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Assessing E-Commerce Service Quality: A Hierarchical Evaluation Model for Online Sales Firms

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ABSTRACT

Purpose: This study aim is to provide a model for evaluating online stores, using the hierarchical analysis method and fuzzy theory.

Methodology: The present study is an applied researche whose information has been collected according to expert opinions and then the result has been examined using multi-criteria decision models.

Findings: The results show that user privacy is most important factors in online shopping. Overall, the results of this study provide a model for decision-makers to help them improve key performance index in e-commerce service design.

Originality/Value: For the first time, this study seeks to propose a new hierarchical evaluation model for online sales firms based on the customer's point of view.

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1. Introduction

Online sales (generally referred to as e-commerce) are nowadays very common, and are gradually becoming the most important selling channel; Social media provides companies with an opportunity to reconnect with customers and eliminates negative publicity [1] . according to [2] , the increase in online sales activities during the period 2002–2010 accounts for 18 per cent of the total growth in labour productivity. E-commerce sales have accelerated dramatically in recent years due to the COVID-19 pandemic. The shift to digital channels is significant, with 43% of consumers shopping more often online [3] . Although the pandemic brought about a rapid transition [4] , the evolutions of high connectivity, ubiquitous computing, and mobile technologies have long been advancing e-commerce and m-commerce [5] ; [6] . As temporal and spatial limitations on shopping are removed by online and mobile platforms, consumers can make purchases 24h per day virtually anywhere.

Online advertising accounts for a very high fraction of all advertising (for example, according to the Annual IAB Internet Advertising Revenue Report, the increase over the period 2011–2013 has been of around 17 per cent each year), and it is naturally associated with online sales [7] . Our world is increasingly moving from the real world to the online and virtual world, so the concept of online marketing is becoming more and more serious [8] . Online marketing is a marketing method that uses online tools and media. The Internet can connect millions of people all over the world and define new and global target markets for you. This method is less expensive and more efficient than other methods [9] .Online marketing enables the company to more rapidly identify and meet the needs of the market and customers regarding the provision of a product or service. It is therefore an important resource for increasing competitive advantage for the organization [10]

Online shopping in the field of e-commerce can be defined as "shopping by electronic technologies and tools". Online shopping succeeds when sellers can deliver more economic benefits to customers than the traditional way. To display products on beautiful websites with varied and attractive photos on online sale isnot enough. According to the Communications Policy Center, 43 percent of Internet users make online purchases, and online shopping is recognized as the third most popular Internet activity after using email and web search. On the other hand, customers are looking for the best quality and services at the lowest price, and e-commerce enables the manufacturer, supplier and customer to find each other easily on a larger scale regardless the geographical distances[11]

The existence of multiple criteria for selecting the best option among online stores complicates decision-making in this field. Consequently, multi-criteria decision-making methods are defined as suitable options in this regard. Unfortunately, the available data in these methods are often based on decision-makers opinions and expressed qualitatively, thereby significantly increasing the likelihood of errors when converting opinions into quantitative values. The utilization of fuzzy theory in addressing problems with qualitative values mitigates these errors. Accordingly, the objective of this present study is to propose a model for evaluating Iranian online stores using the Analytic Hierarchy Process (AHP) as a multi-criteria decision-making method integrated with fuzzy theory, which can be employed by consumers to select appropriate stores for conducting online transactions.

In this research, a questionnaire tool has been utilized to collect the necessary information for analysis and examination. The primary method employed in this study is the Fuzzy AHP approach. This method is based on pairwise comparisons, and the type of questionnaire used in this research involves pairwise comparisons among criteria and options. The AHP method used aims to reduce ambiguity by incorporating fuzzy theory. To the best of the authors' knowledge, the results of such research based on the Fuzzy AHP method are reported for the first time with this precision based on these criteria .

2. Article Structure

1.2 Theoretical Foundations and Research Background

Over the past two decades, the quality of services has transformed into a popular domain within academic studies and has been recognized as a key factor in distinguishing service-based products and establishing competitive advantages [12] , [13] . Bitner and Grönroos have emphasized the assertion that in the virtual realm, all companies compete based on delivering services around their core product [14] , [15] . .Parasuraman has introduced an expanded conceptualization that transcends the boundaries of industry-defined services [16] .

