $c_1, c_2, \ldots, c_n$. The measurement of criterion i of alternative c_j is expressed as f_{ij}. The VIKOR method developed with the L_p form is described in Eq. (8) (Yıldırım and Önder, 2014).

$$L_{pj} = \left\{ \sum_{i=1}^{n} [w_i (f_i^* - f_{ij}) / (f_i^* - f_i^-)]^p \right\}^{(1/p)} , 1 \leq p \leq \infty; j = 1, 2, \ldots, j \tag{8}$$

STEP 1. Creating a Decision Matrix: As in other methods, the decision process in the VIKOR method begins with a definition of the decision problems. In decision problems, the alternatives to be evaluated and the criteria that enable the selection of alternatives are determined. Although the criteria are determined intuitively to meet the expectations of the decision-maker, they can also be obtained by consulting experts on the subject. When evaluated according to the relevant criterion, the values obtained from the alternatives indicate the scores of the alternatives. After the criteria of the decision problem and the scores of the alternatives are determined according to the criteria, the scores are converted into a decision matrix, as shown in Eq. (9). The rows of the decision matrix (i=1,2,. . . ,m) show the alternatives, and the columns (j=1,2,. . . ,n) show the criteria.

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{1n} \\ . & & & . \\ . & & & . \\ . & & & . \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \tag{9}$$

STEP 2. Determination of ideal solution values: After creating the decision matrix, the best f_j^+ and worst f_j^- values are determined for each criterion. In determining the f_j^+ and the f_j^- values, calculations were performed in two ways, considering the criterion features. If criterion j has a benefit feature, f_j^+ and the f_j^- values are;

$$\begin{aligned} f_j^+ &= \frac{max}{i} x_{ij} \\ f_j^- &= \frac{max}{i} x_{ij} \end{aligned} \tag{10}$$

If criterion j represents a cost, that is a loss, f_j^+ and the f_j^- values are;

$$\begin{aligned} f_j^+ &= \frac{max}{i} x_{ij} \\ f_j^- &= \frac{max}{i} x_{ij} \end{aligned} \tag{11}$$

STEP 2. Normalization Process and Creation of Normalization Matrix: A linear normalization process is applied to purify the values that make up the decision matrix from their similarities and keep them at a comparable level. The decision matrix of a decision problem consisting of m alternatives and n criteria is transformed into the R normalization matrix which is $m \times n$ dimensions. The elements of the R matrix are calculated with the help of Eq. (12).

$$r_{ij} = \frac{f_j^+ - x_{ij}}{f_j^+ - f_j^-} \tag{12}$$

$$X = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{12} & r_{22} & \dots & r_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ r_{m1} & r_{m1} & \dots & r_{mn} \end{bmatrix} \tag{13}$$

STEP 3. Weighting of Normalized Decision Matrix: By multiplying the criteria shown in the columns of the normalized decision matrix with the relevant w_j weights, the V weighted normalized decision matrix. is obtained. The weighted normalized decision matrix elements are calculated using Eq. (14).

$$v_{ij} = r_{ij} \times w_j \tag{14}$$

$$X = \begin{bmatrix} v_{11} & v_{12} & \dots & v_{1n} \\ v_{12} & v_{22} & \dots & v_{2n} \\ . & & & . \\ . & & & . \\ . & & & . \\ v_{m1} & v_{m1} & \dots & v_{mn} \end{bmatrix} \tag{15}$$

STEP 4. Calculation of S_i and R_i Values: S_i and R_i values are calculated for (j=1,2,. . . ,n). S_i and R_i values show the average and worst group scores for the alternative i.

$$\begin{aligned} S_i &= \sum_{j=1}^{n} v_{ij} \\ S_i &= \sum_{j=1}^{n} w_j \times r_{ij} \\ S_i &= \sum_{j=1}^{n} w_j \times \frac{f_j^* - x_{ij}}{f_j^* - f_j^-} \end{aligned} \tag{16}$$

$$\begin{aligned} R_j &= \frac{max}{j} v_{ij} \\ R_j &= \frac{max}{j} (w_j \times r_{ij} \\ R_j &= \frac{max}{j} \left(w_j \times \frac{f_j^* - x_{ij}}{f_j^* - f_j^-} \right) \end{aligned} \tag{17}$$

STEP 5. Calculation of Q_i Values: S^*, S^-, R^* and R^- parameters used in the calculation step of Q_i values are shown in Eq. (18).

