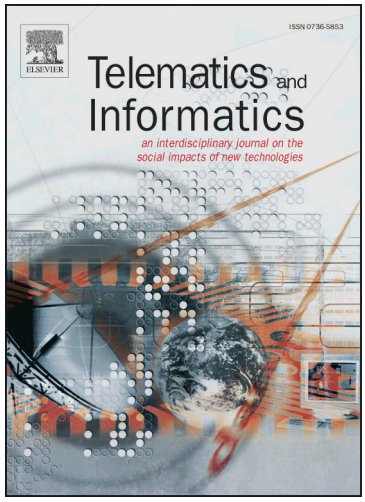

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Classification of Design Parameters for E-commerce Websites: A Novel Fuzzy Kano Approach

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Abstract

Websites have gained vital importance for organizations along with the growing competition in the world market. It is known that usability requirements heavily depend on the type, audience and purpose of websites. For the e-commerce environment, usability assessment of a website is required to figure out the impact of website design on customer purchases. Thus, usability assessment and design of online pages have become the subject of many scientific studies. However, in any of these studies, design parameters were not identified in such a detailed way, and they were not classified in line with customer expectations to assess the overall usability of an e-commerce website. This study therefore aims to analyze and classify design parameters according to customer expectations in order to evaluate the usability of e-commerce websites in a more comprehensive manner. Four websites are assessed using the proposed novel approach with respect to the identified design parameters and the usability scores of the websites are examined. It is revealed that the websites with high usability score are more preferred by customers. Therefore, it is indicated that usability of e-commerce websites affects customer purchases.

Keywords: Kano Model, Fuzzy sets, Usability, E-commerce

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1. Introduction

With the growing competition in the world market, websites have gained vital importance for organizations [1] since the impact of the internet and web technologies on business has been shown by the tremendous success of e-commerce [2]. Online presence and low prices initially appear to be sufficient to achieve success in e-commerce. Nevertheless, online presence and low prices do not assure service quality,and customers have encountered some problems on navigation, online transactions, delivery times, unanswered e-mails, and inadequate information [3]. Such problems are evaluated in the context of usability. Usability is defined by whether the tasks can be easily and quickly performed by the users or not [4]. Moreover, Nielsen and Molich [5] qualify a usable website as (i) easy to learn and remember, (ii) effective to use, (iii) understandable, and (iv) satisfactory. Usability is also defined as a quality attribute for software applications that indicates to what extent identified goals can be accomplished with effectiveness, efficiency and satisfaction by users [6, 7]. However, Lawrence and Tavakol [8] state that usability requirements differ for each website as well as design solutions. The usability requirements heavily depend on the type, audience and purpose of websites [8, 9]. In the case of e-commerce websites, as appropriate to its purpose, usable websites should be able to create a positive attitude toward online stores. Thus, it should be able to increase revisit rates and duration, and eventually encourage online purchases [10, 11].

For the e-commerce environment, assessment of website usability is required to figure out the impact of the design of a website on customer purchases [12]. Moreover, it was revealed in Belanche et al.'s study [13] that website usability has an indirect impact on intention to use through user satisfaction. Usability of a website is thus one of the key factors influencing user satisfaction, but the absence of appropriate techniques and attributes to evaluate website usability is the main obstacle to enhance a website [1].

In the traditional Kano Model, features or design parameters are classified according to

the majority of preferences, and a design parameter can only belong to one class. In other words, the class to which a property belongs may change depending on the response of only one person. Therefore, in this study, a novel approach that allows design parameters to belong to different classes has been introduced by combining Kano model with fuzzy sets. This study therefore aims to classify design parameters according to customer expectations, and to evaluate the usability of e-commerce websites in an effective way.

The rest of this paper is structured as follows: usability and website design related studies are given in Section 2. The methods employed in this study are presented in Section 3. Section 4 describes the proposed approach, an integration of the Kano model and fuzzy sets. Finally, application and concluding remarks are provided in Section 5 and Section 6, respectively.

2. Literature Review

Usability and website design have been widely studied throughout the literature by employing various methods. Yeung and Law [14] utilize a modified version of a heuristic technique to assess the usability of chain and independent hotel websites. In the study of Li and Li [15], business to customer websites are assessed according to the usability criteria which are determined based on two questionnaires. The first questionnaire aims to specify the convenient factors for usability assessment whereas the second one is employed to determine the importance levels of these factors [15]. Cognitive walkthrough and think aloud are utilized by Khajouei et al. [16] to diagnose usability problems. Furthermore, performances of these methods to specify different types of usability problems are investigated [16]. In the study of Rashid et al. [17], occupational safety and health websites are evaluated through eye tracking system, and both subjective and moderator ratings. Heuristic evaluation is employed in the study of Huang and Benyoucef [2] to obtain the views of users on the usability and credibility of e-government websites. After participants take the usability and