The service revolution has increasingly been an informational revolution, with service information experiencing the highest growth in this sector. Information service is an additional dimension of service where information is exchanged between two parties (such as buyers and sellers). With the rise in research conducted in the field of online marketing and e-commerce, service quality in online environments is considered a significant factor in determining the success or failure of e-commerce [17] .

Various companies strive to employ e-commerce to enhance productivity, quality, cost reduction, and rapid responsiveness to customers and partners [18] . The use of e-commerce tools necessitates significant expenses, and therefore, companies need to evaluate their level of success in utilizing these tools [19] . Assessing performance and investigating service quality in any business is a critical activity that preoccupies managers minds [20] , as e-service quality can potentially enhance attractiveness, success rates, and customer retention while maximizing competitive advantages in online e-commerce. The proliferation of online sales firms in recent years has transformed the landscape of commerce, reshaping consumer behavior and market dynamics.[21]

In the contemporary landscape, the role of technology within the realm of marketing has experienced substantial evolution, paralleling the strides made in the domain of information and communication technology[22] . This dynamic infusion of technology into the marketing landscape has unfurled a vibrant tapestry of fresh opportunities, enabling the realization of more efficient and laser-focused outreach strategies tailored to target mark[23] . Modern consumers are increasingly intertwined with technology, affording them greater access to information, products, and consumer reviews[24] . These transformative innovations encompass a diverse spectrum, spanning from the vast realm of social media and the expansive realm of online advertising to the intricacies of advanced data analytics[25] .

Consequently, research in the domain of service quality issues in e-commerce remains pertinent and significant. [26] , [27] , and [28] argue that having a better understanding of consumer evaluations of e-services and identifying determinant factors for suitable e-commerce environments are essential [29] . They addressed qualitative indicators in the provision of services on commercial websites. Additionally,

[30] . added indicators such as reliability and responsiveness to the SERVQUAL model to elucidate online service quality factors. Researchers have also examined the impact of dimensions of e-commerce website quality on direct sales to customers and their satisfaction levels.

2.2 Research Methods

In 1996, Chang introduced a straightforward method to extend the Analytic Hierarchy Process (AHP) to the fuzzy domain [31] . This method, reliant on the arithmetic mean of expert opinions and the Saaty normalization method, utilizing triangular fuzzy numbers, garnered significant attention from researchers. The steps of this approach are as follows:

(1) Hierarchical Tree Construction: The decision hierarchy structure is delineated based on goal levels,

$$A = \begin{bmatrix} (1,1,1) & \begin{Bmatrix} \tilde{a}_{121} \\ \tilde{a}_{122} \\ \vdots \\ \tilde{a}_{12P_{12}} \end{Bmatrix} & \cdots & \cdots & \begin{Bmatrix} \tilde{a}_{1n1} \\ \tilde{a}_{1n2} \\ \vdots \\ \tilde{a}_{1nP_{1n}} \end{Bmatrix} \\ \begin{Bmatrix} \tilde{a}_{211} \\ \tilde{a}_{212} \\ \vdots \\ \tilde{a}_{21P_{21}} \end{Bmatrix} & (1,1,1) & \cdots & \cdots & \begin{Bmatrix} \tilde{a}_{2n1} \\ \tilde{a}_{2n2} \\ \vdots \\ \tilde{a}_{2nP_{2n}} \end{Bmatrix} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ \begin{Bmatrix} \tilde{a}_{n11} \\ \tilde{a}_{n12} \\ \vdots \\ \tilde{a}_{n1P_{n1}} \end{Bmatrix} & \begin{Bmatrix} \tilde{a}_{n21} \\ \tilde{a}_{n22} \\ \vdots \\ \tilde{a}_{n2P_{n2}} \end{Bmatrix} & \cdots & \cdots & (1,1,1) \end{bmatrix} \quad (1)$$

criteria, and options.