$$\begin{aligned} S^* &= \frac{min}{i} S_i \\ S^- &= \frac{max}{i} S_i \\ S^* &= \frac{min}{i} R_i \\ S^- &= \frac{max}{i} R_i \end{aligned} \tag{18}$$

The q parameter used in the calculation of Q_i values shows the weight (maximum group benefit) of the majority of the criteria. While the q value expresses the weight for the strategy that provides the maximum group benefit, (1-q) expresses the weight of the minimum regret of the opponents. Consensus is achieved by "majority vote" (q>0,5), "consensus" (q=0,5) or "veto" (q<0,5).

$$Q_i = \frac{q \times (S_i - S^*)}{(S^- - S^*} + \frac{(1-q) \times (R_i - R^*)}{R^- - R^*} \tag{19}$$

STEP 6. Ranking Alternatives and Checking Conditions: By ordering S_i, R_i and Q_i values from smallest to largest, it is checked whether the alternative with the minimum Q_i value meets the following two conditions to test the accuracy of the rankings of the alternatives.

Condition 1. Acceptable advantage: When Q_i values are listed from smallest to largest and the first alternative is shown as A^1 and the second alternative is shown as A^2, acceptable advantage connected to condition 20.

$$Q(A^2) - Q(A^1) \geq DQ \tag{20}$$

The ***DQ*** parameter used in Eq. (20) depends on the number of alternatives and is calculated using Eq. (21) to indicate the number of alternatives ***m***.

$$DQ = \frac{1}{m-1} \tag{21}$$

Condition 2. Acceptable stability condition: Alternative A^1, which comes first when Q_i values are ranked from smallest to largest, is the best alternative with the minimum value when ranked from smallest to largest according to S and R values. In cases where any of these two conditions are not met, the following solution set is considered. If the acceptable stability condition is not met, both alternatives A^1 and $A^2$are accepted as the compromise solution. If an acceptable advantage is not provided, all alternatives $A^1, A^2, \ldots, A^m$ are included in the compromise best common solution set.

2.3. MOORA Method

The MOORA method was first introduced in 2006 by Brauers and Zavadskas as "a new method proposed for multi-objective optimization with distinct alternatives". The normalization step of the MOORA method was the same as that of TOPSIS. In this method, unlike the TOPSIS and VIKOR methods, non-ideal solutions are considered. The solutions are based solely on the reference point. The relationship between each alternative and the reference point is determined by taking the difference for each criterion (Çelikbilek, 2018).

The MOORA method refers to the matrix of responses of alternatives for the purposes for which the rates are applied. The MOORA method is mostly applied in two methods: the ratio method and the reference point approach. The method begins by writing the data in the form of a matrix, in which alternatives form rows, and criteria (objectives) form the columns (Yıldırım and Önder, 2014).

2.3.1. Ratio Method

The normalization process, which is performed by dividing the criteria by the square root of the sum of the squares of each alternative and where i=1,2,. . . ,m is the number of alternatives and j=1,2,. . . ,n is the number of criteria, is shown in Eq. (22).

$$x_{ij}^{*} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^{2}}} \tag{22}$$

x_{ij}^{*} is used as the normalized value of alternative i for criterion j. $x_{ij}^{*} \in [0,1]$. After the normalization process is completed, the criteria in the prepared table are determined and collected according to their maximum or minimum status, and the collected minimum values are subtracted from the collected maximum values.

$$y_{i^{*}} = \sum_{j=1}^{g} x_{ij^{*}} - \sum_{j=g+1}^{n} x_{ij^{*}} \tag{23}$$

2.3.2. Reference-Point Approach

In this approach, in addition to the ratio method, reference points (r_j'**s**) are determined for each criterion, which are maximum points for maximization and minimum points for minimization. Subsequently, the distances of these determined points to each x_{ij}^{*} are calculated.

$$r_j - x_{ij^{*}} \tag{24}$$

Where
i=1,2,. . . ,m number of alternatives,
j=1,2,. . . ,n number of criteria,
x_{ij}^{*}, The normalized value of alternative i in criterion j,
r_j, reference point of the criterion j

3. APPLICATION

3.1. Determining Alternatives and Criteria to be Used

This study aimed to evaluate the quality of e-commerce sites operating for the sale of second-hand clothes in Turkey using various multi-criteria decision-making methods. For this purpose, first, the trading sites in Turkey that deal with second-hand goods were researched to identify alternatives. The existence of many sites on the subject has supported the work in this field. The alternatives to be used in the content of this study were three e-commerce sites that mainly focused on women's clothing. These sites are "ModaCruz.com", "Dolap.com" and "Gardrops.com" respectively.

