Evaluation and Selection of E-commerce Service Quality Using Fuzzy AHP Method

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Abstract. In the era of rapid technological development, people use information and communication technology to buy and / or sell goods and / or services via the internet. Based on a survey conducted by the Central Statistics Agency (BPS), it shows that of all data collection efforts, only 15.08% were e-commerce businesses. This shows that the business done via the internet in Indonesia is still low. This can be caused by several obstacles, one of which is customer satisfaction. Customer confidence will be built when customer needs and satisfaction are met through quality standards. So that customer satisfaction becomes an important parameter in building a sustainable business. This research was conducted to evaluate and select the quality of e-commerce services using Fuzzy AHP. Determination of criteria and weight of criteria is built based on expert consensus using the Delphi method. After that, the consistency calculation is carried out using the AHP method. In the FAHP method, the weight calculation for each alternative is assessed. In the FAHP method, the highest order of weight values is Tokopedia (0.3680), Bukalapak (0.3190), Shopee (0.1735) and Elevenia (0.1394).

1. Introduction

The quick advancement of data and correspondence innovation affects changes in different fields, for example, social, monetary, political, and social. Individuals use data and correspondence innovation to purchase and/or sell merchandise and/or administrations by means of the web. This marvel is known as internet business (Statistics E-commerce 2019, BPS) [1].

Based on a survey conducted by the Central Statistics Agency (BPS), business operators who already have online businesses account for only 15.08% of the total businesses in Indonesia. Some reasons business owners still have not made an online business can be seen in table 1.

| Reasons company don’t do e-commerce | Percentage (%) |
|-------------------------------------|----------------|
| Not interested in selling online    | 42.52          |
| It's more convenient to sell in person | 70.89       |
| Concerns about security            | 5.69           |
| Concerns about privacy             | 6.13           |
| Concerns about technical issues    | 7.03           |
| Concern about the issue of trust   | 7.25           |
| Lack of knowledge                  | 21.78          |

Table 1. Reasons why company don’t do e-commerce
Based on these data, it can be seen that business actors are still comfortable doing business offline, this shows that the growth potential of the e-commerce market is not comparable with the growth of consumers for shopping online. This can be caused by several obstacles, such as difficulties in making payments, customer trust, website quality and so on. According to Nasrullah Setiawan et al in 2016, customer trust will be built when customer needs and satisfaction are met through quality standards. So that customer satisfaction becomes an important parameter in building a sustainable business. Quality standards that are described in E-commerce in the form of service quality or website / application facilities that can provide convenience for customers [2].

Past exploration that has been directed identified with administration quality appraisal with the title An Application of Fuzzy AHP for Evaluating Course Website Quality by Hsiu-Fen Lin where there are 4 rules utilized in surveying site quality, specifically framework quality, data quality, administration quality, also, engaging quality. A poll is planned as a couple insightful correlation. A regular AHP poll design (nine-point rating scale) shows the overall significance of every rule (or sub-measure) in a similar order. This examination used fluffy AHP to look at the similitudes and contrasts among high-and low-experience bunches as far as the assessment obviously site quality. Both high and low-experience bunches considered 'data quality' to be the most significant factor influencing the site adequacy course. Strikingly, the two gatherings have various recognitions with respect to the significant determinants obviously site quality. Students who have more internet learning experience believe the framework quality to be the basic factor in encouraging course site achievement. In the interim, the low-experience bunch focused on the appeal property [3].

Sutami in 2017 also conducts related research evaluating the quality of web securities services, where this study aims to compare the quality of 6 securities websites at the Yogyakarta Investment Gallery. The criteria used in the assessment of securities websites are user ease, content, accuracy, timeliness of responses and security. This study uses Fuzzy AHP to determine the weight of the specified criteria and uses Fuzzy TOPSIS to determine the ranking of the alternatives that will be selected [4].

The purpose of this research is to determine the criteria and sub-criteria in the quality of e-commerce services and 2. To select e-commerce with the best service quality based on criteria that have become the consensus of experts using the Fuzzy Analytical Hierarchy Process (FAHP).