(2) The pairwise comparison matrix based on fuzzy triangular numbers $\tilde{t}_{ii} = \left(a_{ij},\ b_{ij},\ c_{ij}\right)$ is formed from the decision-maker perspective by utilizing the assessments of multiple decision-makers

$$\tilde{A} = \begin{Bmatrix} (1,1,1) & \tilde{a}_{12} & \tilde{a}_{1n} \\ \tilde{a}_{21} & (1,1,1) & \tilde{a}_{2n} \\ \vdots & \vdots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & (1,1,1) \end{Bmatrix} \quad \tilde{a}_{ij} = \frac{\sum_{k=1}^{p_{ij}} a_{ijk}}{p_{ij}} i,j = 1,2,\ldots,n \quad (2)$$

Here, p_ij represents the number of individuals assessing the priority of element i over j.

(3) Arithmetic Mean of Opinions: The arithmetic mean of decision-makers opinions is computed in matrix form.

$$\tilde{s}_i = \sum_{j=1}^{n} \tilde{a}_{ij} \, i = 1, 2, \dots, n \tag{3}$$

(4) Computation of Row Element Sums: The sum of row elements is calculated

(5) Normalization: Row sums are normalized.

If we denote $\tilde{s}_i$as $(l_i,\ u_i,\ m_i)$ the above equation is calculated in the following order.

$$\widetilde{M}_i = \tilde{s}_i \otimes \left[\sum_{i=1}^{n} \tilde{s}_i\right]^{-1} \quad i = 1, 2, \dots, n \tag{4}$$

$$\widetilde{M}_i = \left(\frac{l_i}{\sum_{i=1}^{n} u_i}, \frac{m_i}{\sum_{i=1}^{n} m_i}, \frac{u_i}{\sum_{i=1}^{n} l_i}\right) \tag{5}$$

(6) Determination of greater likelihood degree: The greater likelihood degree of each μ_i compared to other $\tilde{s}_i$'s is calculated and denoted as $d^{'}(Ai)$. The greater likelihood degree of a fuzzy triangular number $(l_2\mu_2 = u_2, m_2)$compared to another fuzzy triangular number $(l_1\mu_1 = u_1, m_1)$ is equal to:

$$V(M_2 > M_1) = Sub_{y \geq x}\left[\min\left(\mu_{M_1}(x), \mu_{M_2}(y)\right)\right] \tag{6}$$

(7) The equation can be expressed equivalently as follows:

$$V(M_2 > M_1) = hgt(M_2 \cap M_1) = \mu_{M_2}(d)$$
$$= \begin{cases} 1 & M_2 \geq M_1 \ if \\ 0 & l_2 \geq u_1 \ if \\ \dfrac{l_2 - u_1}{(m_2 - u_2) - (m_1 - l_1)} & Otherwise \end{cases} \tag{7}$$

"d" represents the coordinates of the highest point in the intersection region and the convergence of two membership functions μ_{M2} and μ_{M1} (Figure 1) .