After the alternatives were identified, the opportunities offered by these sites and the opportunities they provided were investigated on the basis of quality criteria. During this research, a site called "Şikayetvar", which is frequently visited by internet users, was used. On this site, users can express one or more dissatisfaction related to the area they wish to explore. The three e-commerce sites that will be discussed within the scope of this study were researched, and the complaints of the users about the mentioned sites were evaluated. These complaints were then listed for use as evaluation criteria. The listed criteria are also classified in detail according to criteria in previous studies on this field.

A detailed view of the criteria determined from the reviews is provided in Table 3.

As shown in Table 3, there are many criteria stated by customers regarding the three e-commerce sites. Since using all these criteria in the evaluation phase will create implementation difficulties, the following 12 criteria were determined to be used in practice. The notation C here means criterion.

Table 3. Criteria list stated by customers on Şikayetvar website

Websites Criteria	Gardrops.com	ModaCruz.com	Dolap.com	Matching Criterion from Literature Reviews	Reference
Product Return Issues	+	+	+	Return Policy	Wang ve Huarng (2002), Ramanathan (2010), Ömürbek & Şimşek (2014).
Accessibility	+	+	+	Accessibility	Cebi (2013), Negash et al. (2003), Nilashi et al. (2012), Parasuraman et al. (2005), Wang & Huarng (2002), Ramanathan (2010), Ecer (2014), Alptekin et al. (2015), Kang et al. (2016), İlkbahar & Cebi (2017), Jiang et al. (2022).
After Sales Customer Support	+	+	+	Accessibility	
Support line problems	+	+	+	Customer Support Customer Service	Wang & Huarng (2002), Dündar et al. (2007), Ramanathan (2010), Dey et al. (2015), İlkbahar & Cebi (2017), Kahraman et al. (2018), Li & Sun (2020), Rekik (2021), Mohamed (2024)
Not Canceling The Order	+		+	System Quality	İçtenbaş and Rouyendegh (2012), Vatansever and Akgul (2014), Rouyendegh et al. (2019)
Shipping Fee	+	+		Service Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019), Mohamed (2024)
Fake Product	+	+	+	Accuracy Trust Reliability	Janda et al. (2002), Nilashi et al. (2012), Cebi (2013), Alptekin et al. (2015), Li & Sun (2020), Mohamed (2024)
Defective and missing products	+	+	+	Trust Relevance	Wang & Huarng (2002), DeLone & McLean (2003), Lee & Kozar (2006), Ecer (2014).
Shopping Security	+			Security	Parasuraman et al. (2005), Sun & Lin (2009), Ramanathan (2010), Alptekin et al. (2015), Kaya (2010), Aydın & Kahraman (2012), Santouridis et al. (2012), Dey et al. (2015), Kang et al. (2016), Li & Sun (2020)
Disorders in the System	+	+	+	System Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019)
Receiving Commission	+	+	+	Service Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019)
Failure to Ensure Buyer and Seller Rights	+	+	+	Service Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019)
IBAN not Accepted	+		+	System Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019)

Table 3. Continued

Shipping Problem	+	+	+	System Quality Service Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019)
Failure load money into account	+	+	+	System Quality Service Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019)
Money deduction on product returns	+	+	+	Return Policy	Wang & Huarng (2002), Ramanathan (2010), Ömürbek & Şimşek (2014).
Insufficient live support		+	+	Online Support (Help)	Cebi (2013), Lee & Kozar (2006)
Lack of trust	+	+		Reliability	Devaraj et al. (2002), Kim & Lim (2001), Negash et al. (2003), Yüksel (2007), Nilashi et al. (2012), Parasuraman et al. (2005), Sun & Lin (2009), Kassim & Abdullah (2010), Ömürbek & Şimşek (2014), Alptekin et al. (2015).
Arbitrary refunds		+	+	Service Quality	İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014), Rouyendegh et al. (2019)
Selling products in violation of rules		+	+	Accuracy	Wang & Huarng (2002), DeLone & McLean (2003), Lee & Kozar (2006), Ecer (2014).
Problems encountered in product returns			+	System Quality Service Quality Return Policy	Wang & Huarng (2002), Ramanathan (2010), İçtenbaş & Rouyendegh (2012), Vatansever & Akgul (2014).Ömürbek & Şimşek (2014), Rouyendegh et al. (2019), Li & Sun (2020), Mohamed (2024)