credibility questionnaire, one-way ANOVA, one-sample t-test and paired-sample t-test are employed to analyze the relationships between dependent and independent variables [2]. A statistical study is conducted by Roy et al. [1] to assess the usability and accessibility of academic websites depending upon user perception. The study consists of two types of usability evaluation techniques. One of them is questionnaire-based evaluation whereas the other one is performance-based evaluation [1]. Thowfeek and Salam [18] conduct a survey by employing Shackel's usability model to confirm usability attributes for the assessment of e-learning websites. According to the study of Mvungi and Tossy [19], website evaluation methods can be classified as user-based usability evaluation methods, evaluator-based usability evaluation methods, and automatic website evaluation tools. When redesigning the website is the main objective, website evaluation methods such as user testing and expert evaluation come to the forefront [19]. Moreover, Cebi [20] proposes an integrated method including fuzzy set theory, the decision-making trial and evaluation laboratory method, and generalized Choquet integral techniques to evaluate the design of online shopping websites.

In conjunction with different methods, several parameters have been taken into consideration to assess usability and effectiveness of websites. In the study of Yeung and Law [14], the evaluation framework consists of five dimensions: language usability, information architecture usability, layout and graphics usability, general usability, user interface and navigation usability. In the study of Li and Li [15], usability evaluation criteria are specified as website information technology, website error rate, customer relation, merchandise price, and merchandise promotions. Lee and Kozar [10] examine website usability by considering the following factors: consistency, navigability, supportability, learnability, simplicity, interactivity, telepresence, credibility, readability, content relevance. As a result of a causal mapping analysis and a questionnaire-based field study, several direct and indirect relationships between factors affecting the usability of a website, purchase intention, and purchase action are detected. In the study of Roy et al.[1], while assessing website usability, factors

such as attractiveness, controllability, efficiency, helpfulness, learnability, information sharing, multiple language support, navigation are included in the framework. In the process of usability evaluation, observed task success rates, task completion times, post-task satisfaction ratings and feedbacks are taken into consideration [1]. The usability guideline adopted in the study of Huang and Benyoucef [2] includes the following factors: visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility, efficiency of use, aesthetic design, help user recover errors, help and documentation, inter-operability, support users' skills, and respectful interaction. The usability concept of Shackel [21] employed in the study of Thowfeek and Salam [18] consists of learnability, effectiveness, flexibility and attitude. Furthermore, learnability is composed of speed and errors whereas effectiveness comprises time to learn and retention [18]. The factors considered in the study of Venkatesh et al. [22] are the following: access, content, content organization, graphs, hardware and software, headings, titles and labels, home page, links, list, navigation, page layout, screen, scrolling and paging, search, text, and user experience.

In sum, usability assessment and design of online pages have become the subject of many scientific studies. In particular, the design parameters and features used in these studies are diverse (Appendix A), and the methods used in these studies are generally based on questionnaires. However, in any of these studies, design parameters are not identified in such a detailed way and are not classified according to customer expectations to assess the overall usability of an e-commerce website.

3. Methodology

In this section, components of the proposed approach, Kano model and fuzzy sets, are examined.

3.1. Kano Model

Kano model [23] originally was implemented by classifying quality attributes through a questionnaire consisting of pairs of questions. These pairs involve functional and dysfunctional questions. Functional question asks about the consumer's feelings in the case of fulfillment of an attribute whereas dysfunctional question asks about feelings in the case of non-fulfillment of an attribute [24]. In the questionnaire prepared to implement Kano model, participants need to answer both functional and dysfunctional questions by choosing one of the following linguistic terms: "like", "must-be", "neutral", "live-with", and "dislike" [25]. Then the collected data are analyzed by employing an evaluation table, which provides a categorization of attributes for each respondent. In Table 1, evaluation table for Kano questionnaire is provided in which "M, O, A, I, R, Q" represent Must-Be, One-Dimensional, Attractive, Indifferent, Reverse and Questionable attributes, respectively. Frequencies of single-respondent categorizations are lastly used to find out the final classification of attributes/requirements [24]. When the Kano model is implemented to the data collected through functional and dysfunctional questions, attributes/requirements of a product are classified as follows:

Must-Be attributes: Non-fulfillment of the must-be attributes causes extreme dissatisfaction in customers whereas fulfillment of these attributes does not lead to any increase in their satisfaction level.

One-Dimensional attributes: Customer satisfaction is proportional to the level of fulfillment of the one-dimensional requirements, which means that the higher customer satisfaction can be achieved by the higher level of fulfillment.