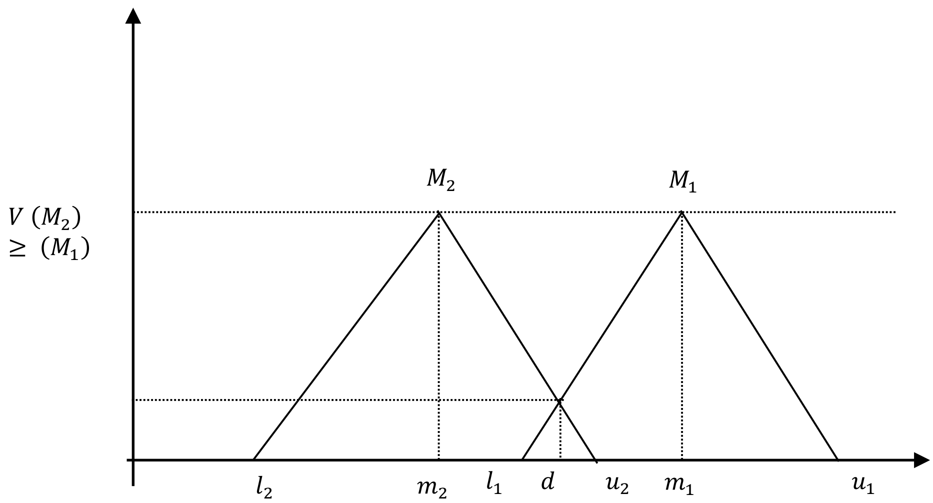

Fig 1. Priority of fuzzy numbers

Comparing M_2, M_1 requires calculating both values $V(M_2 \geq M_1)$, $V(M_1 \geq M_2)$. The degree of greater probability of a convex fuzzy number (M) over K other convex fuzzy numbers $(M_i\ ; i = 1\ , 2\ , \ldots , k)_i$ is differentiated as follows*":*

$$d'(M) = V\ (M\ \geq\ M_1\ , M_2\ , \ldots , M_k) = V[(M\ \geq\ M_1)\ , (M\ \geq\ M_2)\ , \ldots , (M\ \geq\ M_k)]$$
$$= \min V\ (M\ \geq\ M_i) \qquad \mathrm{i} = 1\ , 2\ , \ldots , k \tag{8}$$

(7) Normalization: By normalizing the weight vectors, normalized weights are obtained

.

$$w = \left[\frac{d'(A_1)}{\sum_{i=1}^{n} d'(A_i)}, \frac{d'(A_2)}{\sum_{i=1}^{n} d'(A_i)}, \ldots, \frac{d'(A_n)}{\sum_{i=1}^{n} d'(A_n)}\right]^T \tag{9}$$

The above weights are definite (non-fuzzy) weights. By repeating this process, weights for all matrices are obtained.

(8) Weight Combination: By combining the weights of criteria and options, final weights are obtained.

$$\widetilde{U}_i = \sum_{j=1}^{n} \widetilde{w}_i \tilde{r}_{ij} \qquad \forall i \tag{10}$$

The steps to calculate the compatibility index of pairwise fuzzy comparison matrices are as follows:

(1) In the first stage, the fuzzy triangular matrix is divided into two matrices. The first matrix consists of intermediate triangular judgment numbers $A^m = [a_{ijm}]$. While the second matrix comprises the geometric means of the upper and lower bounds of the triangular numbers $A^g = \sqrt{a_{ijm} a_{ijl}}$.

(2) Calculating the weight vector for each matrix is done using the following equation:

$$w_i^m = \frac{1}{n} \sum_{j=1}^{n} \frac{a_{ijm}}{\sum_{j=1}^{n} a_{ijm}} \; THAT \; w^m = [w_i^m] \tag{11}$$

$$w_i^g = \frac{1}{n} \sum_{j=1}^{n} \frac{\sqrt{a_{ijm} \, a_{ijl}}}{\sum_{j=1}^{n} \sqrt{a_{ijm} \, a_{ijl}}} \; THAT \; w^g = [w_i^g] \tag{12}$$

(3) The largest eigenvalue for each matrix is calculated using the following equations:

$$A_{max}^g = \frac{1}{n} \sum_{j=1}^{n} \sum_{j=1}^{n} a_{ijm} \left(\frac{w_j^m}{w_i^m} \right) \tag{13}$$

$$A_{max}^g = \frac{1}{n} \sum_{j=1}^{n} \sum_{j=1}^{n} \sqrt{a_{ijm} \, a_{ijl}} \left(\frac{w_j^g}{w_i^g} \right) \tag{14}$$

(4) The compatibility index is calculated using the following equations:

$$CI^m = \frac{(A_{max}^m - n)}{(n-1)} \tag{15}$$

$$CI^g = \frac{(A_{max}^g - n)}{(n-1)} \tag{16}$$

(5) To calculate the Consistency Ratio (CR), the Consistency Index (CI) is divided by the Random Index (RI). If the resulting value is less than 0.1, the matrix is deemed consistent and usable.

To obtain the values for the Random Index (RI), 100 matrices are generated using random numbers while ensuring the mutual condition of the matrices. The values of inconsistency are then calculated, and their average is determined.