*C*1: Product Return Convenience
*C*2: Support Line Presence (Adequate Live Support)
*C*3: Preventing the Sale of Illegal Products (Fake Products)
*C*4: Shortage of Defective and Missing Product Shipments
*C*5: After Sales Customer Support
*C*6: Solution to Cargo Problem
*C*7: Money is loaded into account in a short period
*C*8: Fewer System Problems
*C*9: Security
*C*10: Accuracy
*C*11: Ease of Use of the Web Page
*C*12: Reputation

3.2. Preparation of the Survey and Data Collection

After the alternatives and criteria were determined, an evaluation survey was prepared in the EXCEL environment, and 12 decision-makers using three e-commerce sites were asked to evaluate both the criteria and the alternative e-

commerce sites among themselves. To help decision makers better understand the purpose of the survey, the information given in Tables 4 and 5 was shared with them before the evaluations.

When comparing criteria individually, only one side of the principal diagonal of the matrix is filled by decision-makers. In common use, the upper part of the prime diagonal is filled in by decision-makers, and the values below the prime diagonal are completed accordingly.

Table 4. Example criterion pairwise comparison matrix

EXAMPLE-1				
QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Criterion A	Criterion B	Criterion C	Criterion D
Criterion A	---	Less Important	Equally Important	Absolutely Important
Criterion B		---	Much More Important	Absolutely Unimportant
Criterion C			---	Equally Important
Criterion D				---

The expressions in the matrix given in EXAMPLE-1 are as follows. (Less important) Criterion A is less important than Criterion B when evaluating the quality of e-commerce sites selling second-hand clothes. (Equally important) Criterion A is equally important as Criterion C when evaluating the quality of e-commerce sites selling second-hand clothes. (Much more important) Criterion B is much more important than Criterion C when evaluating the quality of e-commerce sites selling second-hand clothes. (Absolutely unimportant) Criterion A is Absolutely unimportant compared to Criterion D when evaluating the quality of websites selling second-hand clothes.

Table 5. Evaluation of alternative example matrix

EXAMPLE-2				
QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Criterion A	Criterion B	Criterion C	Criterion D
Dolap	Poor	Good	Good	Very Poor
Moda Cruz	Good	Excellent	Excellent	Good
Gardrops	Average	Good	Average	Good

The expressions in the matrix given in EXAMPLE-2 are expressed as follows. “Dolap” second-hand e-commerce site is Poor in Criterion A, Good in Criterion B, Good in Criterion C, and Very Poor in Criterion D. “ModaCruz” second-hand e-commerce site is Good in terms of Criterion A, Excellent in Criterion B, Excellent in Criterion C, and Good in Criterion D. “Gardrops” second-hand e-commerce site is Average in terms of Criterion A, Good in terms of Criterion B, Average in terms of Criterion C, and Good in terms of Criterion D.

3.3. Importance Weights of Criteria Determined by the AHP Method

In this step, first, the verbal data obtained from the 12 decision-makers were converted into numerical equivalents for pairwise comparisons of the criteria. The numerical equivalents are given in Table 6.

Then, a single matrix is obtained by taking the average of all responses. In the obtained pairwise comparison matrix, row totals were taken, and normalization operations were carried out with the help of Eq. (1), and the pairwise comparison normalized matrix in Table 7 was created.

After the criterion pairwise comparison normalized matrix was obtained, the priority vector was obtained by taking the row averages of the normalized matrix. The priority vector obtained in this study are listed in Table 8.

In order to perform the consistency test, first, the normalized pairwise comparison matrix must be multiplied by the priority vector. The consistency calculations were carried out following Eq.s (2.4)-(2.7) and the consistency ratio was calculated as -0.614. This means that the matrix is consistent, and the results obtained through this matrix are usable. As a result, the priority vector of the criteria calculated by the AHP method (in other words the importance weights of the criteria) can be used in the VIKOR and MOORA methods.