Attractive attributes: Fulfillment of the attractive attributes generates more than proportional satisfaction whereas non-fulfillment of these requirements does not cause any dissatisfaction [26].

Indifferent attributes: If existence or absence of an attribute does not have an impact

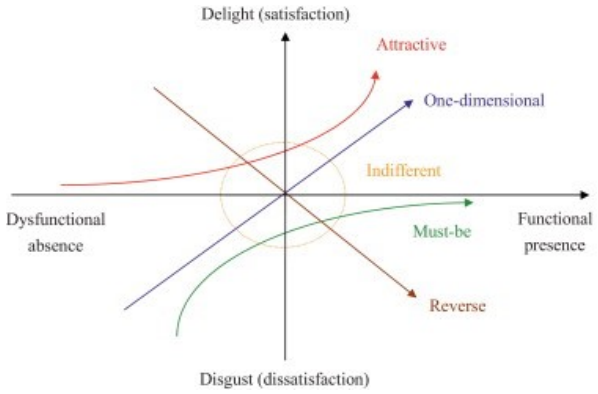

Figure 1: Relation between satisfaction and fulfillment of different types of attributes [25]

Customer Response		Dysfunctional Question				
		Like	Must be	Neutral	Live-with	Dislike
Functional Question	**Like**	Q	A	A	A	O
	Must be	R	I	I	I	M
	Neutral	R	I	I	I	M
	Live-with	R	I	I	I	M
	Dislike	R	R	R	R	Q

Table 1: Evaluation table for Kano questionnaire

on customer satisfaction, this attribute qualified as indifferent.

Reverse attributes: If existence of an attribute is harmful to customer satisfaction, it is called reverse attribute.

Questionable attributes: This outcome demonstrates that either the respondent provides an illogical answer or the question is described incorrectly [25].

The impacts of these attributes on customer satisfaction are exhibited in Figure 1. In the Kano Model, the horizontal axis indicates the fulfillment level of the attribute whereas the vertical axis represents customer satisfaction [27].

3.2. Fuzzy Sets

Fuzzy sets were introduced by Zadeh [28] to represent vagueness and impreciseness of human thoughts. Since its development, fuzzy sets have been widely utilized as integrated to various methods. Kano model is also combined with fuzzy approach in the literature. In the study of Lee et al. [29], quality function deployment based on both Kano model and fuzzy approach was employed for product life-cycle assessment. It was indicated that fuzzy logic enables Kano model to provide a more objective weighting. Florez-Lopez and Ramon-Jeronimo [30] proposed an approach including Kano model, fuzzy distances, and 2-tuple fuzzy-linguistic model for effective management of customer-service logistics.

In the study of Wang and Wang [25], participants may respond to functional and dysfunctional questions with a percentage showing their agreement (i.e. 70% like, 30% neutral etc.) if they may not express their opinions exactly through a single choice. However, answering both functional and dysfunctional questions for the same attribute in a questionnaire is already a difficult process for the decision maker. Being able to choose more than one option with percentages makes it even harder. Moreover, Wang [31] used an integrated method which consists of fuzzy Kano model, information entropy and TOPSIS for customer satisfaction and product configuration, specifically configuring varieties of smart pads. In the study, Kano model was fuzzified by enabling respondents to express their opinions with percentages as well. Lee and Huang [32] also made Kano questionnaires fuzzy by allowing respondents to agree with options in percentage.

The disadvantage of Kano Model is that it takes the majority of responses into consideration to determine the class of any attribute/design parameter. Assume that a survey of 140 participants is analyzed and it is revealed that *A, O, M, I, R*, and *Q* values for a particular parameter are 39, 34, 38, 28, and 1, respectively. The class of this particular parameter is determined as *A*, because *A* value is the highest. However, 38 people qualify this parameter as M. In this case, only one person determines the class of the related parameter. Therefore, this part of the Kano model needs fuzzification. Each parameter has to be defined by values representing the membership degree of the parameter to each class. Unlike the study of Wang and Wang [25], the fuzzy sets should be used in determining class of a parameter. For this purpose, in this study, an integrated method including fuzzy sets theory and Kano Model has been proposed to classify design parameters of e-commerce websites, and consequently to assess their usability.

4. Proposed Approach

The proposed approach mainly consists of Kano model and fuzzy sets. The framework of the proposed integrated approach is presented in Figure 3. The main steps of the proposed approach are as follows:

Step 1. A thorough research is conducted to identify main design parameters for assessment.

Step 2. A questionnaire with respect to the identified parameters is prepared and conducted for analysis.