However, due to the fact that fuzzy comparison values are not always integer numbers, and even then, the geometric mean often converts them into non-integer values, using a 9-point scale doesn't necessarily allow the use of the table of Random Indices (RI). Consequently, some researchers have created a new table of Random Indices (RI) for fuzzy pairwise comparison matrices by generating 400 new random matrices.

Table 1- Random Index

matrix size	RI^m	RI^g	matrix size	RI^m	RI^g	matrix size	RI^m	RI^g
1	0/4890	0/1796	6	1/3410	0/4164	11	1/4555	0/4691
2	0/7939	0/2627	7	1/3793	0/4348	12	1/4913	0/4804
3	1/0720	0/3597	8	1/4095	0/4455	13	1/4986	0/4880
4	1/1996	0/3818	9	1/4181	0/4536	14	0/4890	0/1796
5	1/2874	0/4090	10	1/4462	0/4776	15	0/7939	0/2627

To generate random matrices, the middle value of a triangular fuzzy number is initially randomly selected within the interval $\left[\frac{1}{9},\ 9\right]$. Subsequently, the lower limit value for each triangular number is generated within the interval [generated middle value, $\frac{1}{9}$] and the upper limit value within the interval [$\frac{1}{9}$. generated middle value] in a random manner. Finally, by dividing the resultant random matrix into two matrices representing upper and lower bounds, the values of the random index (RI) for their upper and lower approximations are obtained.

An important note is that the inconsistency value in the column RI^g is greater than RI^g, This difference arises because while the range of random numbers generated for the middle value is $\left[\frac{1}{9},\ 9\right]$. The range for the upper and lower bounds, based on the generated middle value, is more restricted. Consequently, there is a lower probability of inconsistency in the latter. By calculating the inconsistency rate for these two matrices using the following formulas, they are compared against the threshold of 0/1:

$$CR^g = \frac{(CI^g)}{(RI^g)} \qquad CR^m = \frac{(CI^m)}{(RI^m)} \qquad (17)$$

If both of these indices are less than 0.1, the fuzzy matrix is consistent. If both exceed 0.1, the decision-maker is requested to reconsider the provided priorities. If only $CR^m(CR^g)$ exceeds 1/0, the decision-maker revises the middle (upper and lower) values of fuzzy judgments provided .

3.2 The Research Findings

This article employs the Es-Qual model, known as a prominent and widely-used model in the field of e-service quality, encompassing 23 criteria across four categories, to rank and investigate the factors affecting electronic service quality. The principal criteria in this model include:

Efficiency: Comprising 8 sub-criteria associated with website ease and speed.

System Accessibility: Covering 4 sub-criteria related to website technical issues.

Integrity and Completeness: Involving 7 sub-criteria concerning orders and delivery.

Privacy: Encompassing 3 sub-criteria linked with website confidentiality.

Furthermore, to compare the criteria among themselves, 9 verbal expressions are introduced in Table 2 .

Table 2- Verbal criteria

Code	Expressions	Numerical value	Fuzzy number
1	Equal preference	1	(1, 1, 1)
2	Low to moderate preference	2	(5.1, 5.1, 1)
3	Moderate preference	3	(2, 2, 2)
4	Moderate to high preference	4	(4, 5.3, 3)
5	High preference	5	(5.4, 4, 3)
6	High to very high preference	6	(5, 5.4, 3)
7	Very high preference	7	(6, 5.4, 3)
8	Very high to extremely high preference	8	(7, 6, 5)
9	Extremely high preference	9	(9, 7, 5)

Three options for ranking have been used: the most significant and top online stores in Iran concerning the range of products offered and user utilization. These options are denoted as A1, A2, and A3, respectively. To construct the pairwise comparison matrix, a research questionnaire was sent to 20 IT and e-commerce experts, asking them to rank the research criteria and options. Upon completion of the questionnaires, due to some inconsistencies found in some responses, the relevant experts were asked to meticulously revise and complete the questionnaires. After several stages, all questionnaires were rendered compatible and ready for analysis.