Table 6. Scales used to evaluate criteria

VERBAL EVALUATION	NUMERICAL EQUIVALENT
Absolutely Unimportnt	1/7
Much Less Important	1/5
Less Important	1/3
Equally Important	1
More Important	3
Much More Important	5
Absolutely Important	7

Table 7. Criterion pairwise comparison normalized matrix

QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Product Return Convenience	Support Line Presenc(Adequate Live Support)	Preventing the Sale of Illegal Products (Fake Products)	Shortage of Defective and Missing Product Shipments	After Sales Customer Support	Solutions to Cargo Problems	Money is loaded into the account in a short period	Fewer System Problems	Security	Accuracy	Ease of Use of the Web Page	Reputation
Product Return Convenience	0,044	0,133	0,084	0.067	0.108	0.056	0.094	0.076	0.089	0.115	0.063	0.124
Support Line Presence (Adequate Live Support)	0.123	0.048	0.066	0.089	0.077	0.071	0.098	0.096	0.091	0.052	0.077	0.078
Preventing the Sale of Illegal Products (Fake Products)	0.090	0.076	0.041	0.076	0.161	0.092	0.128	0.135	0.060	0.104	0.109	0.055
Shortage of Defective and Missing Product Shipments	0.060	0.086	0.064	0.049	0.126	0.075	0.101	0.122	0.038	0.058	0.083	0.085
After Sales Customer Support	0.093	0.071	0.129	0.120	0.052	0.056	0.063	0.077	0.068	0.042	0.064	0.055
Solutions to Cargo Problems	0.046	0.063	0.071	0.068	0.054	0.054	0.104	0.075	0.088	0.062	0.092	0.071
Money is loaded into the account in a short period	0.096	0.108	0.122	0.114	0.075	0.129	0.043	0.085	0.065	0.057	0.095	0.080
Fewer System Problems	0.068	0.092	0.112	0.120	0.080	0.081	0.074	0.050	0.048	0.072	0.061	0.076
Security	0.084	0.094	0.053	0.040	0.075	0.101	0.060	0.051	0.047	0.113	0.137	0.127
Accuracy	0.105	0.051	0.089	0.059	0.045	0.069	0.051	0.073	0.109	0.048	0.119	0.121
Ease of Use of the Web Page	0.075	0.100	0.122	0.111	0.090	0.135	0.112	0.083	0.174	0.156	0.037	0.081
Reputation	0.115	0.078	0.048	0.087	0.060	0.080	0.073	0.079	0.125	0.123	0.062	0.048

Table 8. Priority Vector

		Priority Vektor
$C1$	Product Return Convenience	0.088
$C2$	Support Line Presence (Adequate Live Support)	0.080
$C3$	Preventing the Sale of Illegal Products (Fake Products)	0.094
$C4$	Shortage of Defective and Missing Product Shipments	0.079
$C5$	After Sales Customer Support	0.074
$C6$	Solutions to Cargo Problems	0.071
$C7$	Money is loaded into the account in a short period	0.089
$C8$	Fewer System Problems	0.078
$C9$	Security	0.082
$C10$	Accuracy	0.078
$C11$	Ease of Use of the Web Page	0.106
$C12$	Reputation	0.081
TOTAL		1.000

3.4. Evaluation of Alternatives using the VIKOR Method

To apply the VIKOR method, a decision matrix must first be created. For this purpose, the verbal values that decision-makers assign to alternatives by evaluating them according to the relevant criteria must be converted into numerical equivalents and the average of 12 decision-makers must be taken, as in the AHP method. The scale used to evaluate alternatives is shown in Table 9, and the resulting decision matrix is shown in Table 10.

Table 9. Scales used to evaluate alternatives

VERBAL EVALUATION	NUMERICAL EQUIVALENT
VERY POOR	1
POOR	2
AVERAGE	3
GOOD	4
EXCELLENT	5

Table 10. Decision matrix

QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Product Return Convenience	Support Line Presence (Adequate Live Support)	Preventing the Sale of Illegal Products (Fake Products)	Shortage of Defective and Missing Product Shipments	After Sales Customer Support	Solutions to Cargo Problems	Money is loaded into the account in a short period	Fewer System Problems	Security	Accuracy	Ease of Use of the Web Page	Reputation
Dolap	2.846	3.154	3.077	3.308	3.231	3.615	3.923	3.385	3.769	3.308	3.846	3.750
ModaCruz	2.769	2.692	2.615	2.846	2.846	3.000	2.923	2.846	2.846	3.077	3.154	3.250
Gardrops	2.462	2.692	2.692	3.000	2.769	2.923	3.154	3.077	3.000	3.000	3.154	3.333

After creating the decision matrix, the best and worst values for each criterion are determined. Here, it is important to determine whether the criteria have benefits or costs. Therefore, is the criterion a desirable or undesirable situation?

The 12 criteria considered in this study have benefits, and accordingly, the ideal solution values in Table 11 were determined by taking Eq. (10).