Step 3. According to results of the questionnaire, A, O, M, I, R, Q values are obtained, and weights of the parameters are determined according to formulas given in Eqs. (1)-(3). Eq. (1) is used when $(A+O+M) > (I+R+Q)$ holds, otherwise Eqs. (2)-(3) are adopted.

$$W_i = \frac{A+O}{A+2\times O+M} \quad \text{for} \quad i\epsilon\{A, O, M\} \tag{1}$$

$$W_i = 0 \quad \text{for} \quad i\epsilon\{I\} \tag{2}$$

$$W_i = \frac{-R}{I+R+Q}, \quad \text{for} \quad i\epsilon\{R\} \tag{3}$$

Step 4. Normalized values are obtained by dividing the responses belong to a particular class by the total number of responses.

Step 5. For each parameter, the normalized values belonging to the group "A-O-M" or "I-R-Q" to which the parameter belongs are placed on the graph (see Figure 2). Then, this graph is defuzzified by using the center of gravity formula given in Eq. (4) [33] to determine the class of the considered parameter.

$$COG(F) = \frac{\int_X xF(x)dx}{\int_X F(x)dx} \tag{4}$$

where F is a fuzzy set on X.

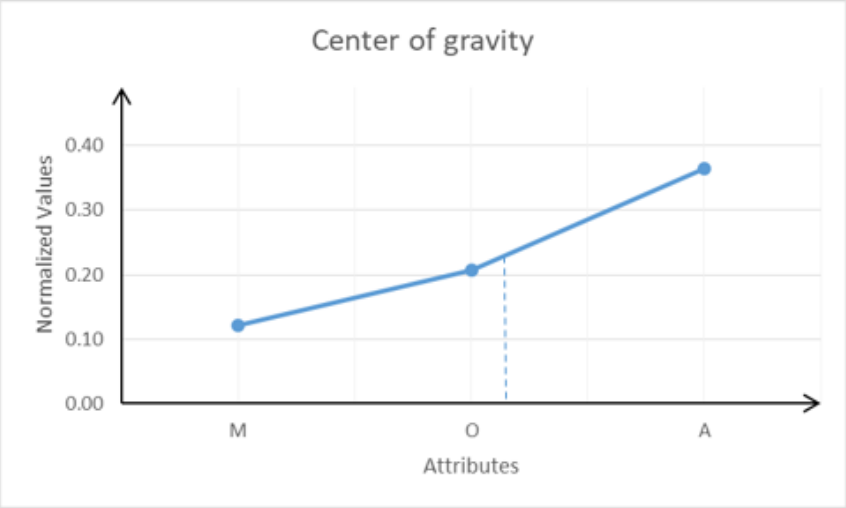

Figure 2: Graph example for center of gravity step

After a crisp number is obtained by Eq. (4), membership degrees to classes are calculated based on distances of the obtained crisp number to numbers corresponding to these classes. Eqs. (5)-(7) are used when $(A+O+M) > (I+R+Q)$ holds to find the membership degrees to classes *M, O, A*; otherwise Eqs. (8)-(9) are adopted to find the membership degrees to classes *R, I*.

$$\mu_{ij} = max((1 - |COG - 1|), 0) \quad \text{for} \quad j\epsilon\{M\} \tag{5}$$

$$\mu_{ij} = max((1 - |COG - 2|), 0) \quad \text{for} \quad j\epsilon\{O\} \tag{6}$$

$$\mu_{ij} = max((1 - |3 - COG|), 0) \quad \text{for} \quad j\epsilon\{A\} \tag{7}$$

$$\mu_{ij} = max((1 - |COG - 1|), 0) \quad \text{for} \quad j\epsilon\{R\} \tag{8}$$

$$\mu_{ij} = max((1 - |COG - 2|), 0) \quad \text{for} \quad j\epsilon\{I\} \tag{9}$$

where μ_{ij} represents membership degree of design parameter i^{th} to class j.

Step 6. In this step, presence and absence point of a design parameter is calculated by using Eq.(10)

$$P_{ik} = \sum_{j \epsilon J} W_i \times S_{kj} \times \mu(ij) \tag{10}$$

where W_i is the weight of i^{th} parameter. State point, S_{kj}, represents the presence and absence effects of any parameters depending on the class where $k\epsilon\{Presence, Absence\}$, $j\epsilon\{A, O, M, I, R\}$. $\mu(ij)$ is the membership degree of i^{th} parameter to class j. When k is 'presence', then P_{ik} represents presence point of i^{th} parameter. When k is 'absence', then P_{ik} represents its absence point. As state point, S_{kj}, the scale given in Table 2 is used. The following information is taken into consideration to form this scale. Presence or absence of a parameter provides a certain amount of points contributing the overall usability score of an e-commerce website based on the class of the parameter. For instance, if a parameter is qualified as "*must be*", the presence of this parameter does not provide any point to the overall usability of a website, because customers already think the website must have this feature. However, absence of a "*must be*" parameter reduces the overall usability score since it causes extreme dissatisfaction. On the other hand, if a parameter belongs to the class "*attractive*", then the presence of this parameter positively affects the usability of a website. However, the absence of this feature does not have any negative impact on usability because its absence does not cause any dissatisfaction. If a parameter is a member of "*indifferent*" class, then its presence or absence has no impact on the customers. Presence of "*one dimensional*" parameters increases the overall usability score whereas its absence decreases, because it is known by the definition of "*one dimensional*" attributes that customer satisfaction is proportional to the level of fulfillment.