The steps from 3 to 7, being sequential and contingent, are not explicitly detailed in the study. Initially, the ranking of the main fourfold criteria is discussed (supplementary results are presented in the appendix). The mean matrix of opinions along with normalized values in Table 3 is depicted

Table 3- Pairwise comparison matrix for ranking the main criteria

	1c	2c	3c	4c	Total	Normalized
1c	(1, 1, 1)	(2/875, 2/625, 2)	(2/875, 2/625, 3)	(7/5, 6/25, 5)	(15/75, 13/75, 11)	(0/776, 0/534, 0/373)
2c	(0/667, 0/467, 0/451)	(1, 1, 1)	(1/5, 1/292, 0/792)	(2/75, 2/25, 1/75)	(5/917, 5/009, 3/993)	(0/291, 0/194, 0/135)
3c	(0/333, 0/259, 0/229)	(1/375, 1/125, 0/75)	(1, 1, 1)	(1/5, 1/333, 0/833)	(4/208, 3/717, 2/812)	(0/207, 0/144, 0/095)
4c	(0/2, 0/162, 0/139)	(1/167, 1/127, 0/612)	(1/25, 1, 0/75)	(1, 1, 1)	(3/617, 3/289, 2/501)	(0/178, 0/128, 0/085)

Following this, the preference matrix related to Table 3 is seen in Table 4.

Table 4- Preference matrix for ranking the main criteria according to Table 3

	1c	2c	3c	4c
1c	-	1	1	1
2c	0	-	1	1
3c	0	0.5890	-	1
4c	0	0.39	0.833	-1

Using Table 4, it's discernible that criterion 1c is preferable compared to other criteria. In other words, in the ranking of the main criteria, this criterion holds the top position. After this criterion, criteria 2c, 3c, and 4c respectively hold the second to fourth positions. A second examination was conducted to rank the sub-criteria related to the privacy criterion. In other words, in the ranking of the main criteria, this sub-criterion secures the top position. After this sub-criterion, sub-criteria P2 and P3 respectively hold the second and third positions. Subsequently, the ranking of sub-criteria related to the system accessibility criterion is addressed.

Table 5- Preference matrix for ranking under the criteria of comprehensiveness and completeness

3c	1f	2f	3f	4f	5f	6f	7f
1f	-	1	1	1	1	1	1
2f	0/287	-	0/691	0/847	0/922	1	0/344
3f	0/496	1	-	1	1	1	0/597
4f	0/359	1	0/832	-	1	1	0/136
5f	0/312	1	0/747	0/91	-	1	0/377
6f	0/209	0/94	0/615	0/786	0/856	-	0/253
7f	0/877	1	1	1	1	1	-

In the final step, the sub-criteria of efficiency are examined for their precedence. As indicated in Table 6, sub-criterion 8e stands as the most preferable, securing the first rank, followed by sub-criteria 5e, 2e, 7e, 3e, 1e, and 6e in the second to eighth ranks, respectively

Table 6- Preference matrix for ranking under performance criteria.

	1e	2e	3e	4e	5e	6e	7e	8e
1e	-	0/718	0/908	1	0/591	1	0/785	0/359
2e	1	-	1	1	0/863	1	1	0/613
3e	1	0/811	-	1	0/676	1	0/876	0/431
4e	0/545	0/243	0/456	-	0/147	1	0/327	0
5e	1	1	1	1	-	1	1	0/755
6e	0/523	0/214	0/433	0/988	0/119	-	0/302	0
7e	1	0/944	1	1	0/812	1	-	0/569
8e	1	1	1	1	1	1	1	-

After ranking the fourfold criteria and their sub-criteria, it is now time to rank different options based on these sub-criteria and criteria. Option A3 has been found to be the most preferable across all privacy-related sub-criteria, followed by options A1 and A3. Subsequently, after the privacy-related sub-criteria, the ranking of sub-criteria relevant to system accessibility is conducted. Option A2 exhibits the lowest precedence across all sub-criteria. However, concerning options A1 and A3, it should be noted that A1 holds the highest precedence in 2 sub-criteria, while A3 holds the highest precedence in 2 other sub-criteria.

Moving forward, the ranking of each option regarding the comprehensiveness and completeness sub-criteria is addressed. Option A3 is identified as the most preferable across 6 out of 7 comprehensiveness and completeness sub-criteria. After that, options A1 and A2 occupy the second and third ranks, respectively. Only in one sub-criterion, A1 holds the first rank, while A3 and A2 follow in subsequent ranks.