Table 11. Ideal Solution Values

QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Product Return Convenience	Support Line Presence (Adequate Live Support)	Preventing the Sale of Illegal Products (Fake Products)	Shortage of Defective and Missing Product Shipments	After Sales Customer Support	Solutions to Cargo Problems	Money is loaded into the account in a short period	Fewer System Problems	Security	Accuracy	Ease of Use of the Web Page	Reputation
f_j^+	2.846	3.154	3.077	3.308	3.231	3.615	3.923	3.385	3.769	3.308	3.846	3.750
f_j^-	2.462	2.692	2.615	2.846	2.769	2.923	2.923	2.846	2.846	3.000	3.154	3.250

In the next stage, decision matrix normalization was performed depending on the ideal solution values. Subsequently, the weighted normalized decision matrix in Table 12 was obtained by considering the weights calculated using the AHP method.

Table 12. Weighted normalized decision matrix

QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Product Return Convenience	Support Line Presence (Adequate Live Support)	Preventing the Sale of Illegal Products (Fake Products)	Shortage of Defective and Missing Product Shipments	After Sales Customer Support	Solutions to Cargo Problems	Money is loaded into the account in a short period	Fewer System Problems	Security	Accuracy	Ease of Use of the Web Page	Reputation
Dolap	0	0	0	0	0	0	0	0	0	0	0	0
ModaCruz	0.018	0.080	0.094	0.079	0.062	0.063	0.089	0.078	0.082	0.059	0.106	0.081
Gardrops	0.088	0.080	0.078	0.053	0.074	0.071	0.068	0.044	0.068	0.078	0.106	0.068

Then, considering Eq. (18) and Eq. (19), compromise solution values were calculated, and alternative e-commerce sites were ranked in terms of quality. The results obtained are stated in table 13.

Table 13. Ranking of alternatives using the VIKOR method

	Q_i	Ranking
Dolap	0	1
ModaCruz	1	3
Gardrops	0,9926	2

The results in Table 13 clearly show that the e-commerce site found to be of the highest quality by decision makers is "Dolap". Gardrops ranks second. ModaCruz was ranked last in terms of quality.

3.5. Evaluation of Alternatives using the MOORA Method

As in the other methods, the decision matrix in the MOORA method must first be created. The decision matrix shown in Table 10 is the main input of the proposed method. To normalize the decision matrix, the square root of the sum of the squares of the values of the alternatives under each criterion was taken; the value in the relevant column was divided by this value, and a normalized decision matrix was created. The relevant matrix is shown in Table 14.

Table 14. The normalized decision matrix

QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Product Return Convenience	Support Line Presence (Adequate Live Support)	Preventing the Sale of Illegal Products (Fake Products)	Shortage of Defective and Missing Product Shipments	After Sales Customer Support	Solutions to Cargo Problems	Money is loaded into the account in a short period	Fewer System Problems	Security	Accuracy	Ease of Use of the Web Page	Reputation
Dolap	0.609	0.638	0.634	0.625	0.631	0.653	0.674	0.628	0.674	0.610	0.653	0.627
ModaCruz	0.593	0.545	0.539	0.537	0.556	0.542	0.502	0.528	0.509	0.567	0.536	0.544
Gardrops	0.527	0.545	0.555	0.567	0.541	0.528	0.542	0.571	0.536	0.553	0.536	0.558

In the next stage, the weighted normalized decision matrix shown in Table 15 was obtained by considering the weights calculated using the AHP method.

Table 15. Weighted normalized decision matrix

QUALITY OF E-COMMERCE SITES FOR SELLING SECOND-HAND CLOTHES	Product Return Convenience	Support Line Presence (Adequate Live Support)	Preventing the Sale of Illegal Products (Fake Products)	Shortage of Defective and Missing Product Shipments	After Sales Customer Support	Solutions to Cargo Problems	Money is loaded into the account in a short period	Fewer System Problems	Security	Accuracy	Ease of Use of the Web Page	Reputation
Dolap	0.053	0.051	0.060	0.049	0.047	0.046	0.060	0.049	0.055	0.048	0.069	0.051
ModaCruz	0.052	0.044	0.051	0.042	0.041	0.038	0.045	0.041	0.042	0.044	0.057	0.044
Gardrops	0.046	0.044	0.052	0.045	0.040	0.037	0.048	0.044	0.044	0.043	0.057	0.045

After obtaining the weighted normalized matrix, the reference points and distances of each alternative to these reference points were calculated, and the overall distances were obtained by taking the row totals. These distance values were also considered when ranking alternatives. The obtained results are shown in Table 16.