Class / **State**	**R**	**I**	**M**	**O**	**A**
Presence (✓)	-50	0	0	50	100
Absence (✗)	0	0	-100	-50	0

Table 2: Presence and absence effects of any parameters depending on the class (S_{kj})

Step 7. Overall usability score is computed by Eq. (11).

$$Usability \quad Score = \sum_{\forall k,i} X_{ik} \times P_{ik} \tag{11}$$

where X_{ik} is a binary variable representing whether parameter i is present or absent in the website. In other words, when k is present, then $X_{ik} = 1$, and it indicates that parameter i exists in the website whereas when k is absent, then $X_{ik} = 0$.

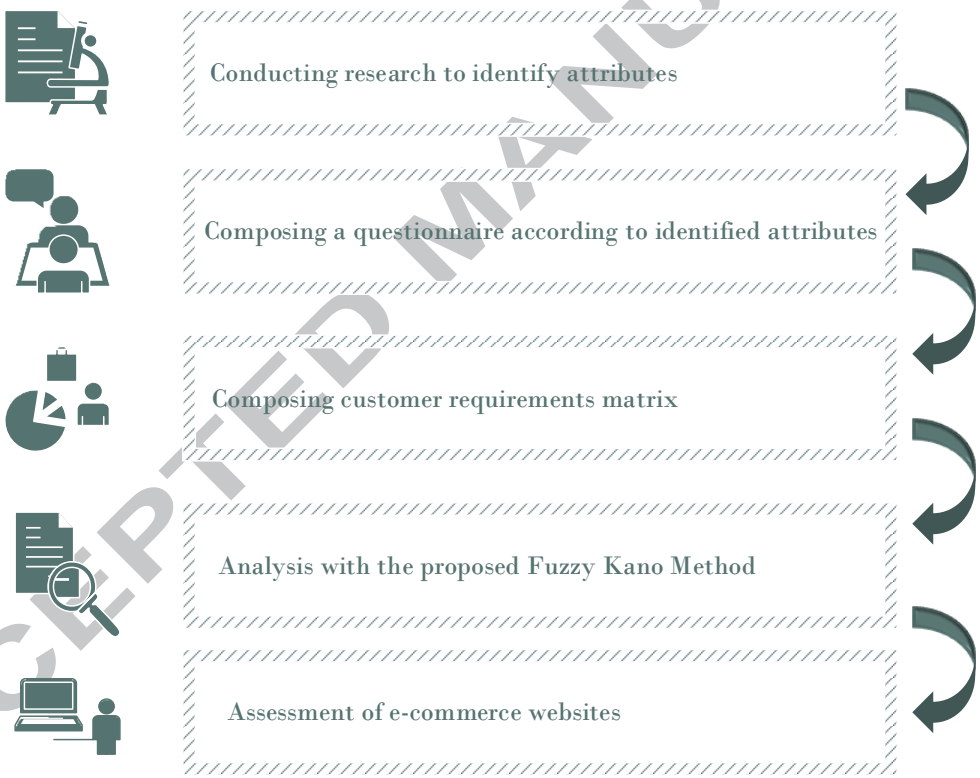

Figure 3: Main steps of the proposed approach

5. Application

A questionnaire on the usability of an e-commerce website is prepared and conducted with 147 respondents. 29% and 71% of the participants are male and female, respectively.

Moreover, 75%, 19%, and 6% of the participants are student, employees, and part-time employees, respectively. 69% of the participants spends at least 3 hours a day on the internet and 42% of the participants are shopping online at least once a month. 43%, 18%, 5%, 28%, and 6% of the participants prefer online shopping for textile, electronics, cosmetics, books-stationery and others, respectively. Furthermore, 71% of the participants give credit card response to the question "Which payment method do you usually prefer for online shopping?". 73% of the participants give mobile phone response to the question "Which device do you use the most to connect the internet?".