## 2. Theoretical Background

### 2.1. E-commerce

According to Dave Chaffey in 2002 The extent of electronic trade (e-commerce) is smaller than advanced business. Frequently considered just alluding to purchasing and selling utilizing the Internet; individuals promptly thought of customer retail buys from organizations like Amazon. Be that as it may, internet business must be thought of, in light of the fact that all exchanges are electronically intervened between an association and the outsiders with whom it bargains. By this definition, non-money related exchanges, for example, client assistance and solicitations for additional data will likewise be viewed as a major aspect of internet business [5].

### 2.2. E-commerce Category Based on Business Model in Indonesia

Based on research conducted by Mahir P in 2015 which classifies the E-commerce business in Indonesia [6]. The results of e-commerce classification based on business models can be seen in table 2.

| No | Business Model | E-commerce                           |
|----|----------------|-------------------------------------|
| 1  | B2B            | Blibli.com                          |
| 2  | B2C            | OLX, Zalora.com, Lazada             |
| 3  | C2C            | Tokopedia, Bukalapak, Elevenia, Shopee |
| 4  | C2B            | Kitabisa.com, wujudkan.com          |
2.1. Delphi Method
The Delphi method is an adjustment of the brainwriting and review methods. In this strategy, boards are utilized in the development of correspondence through a few polls contained recorded as a hard copy. The Delphi strategy was created in the mid 1950s to evoke master supposition. The object of this strategy is to get the most solid agreement from a gathering of specialists. This strategy is applied in different fields, for instance for anticipating innovation, public arrangement examination, instructive advancement, arranging projects and others. Based on research by Rowe in 1999 in the Delphi method it is not determined how many experts are involved because the emphasis is that these experts represent the parties involved in the system being studied by Rifki Kurniawan. et al in 2017. This Delphi method is used to improve the existing opinions of respondents or to combine respondents' opinions on a problem or event[7][8].

2.2. Service Quality
According to Leonard L Berry and A Parasuraman in 1990 there are 5 dimensions of service quality that are commonly used as a reference. The five dimensions used as criteria for service quality assessment are as follows [9]:

- Reliability – The ability to perform the promised service dependably and accurately
- Responsiveness – The willingness to help customers and to provide prompt service
- Assurance – The knowledge and courteousness of employees and their ability to convey trust and confidence
- Empathy – The provision of caring, individualized attention to customers
- Tangibles - The appearance of physical facilities, equipment, personnel and communications materials

2.2. Analytic Hierarchy Process (AHP)
AHP is an organized multi-criteria procedure for sorting out and examining complex choices dependent on numerous models [16]. AHP is a choice help model created by Thomas L. Saaty. This choice help model will portray a complex multifaceted or multi-standards issue into an order as indicated by Saaty, progressive system is characterized as a portrayal of an unpredictable issue in a staggered structure where the main level is the objective, trailed by the degree of elements, rules, sub-measures, etc down to the last degree of choices. AHP can deal with subjective and quantitative elements from dynamic cycle for all intents and purposes, methodically and quickly [17, 18, 19]. With hierarchy, a complex problem can be broken down into groups which are then arranged into a hierarchical form so that the problem will appear more structured and systematic [10].

The stages of decision making in the AHP method are basically as follows:

- Define the problem and determine the desired solution
- Create a hierarchical structure that starts with general objectives, followed by criteria and alternative choices to be ranked.
- Form a pairwise comparison matrix that illustrates the relative contribution or influence of each element to each of the objectives or criteria level above it. Comparisons are made based on the choice or judgment of the decision maker by assessing the level of importance of an element compared to other elements.
- Normalize data is by dividing the value of each element in the paired matrix with the total value of each column.
- Calculate the eigenvector value and test its consistency, if it is not consistent then data retrieval (preference) needs to be repeated. The eigenvector value in question is the maximum eigenvector value obtained using MATLAB or manually.
- Repeat steps 3, 4, and 5 for all levels of the hierarchy.
- Calculates the eigenvector of each paired comparison matrix. The eigenvector value is the weight of each element. This step is to synthesize choices in prioritizing elements at the lowest level of the hierarchy to the achievement of objectives.
- Test the consistency of the hierarchy. If it does not meet with CR < 0, 100 then the assessment must be repeated.