Table 16. Ranking of alternatives using the MOORA method

	d_i	Ranking
Dolap	0,000	1
ModaCruz	0,097	3
Gardrops	0,092	2

As a result of all these steps, the same results were obtained using the VIKOR method, and it was calculated that the "Dolap" e-commerce site was of higher quality in light of the considered criteria.

4. DISCUSSION AND CONCLUSION

Second-hand shopping is becoming increasingly popular and widespread across digital channels, especially in the context of consumer-to-consumer e-commerce. This initiative, which aims to extend the product life cycle, can include other options, such as rental, exchange, redesign, and repair, in addition to simply selling used products. From an environmental perspective, such alternative forms of consumption are needed to simultaneously reduce the use of material resources, meet consumers' need for innovation, and respond to the revenue demands of a global industry.

The sale of second-hand clothes on websites has increased considerably. The large number of sites for this purpose causes confusion among consumers regarding which site to shop from. Determining the most suitable website in terms of many criteria, such as price, security, after-sales support, and accessibility, is a problem that consumers need to solve. In this study, the quality of three e-commerce sites operating for the sale of second-hand clothes in Turkey was evaluated using the AHP, VIKOR, and MOORA methods. The criteria most taken into consideration when shopping on e-commerce sites were determined from studies in the literature and from a site called "Şikayetvar", which is frequently visited by internet users. The weights of the determined criteria were then calculated using the AHP method. Evaluations were performed among the websites using these weights in the VIKOR and MOORA methods.

According to the evaluation results, "ease of use of the web page", "preventing the sale of illegal products (fake products)", "money being deposited into the account in a short time", "product return convenience" and "security" are the five criteria that users most take into consideration, respectively. The "solution for cargo problem" is often considered the least significant criterion by decision-makers. These details are clearly shown in Fig. 2.