Impacts of twenty two parameters on the usability of an e-commerce website are investigated through functional and dysfunctional questions. According to the results of the questionnaire, A, O, M, I, R, Q values are obtained, and the weights of the parameters are determined according to the formulas given in Eqs. (1)-(3). In order to obtain membership degrees of parameters to the classes, firstly, the normalized A, O, M, I, R, Q values are obtained by dividing the number of responses for this particular class by the total number of responses. After a graph is built for each parameter by using these normalized values, they are defuzzified by using the center of gravity formula provided in Eq. (4). According to Eqs. (5)-(9), membership degrees of the parameters to the classes are calculated. The classes to which the parameters belong in the traditional Kano model and the membership grades to the classes found through the proposed method are given in Table 3.

Design Parameters	**Class in Traditional Kano Model**	**Fuzzy Kano Model**		
		$\mu(M)$	$\mu(O)$	$\mu(A)$
Compare-with option	A	0.00	0.61	0.39
Live support	A	0.00	0.75	0.25
Access to customer representative via telephone	M	0.09	0.91	0.00
Customer comments	O	0.00	0.95	0.05
Ability to purchase without signing in	A	0.00	0.80	0.20
3D secure	O	0.05	0.95	0.00
Availability of customer comments on the website	I	0.00	0.00	0.00
Existence of product rates	A	0.00	0.82	0.18
Search in the website option	M	0.08	0.92	0.00
Sort by price option	A	0.00	0.93	0.07
Sort by customer satisfaction score option	A	0.00	0.78	0.22
Sort by sales amount option	A	0.00	0.73	0.27
High resolution photo and photo magnification	O	0.00	0.99	0.01
Shopping in a different language	I	0.00	0.00	0.00
Different payment options	A	0.00	1.00	0.00
Information on product features	M	0.22	0.78	0.00
Information on product delivery	M	0.24	0.76	0.00
Access to the page through applications	A	0.00	0.68	0.32
Saving address and contact information for future operations	A	0.00	0.76	0.24
Access to the site through a common account (Google, Facebook etc.)	A	0.00	0.77	0.23
Sort by product features option	O	0.02	0.98	0.00
Cargo integrated product tracking system	M	0.13	0.87	0.00

Table 3: Comparison of classes of the parameters by traditional Kano model and the proposed fuzzy Kano model

Then, presence and absence points of the parameters are computed using Eq. (10) and provided in Table 4.

Design Parameters	State Point	
	Presence Point	Absence Point
Compare-with option	54.914	-24.099
Live support	43.125	-25.875
Access to customer representative via telephone	19.612	-27.802
Customer comments	28.241	-25.552
Ability to purchase without signing in	39.174	-26.116
3D secure	22.145	-24.476
Availability of customer comments on the website	0.000	0.000
Existence of product rates	34.286	-22.857
Search in the website option	20.294	-23.824
Sort by price option	29.545	-25.679
Sort by customer satisfaction score option	40.667	-26.000
Sort by sales amount option	44.450	-25.550
High resolution photo and photo magnification	25.720	-25.211
Shopping in a different language	0.000	0.000
Different payment options	25.172	-25.172
Information on product features	12.923	-20.213
Information on product delivery	12.237	-19.966
Access to the page through applications	48.968	-25.226
Saving address and contact information for future operations	42.186	-25.856
Access to the site through a common account (Google, Facebook etc.)	41.218	-25.803
Sort by product features option	23.888	-24.863
Cargo integrated product tracking system	17.400	-22.600

Table 4: Presence and absence points of the parameters (P_{ik})

Four e-commerce websites, $D\&R, Hepsiburada, Trendyol, LCWaikiki$, are evaluated through the proposed novel method with respect to the design parameters identified for usability assessment.

D&R: D&R provides books, stationery equipment, movies-musics (DVDs-CDs), electronics, toys, outdoor products and some personal products to its customers through its website [34].

Hepsiburada: Hepsiburada (HB) is one of the online retailers in Turkey and its product range includes white goods, electronic devices, sports goods, accessories, cosmetics, clothing, supermarket products and home decoration products [35].

Trendyol: Trendyol (TY) is one of the leading e-commerce websites in Turkey's fashion sector. Customers may access clothing, shoes-bags, watches, accessories, cosmetics, home textile and decoration products, small home appliances and books through this website [36].

LCWaikiki: LCWaikiki (LCW) provides clothing, shoes, cosmetics, accessories, home textile and decoration products to its customers [37].

Assessment of these four e-commerce websites with respect to the identified design parameters are given in Table 5. It shows whether the identified parameters exist in these websites or not.