In resolving AHP issues, there are several principles that need to be understood including [11]:

- Decomposition
  After the problem is defined, it is necessary to decomposition, which is to break the whole problem into its elements. If you want to get accurate results, the solution is also carried out on the elements until it is not possible to do further solutions so that some actions are obtained from the problem earlier. For this reason, the analysis process is called a hierarchy.

![Hierarchy](image)

**Figure 1. Hierarchy**

- Comparative Judgment
  This principle means making judgments about the relative importance of two elements at a certain level in relation to the level above it. This assessment is the core of AHP, because it will affect the priority of the elements. The results of this assessment will be placed in the form of a matrix called a pairwise comparison matrix. In preparing the scale of interests using benchmarks that can be seen in Table 3.

| Intensity Importance | Definition                                      |
|----------------------|-------------------------------------------------|
| 1                    | Both elements are equally important             |
| 3                    | One element is slightly more important than the other |
| 4                    | One element is more important than the other elements |
| 7                    | One element is clearly more important than another element |
| 9                    | One absolute element is more important than the other elements |
| 2,4,6,8              | The values between the two considerations are close together |

- Synthesis of Priority
  From each pairwise comparison matrix then the eigenvector value is searched to get local priority. Because pairwise comparison matrices exist at each level, to get global priority, synthesis must be performed between local priority. The ordering of elements according to relative importance through synthesis procedures is called priority setting.
• Logical Consistency
  Consistency has two meanings, first is that similar objects can be grouped according to uniformity and relevance. The second meaning is related to the level of relationship between objects based on certain criteria. The consistency indicator is measured through the Consistency Index (CI) which is formulated:

\[ Z_{\text{max}} = \sum_{i=1}^{n} \text{Vector Consistency} \]  

\[ \text{CI} = \frac{Z_{\text{max}} - n}{n-1} \]  

Information:
- \( n \) = Number of items compared
- \( Z_{\text{max}} \) = Average value calculated earlier

Random consistency index can be seen in Table 4.

| N  | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 |
|----|----|----|----|----|----|----|----|----|----|
| RI | 0  | 0.58 | 0.90 | 1.12 | 1.24 | 1.32 | 1.41 | 1.45 | 1.51 |

So the degree of inconsistency for pair comparison in the decision criteria matrix in the previous example is calculated by the ratio of CI to RI:

\[ \text{CR} = \frac{\text{CI}}{\text{Random Consistency Index}} \]  

Information:
- CR = Consistency Ratio
- CI = Consistency Index
- RI = Random Index

In general, the degree of consistency is satisfactory if: \( \text{CI} \) / \( \text{RI} \) < 0.10

2.2. Fuzzy Association Theory
Fuzzy set theory is a mathematical framework used to represent uncertainty, obscurity, inaccuracy, lack of information, and partial truth. Lack of information, in solving problems, is often found in various fields of life. The discussion of vagueness began in 1937, when a philosopher named Max Black expressed his opinion about obscurity. Black defines a proportion of obscurity as a proportion where the probable status of the proportion is not clearly defined. For example, to state that someone belongs to the young category, the statement “young” can give a different interpretation than by each individual, and we cannot give a certain age to say someone is young or not young[12].

There are several reasons why people use fuzzy logic including:

• The concept of fuzzy logic is easy to understand. The mathematical concept underlying fuzzy reasoning is very simple and easy to understand.
• Fuzzy logic is very flexible.
• Fuzzy logic has a tolerance for incorrect data.
• Fuzzy logic is able to model nonlinear functions that are very complex.
• Fuzzy logic can build and apply the experiences of experts directly without having to go through a training process.
• Fuzzy logic can work with conventional control techniques.
• Fuzzy logic is based on natural language.
2.2.1. **Membership Function.** Membership function is a curve that shows the mapping of data input points into the membership value (degree of membership) which has an interval between 0 to 1. One way that can be used to obtain membership values is through the function approach [13].