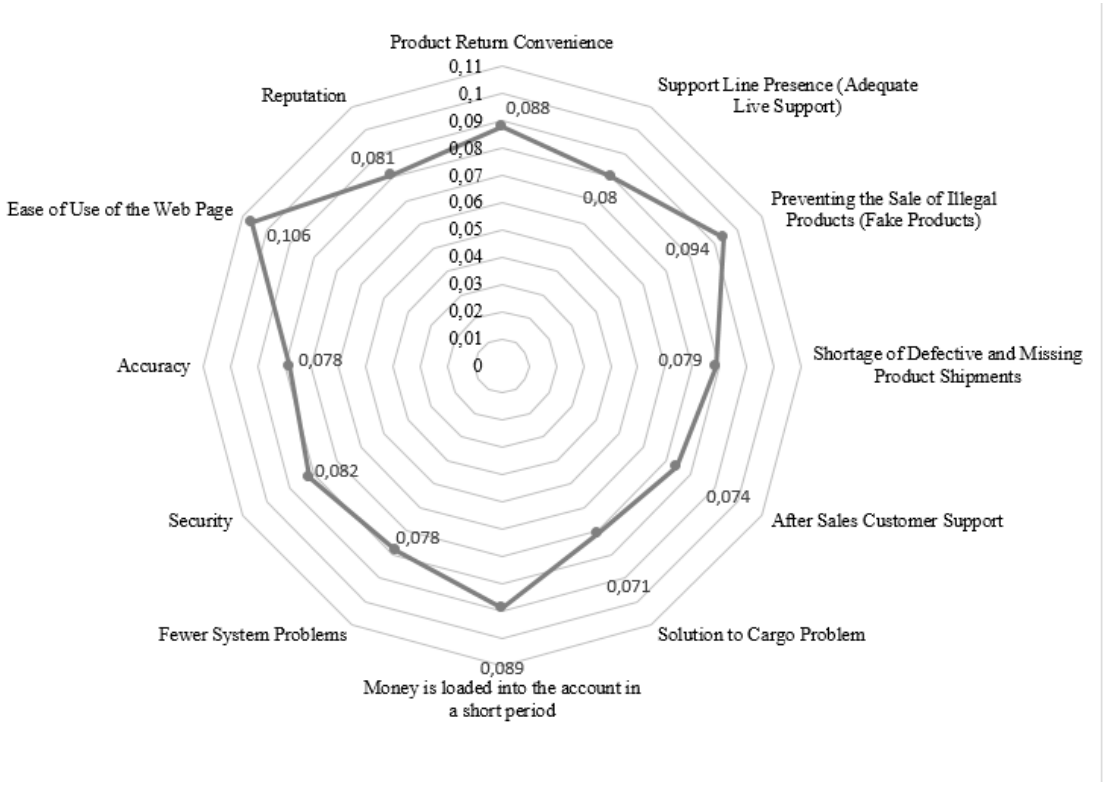

Figure 2. Importance Weights of Criteria

In addition, it was determined that the Dolap website was of higher quality than the ModaCruz and Gardrops websites considering 12 criteria and evaluations of only 12 decision makers. This is because the Dolap website exhibits the lowest value among the distances calculated using both the VIKOR and MOORA methods, as shown in Fig. 3. These findings guide how second-hand clothing-selling websites should improve their service and system quality. In today's world, where online shopping is increasingly favored due to considerations of time efficiency and speed, it is unavoidable that users seek to conduct their transactions with ease. Consequently, the criterion of " ease of use of the website"

carries the highest weight in this context. The issue of "fake products," which poses significant challenges in the sale of second-hand clothes, ranks second in importance. The primary concern is that inflated prices may be charged for items that do not genuinely belong to the specified brand, thereby deceiving buyers. As a result, users anticipate that the websites from which they purchase products will provide assurances and implement measures to prevent the sale of illegal (fake) products.

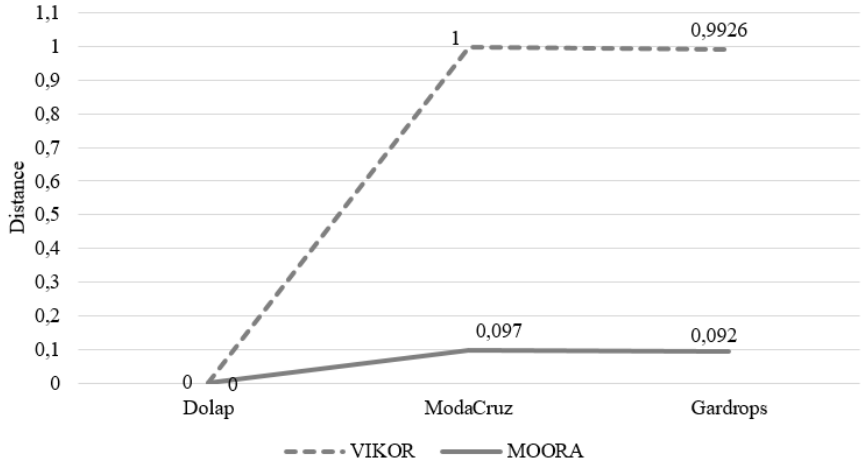

Figure 3. Distance Values of Alternatives

It is important to note that the findings of this study are derived from the personal evaluations of only 12 decision-makers. Consequently, the performance rankings of the websites identified in this study may vary depending on the numbers and characteristics of the decision-makers. This limitation is a significant aspect of the research. This study reflects a specific time frame, a particular user group and a single country context. Nonetheless, the individuals interviewed were selected for their impartiality and lack of any material or ethical interests or relationships with the websites under evaluation, and their opinions were presented in the study without any modification. It is also essential to emphasize that the primary objective of this study is to demonstrate the application of various multi-criteria decision-making methods to address this particular problem.

In this study, it is assumed that decision-makers possess the same knowledge and experience, an assumption critiqued in the literature as a limitation of MCDM methods. Scholars argue that it is unrealistic for decision-makers to expect consensus on knowledge, experience, and perspectives. Consequently, assigning equal weights to individuals may undermine the reliability and effectiveness of the outcomes. (Koksalmis and Kabak, 2019; Ayasrah and Turan, 2021; Škoda et al., 2021). Therefore, determining the weights of decision-makers using different methods will be beneficial in future studies.

The topic discussed in this study contributes to the literature, especially because it is related to sustainable fashion, which is currently highly emphasized. In addition, since this study includes more than one method, it proposes an integrated solution to the literature. In addition, a holistic perspective was provided by matching the real user comments received from the "Şikayetvar" website with the evaluation criteria described in the literature.

It is possible to update considering different methods and using more evaluators in future studies. The use of evaluation methods, especially those involving fuzzy datasets, will increase the reliability of the findings. It is also possible to update the criteria considered.

Peer Review: Externally peer-reviewed.

Conflict of Interest: The author have no conflict of interest to declare.

Grant Support: The author declared that this study has received no financial support.

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How cite this article

Büyüksaatçı Kiriş, S. (2024). Evaluation of the Quality of Second-Hand Clothes Trading Websites using the VIKOR and MOORA Methods. *Acta Infologica, 8*(2), 157-175. https://doi.org/10.26650/acin.1462978