The last ranking of options pertains to the efficiency sub-criteria. Based on the results obtained from the ranking of option A3 across 6 out of 8 efficiency sub-criteria, it is deemed the most preferable. Following that, options A1 and A2 hold the second and third ranks, respectively. In one of the sub-criteria, A1 secures the first rank, while in the subsequent ranks, A3 and A2 follow. In one of the sub-criteria, A2 attains the second rank, while in the rest of the sub-criteria, it occupies the third rank .

Based on the research findings, it's evident that the Privacy criterion among the primary criteria in the Es-Qual model holds the highest importance, as perceived by experts, in assessing the quality of e-services provided by online stores. Following Privacy, the Accessibility criterion ranks second, Completeness and Comprehensiveness third, and Efficiency fourth. The prioritization of sub-criteria within Privacy is as follows: Customer information protection, Non-disclosure of customer information to other websites, and Protection of customers' banking information.

For the Accessibility criterion, the precedence and ranking of its sub-criteria are as follows: Constant availability of the website (24/7 shopping), website uptime without crashes, prompt response to order-related information without freezing, and immediate website usability after loading. The seven sub-criteria relevant to Completeness and Comprehensiveness are prioritized as follows: Timely delivery as promised, Consistency of delivered products or services with listed specifications on the website, Reasonable delivery times and predicted features, Timely website information during critical payment moments, Accurate and complete inventory information disclosure, Accurate, complete, and honest registration of all records on the website, Honesty regarding offered products or services on the website.

Eight Efficiency sub-criteria are ranked as follows: Efficient website organization, Fast website page loading, Easy navigation (transition between various website pages), Easy website access (some websites require registration or email requests for entry), Swiftness in the website's purchasing process (fewer buying steps), Ease in finding desired products on the website, User-friendly website operations.

Continuing the research and considering expert opinions, a fuzzy analytic hierarchy process was used to rank the three options examined in the study. The results indicate that Option A3 shows significant superiority across most sub-criteria and holds the top rank in the most crucial sub-criteria. It secures the first rank in 18 sub-criteria and in the Privacy criterion, which was acknowledged as the most critical criterion, holding the first rank across all sub-criteria. Following Option A3, Option A1 secures the second rank, and Option A2 occupies the third rank in terms of preference according to the experts .

Conflicts of Interest

None.

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None.

Authors Contributions

Ali Mahdifar: conceptualization, methodology, software.

Reza Mortazavi: Supervision

Rasoul Jamshidi: visualization,validation,writing-reviewing and editing

Vahid Aliakbar: validation and editing

Mohammad Ebrahim Sadeghi:visualization,validation,writing-reviewing and editing

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Attachments

Table 7- Criteria title

Main Criterion	Indicator	Sub-Criteria	Indicator
Privacy	C_1	Protection of customer purchase information	1p
		Non-disclosure of customer information to other websites	2p
		Safeguarding customers' banking information	3p
System accessibility	C_2	Constant website availability (ability to make purchases 24/7)	1sa
		Website readiness for immediate use upon loading	2sa
		Absence of website malfunctions	3sa
		Prompt response to order-related input without freezing	4sa
Comprehensiveness and Completeness	C3	Timely delivery of promised goods	1f
		Accurate and complete registration of all records on the website	2f
		Reasonable and predicted timelines for product delivery	3f
		Timely communication on significant payment matters	4f
		Accurate and precise updates on available inventory	5f
		Honesty in the products or services offered by the website	6f
		Consistency between dispatched product specifications and those on the website	7f
Efficiency	C4	Ease of finding desired products on the website	1e
		Easy navigation (smooth transition between various website pages)	2e
		Speedy purchasing process on the website (short purchase steps)	3e
		Proper categorization of products, news, announcements, etc.	4e
		Swift loading of website pages	5e
		User-friendly website functionality	6e
		Easy access to the website (some websites require registration or email requests for entry)	7e
		Well-organized website structure	8e