Design parameters	**E-commerce websites**			
	D&R	**HB**	**TY**	**LCW**
Compare-with option	✗	✓	✗	✗
Live support	✗	✓	✓	✗
Access to customer representative via telephone	✓	✓	✓	✓
Customer comments	✓	✓	✓	✗
Ability to purchase without signing in	✗	✓	✗	✓
3D secure	✓	✓	✓	✗
Availability of customer comments on the website	✗	✓	✗	✗
Existence of product rates	✓	✓	✗	✗
Search in the website option	✓	✓	✓	✓
Sort by price option	✓	✓	✓	✓
Sort by customer satisfaction score option	✗	✓	✗	✗
Sort by sales amount option	✓	✓	✗	✗
High resolution photo and photo magnification	✓	✓	✓	✓
Shopping in a different language	✗	✗	✗	✗
Different payment options	✓	✓	✓	✓
Information on product features	✓	✓	✓	✓
Information on product delivery	✗	✓	✓	✗
Access to the page through applications	✓	✓	✓	✓
Saving address and contact information for future operations	✓	✓	✓	✓
Access to the site through a common account (Google, Facebook etc.)	✓	✗	✓	✗
Sort by product features option	✗	✓	✓	✓
Cargo integrated product tracking system	✗	✓	✓	✓

Table 5: Assessment of four e-commerce websites with respect to the identified design parameters

Overall usability scores of these websites are calculated by using Eq. (11) and the results are presented in Table 6.

Design parameters	**D&R**	**HB**	**TY**	**LCW**
Compare-with option	-24.099	54.914	-24.099	-24.099
Live support	-25.875	43.125	43.125	-25.875
Access to customer representative via telephone	19.612	19.612	19.612	19.612
Customer comments	28.241	28.241	28.241	-25.552
Ability to purchase without signing in	-26.116	39.174	-26.116	39.174
3D secure	22.145	22.145	22.145	-24.476
Availability of customer comments on the website	0.000	0.000	0.000	0.000
Existence of product rates	34.286	34.286	-22.857	-22.857
Search in the website option	20.294	20.294	20.294	20.294
Sort by price option	29.545	29.545	29.545	29.545
Sort by customer satisfaction score option	-26.000	40.667	-26.000	-26.000
Sort by sales amount option	44.450	44.450	-25.550	-25.550
High resolution photo and photo magnification	25.720	25.720	25.720	25.720
Shopping in a different language	0.000	0.000	0.000	0.000
Different payment options	25.172	25.172	25.172	25.172
Information on product features	12.923	12.923	12.923	12.923
Information on product delivery	-19.966	12.237	12.237	-19.966
Access to the page through applications	48.968	48.968	48.968	48.968
Saving address and contact information for future operations	42.186	42.186	42.186	42.186
Access to the site through a common account (Google. Facebook etc.)	41.218	-25.803	41.218	-25.803
Sort by product features option	-24.863	23.888	23.888	23.888
Cargo integrated product tracking system	-22.600	17.400	17.400	17.400
TOTAL	225.243	559.143	288.053	84.703

Table 6: Evaluation of four e-commerce websites with respect to the proposed method

Robustness of the scale provided in Table 2 is controlled through a sensitivity analysis. The numbers in the scale are changed without losing the relationship between the classes and it is revealed that order of the sites is not affected by the numerical changes in the scale. Figure 4 shows the normalized points of the alternatives with respect to numerical changes in the scale.

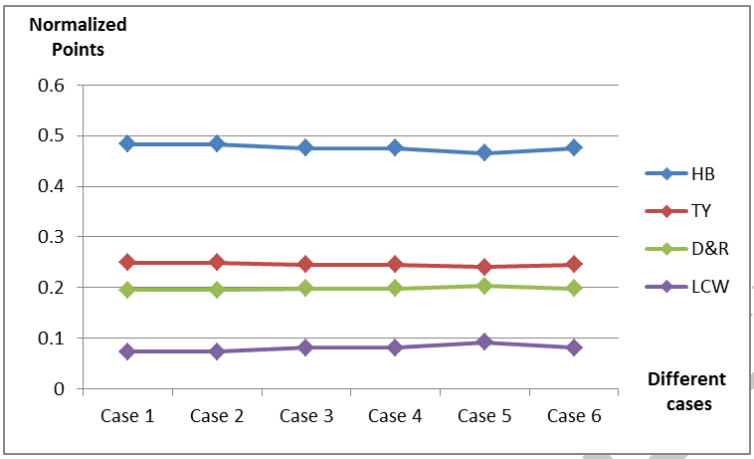

Figure 4: Sensitivity analysis on robustness of the scale

As a result of the analysis, it is revealed that *Hepsiburada* is the best e-commerce website among the alternatives in terms of usability, and it is followed by *Trendyol*, *D&R*, *LCWaikiki*, respectively. The trends in the use of e-commerce websites in Turkey were examined [38, 39] and it was found that *Hepsiburada* and *Trendyol* are the most preferred websites, followed by *D&R*, and *LCWaikiki*, respectively. Thus, it is possible to say that the usability scores obtained with the proposed method are valid since it is known that usability has a positive impact on intention to buy, and consequently customer purchases. In other words, the proposed approach provides reliable information about the importance of design parameters of e-commerce websites, and successfully evaluates their usability.