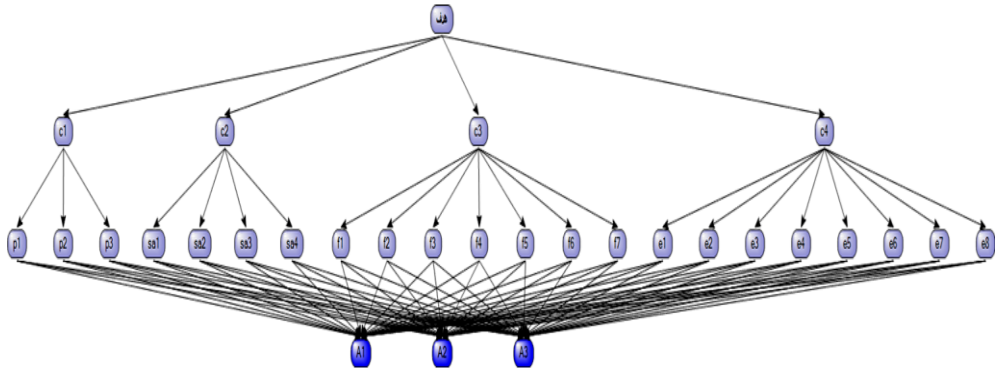

Fig. 2. Hierarchical tree examined

Table 8- Pairwise comparison matrix for ranking sub-criteria of system availability

	1sa	2sa	3sa	4sa	Total	Normalized
1sa	(1, 1, 1)	(4/875, 4/375, 3)	(3/5, 3/125, 2/5)	(5/75, 5/25, 4/5)	(15/125, 13/75, 11)	(0/743, 0/546, 0/391)
2sa	(0/333, 0/229, 0/206)	(1, 1, 1)	(0/958, 0/78, 0/646)	(1/25, 1/042, 0/792)	(3/541, 3/051, 2/644)	(0/174, 0/121, 0/094)
3sa	(0/5, 0/372, 0/347)	(2, 1/792, 1/417)	(1, 1, 1)	(2/25, 2, 1/375)	(5/75, 5/164, 4/139)	(0/283, 0/205, 0/147)
4sa	(0/233, 0/192, 0/175)	(1/375, 1/208, 0/833)	(1/083, 0/821, 0/562)	(1, 1, 1)	(3/691, 3/221, 2/57)	(0/181, 0/128, 0/091)

Table 9- Pairwise comparison matrix for ranking sub-criteria of system availability

	1sa	2sa	3sa	4sa
1sa	-	1	1	1
2sa	0	-	0.242	0.924
3sa	0	1	-	1
4sa	0	1	0.306	-

Table10- Results of ranking options based on all sub-criteria

Main Criterion	Sub-criteria	Option one	Option Two	Option Three
Privacy	Protection of customer purchase information	A3	A1	A2
	Non-disclosure of customer information to other websites	A3	A1	A2
	Safeguarding customers' banking information	A3	A1	A2
System accessibility	Constant website availability (ability to make purchases 24/7)	A1	A3	A2
	Website readiness for immediate use upon loading	A3	A1	A2
	Absence of website malfunctions	A3	A1	A2
	Prompt response to order-related input without freezing	A1	A3	A2
Comprehensiveness and Completeness	Timely delivery of promised goods	A1	A3	A2
	Accurate and complete registration of all records on the website	A3	A1	A2
	Reasonable and predicted timelines for product delivery	A3	A1	A2
	Timely communication on significant payment matters	A3	A1	A2
	Accurate and precise updates on available inventory	A3	A1	A2
	Honesty in the products or services offered by the website	A3	A1	A2
	Consistency between dispatched product specifications and those on the website	A3	A1	A2
Efficiency	Ease of finding desired products on the website	A3	A1	A2
	Easy navigation (smooth transition between various website pages)	A1	A3	A2
	Speedy purchasing process on the website (short purchase steps)	A3	A1	A2
	Proper categorization of products, news, announcements, etc.	A1	A3	A2
	Swift loading of website pages	A3	A1	A2
	User-friendly website functionality	A3	A1	A2
	Easy access to the website (some websites require registration or email requests for entry)	A3	A2	A1