6. Conclusions

The usability of e-commerce websites is extremely important in this competitive market because of its possible effects on customer purchases. However, there is not yet such a study dealing with this critical issue in the literature. In this study, design parameters affecting the usability of e-commerce websites are determined in a comprehensive manner, and these parameters are classified in line with customer expectations to assess the overall usability of e-commerce websites. The combination of Kano model with fuzzy sets is used

to determine the membership degrees of design parameters to the classes. The fuzzy sets is integrated to Kano model because Kano model has a shortcoming that it takes the majority of responses into account to determine the class of a parameter, and a parameter can only belong to one class. In the proposed approach, the design parameters of e-commerce websites are classified based on the level of satisfaction that these parameters provide to potential users. Then, the effects of presence or absence of these parameters on the usability of an e-commerce website were examined. The parameters which provide maximum contribution to the overall usability score of the website are "*Compare-with option*" and "*Access to the page through applications*". The parameters whose absence reduces the overall usability score of the website the most are "*Access to customer representative via telephone*" and "*Ability to purchase without signing in*".

Four websites, *D&R*, *Hepsiburada, Trendyol, LCWaikiki*, are assessed through the proposed novel method with respect to the design parameters identified for usability assessment. *Hepsiburada* is found to be the best e-commerce website in terms of usability, followed by *Trendyol*, *D&R*, *LCWaikiki*, respectively. Furthermore, it is revealed that the websites with higher usability score are found to be more preferred site, which indicates the impact of usability on customer preferences.

One limitation of this study might be that it reflects the characteristics of Turkish youth. People with different backgrounds and characteristics might have different expectations on parameters that an e-commerce website should have. Therefore, as future research, the impact of these parameters on the usability of e-commerce websites might be determined in a more comprehensive way with the participation of people from different backgrounds. Moreover, the proposed approach might be adopted to assess the usability of other types of websites such as personal websites, photo sharing websites, and information websites, after their design parameters are identified.

Appendix A. Table of usability studies, their purpose and parameters used for assessment

Authors	Year	Parameters	Purpose
Roy et al. [40]	2017	Attractiveness Controllability Efficiency Helpfulness Learnability	To evaluate academic websites via usability testing
Li et al. [41]	2017	Entertainment Ease of use Complementarity Usability	To investigate the impact of economy hotel website quality on online booking intentions
Hasan [42]	2016	Visual design Navigational design Information design	To investigate the effects of website design features on perceived discomfort in online shopping
Masood and Musman [43]	2015	Forum discussion Message box Updating blog	To measure the effectiveness of online learning site with usability test
		Accuracy of content	

		Currency of content Completeness of content Relevance of content Navigability Customizability Understandability Multimedia capability Security features Payment systems security Privacy policy statements Site authentication	
Sari et al. [45]	2015	Navigation Connectivity System Function Display including font style Font size Icon Color	To examine the usability of laboratory website design to enhance learning process

		Image Ease of use Design Content	
Roy et al. [1]	2014	Task success rates Task completion times Posttask satisfaction ratings Feedback Number of clicks	To measure the usability of academic web sites
Venkatesh et al. [22]	2014	Content organization User experience Graphs List Navigation Screen Access Content Home page Headings, titles and labels	Evaluating the usability for a health website

		Hardware and Software Links Page layout Scrolling and paging Search Text	
Raji et al. [46]	2013	Time taken Participants observation Subjective user preferences Visibility Learnability Navigation Flexibility and efficiency Aesthetic Recovery from error Help and documentation	To assess hospital websites
Cetin and Ozdemir [47]	2013	Time to complete a task Ease-of-use Satisfaction	To measure the usability of educational web sites

Du et al. [48]	2013	Perceived usefulness E-service quality Ease of use Security Reliability Responsiveness Social influence	Analyzing the user acceptance of the software as a service
Bringula [49]	2013	Ease of navigation Information content Availability Speed Aesthetics	Evaluating web portal usability
Li and Li [15]	2011	Merchandise catalog Website security Website popularity Navigation system Privacy protection Pay system Search efficiency	To evaluate the usability of e-commerce websites

		Merchandise catalog update Evaluation information	
Gonzalez et al. [50]	2010	Effectiveness Efficiency Engaging Error tolerance Easy to learn	To develop Argument Assistant System with usability perspective

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