2.2.2. **Triangular Fuzzy Number.** Laarhoven and Pedrycz in the journal Yu-Lung Hsu in 2010 proposed the Fuzzy Analytic Hierarchy Process in 1983, which is an application of a combination of Analytic Hierarchy Process (AHP) and Fuzzy Theory. The linguistic scale of the traditional AHP method can express uncertainty when decision makers make decisions. Therefore, FAHP converts the expert opinion from the previously defined values into fuzzy numbers and membership functions, presents the Triangular Fuzzy Number in a pairwise comparison matrix to develop the FAHP, so that the opinions of experts approach the human thinking model, as well as to achieve the evaluation criteria that are makes more sense [14].

Triangular fuzzy number is a combination of two lines (Linear). The graph of the triangular membership function is depicted in the form of a triangular curve as seen in Figure 2[15].

![Figure 2. Triangular fuzzy number](image)

Triangular fuzzy number is a fuzzy set theory helps in measurements related to the subjective assessment of humans using language or linguistics. The essence of fuzzy AHP lies in the pairwise comparison which is illustrated by the ratio scale associated with the fuzzy scale. Fuzzy triangular numbers are symbolized and the following membership function provisions for 5 scale linguistic variables.

| AHP scale | Fuzzy Number | Invers Value of Fuzzy Number | Definition |
|-----------|--------------|-------------------------------|------------|
| 1         | (1,1,1)      | (1, 1, 1)                     | Equally important |
| 2         | (1,2,3)      | (1/3,1/2,1)                   | Scale between the same and a little more important |
| 3         | (2,3,4)      | (1/4,1/3,1/2)                 | Low dominance |
| 4         | (3,4,5)      | (1/5,1/4,1/3)                 | Scale between low dominance and high dominance |
| 5         | (4,5,6)      | (1/6,1/5,1/4)                 | High dominance |
| 6         | (5,6,7)      | (1/7,1/6,1/5)                 | Scale between high dominance and very high dominance |
| 7         | (6,7,8)      | (1/8,1/7,1/6)                 | Very high dominance |
| 8         | (7,8,9)      | (1/9,1/8,1/7)                 | Scale between very high dominance and absolute dominance |
| 9         | (8,9,9)      | (1/9,1/9,1/8)                 | Absolute dominance |
3. Research Methodology

In this study, the Delphi method is used to determine the criteria and sub-criteria in assessing the quality of e-commerce services. While the Fuzzy AHP method is used to weight each criterion and the ranking is done by using the aggregated weighted scores approach.

4. Result

4.1. Delphi Method

In this study, using 2 types of data, namely primary data and secondary data. Primary data is data obtained by searching / digging directly from the source by researchers. Primary data obtained from distributing questionnaires. Primary data obtained from the results of questionnaires distributed to researchers and practitioners in the field of e-commerce service quality, where the questionnaire is a clarification-verification-validation questionnaire to experts. The questionnaire used is the sub-criteria determination questionnaire and the AHP questionnaire. The sampling technique used for data collection was purposive sampling in which the selected respondents were certain people with knowledge or expertise in the field of e-commerce services. Meanwhile, secondary data is data obtained from the Central Bureau of Statistics (BPS) and literature studies from books, journals and previous research.

The recapitulation of the results from the sub-criteria determination questionnaire can be seen in table 6.

| No | Criteria  | Sub-Kriteria                                                                 | Respondents | Average | Standard Deviation |
|----|-----------|------------------------------------------------------------------------------|-------------|---------|--------------------|
|    |           | E-commerce provides the right service                                         | 4 4 5 5     | 4.5     | 0.58               |
| 1  | Reliability| E-commerce provides services according to the promised time                   | 4 5 4 5     | 4.5     | 0.58               |
|    |           | E-commerce makes transactions accurately                                      | 4 5 5 5     | 4.75    | 0.5                |
|    |           | E-commerce tells you when the goods will be delivered                         | 4 5 4 5     | 4.5     | 0.58               |
| 2  | Responsiveness| Customer service is willing to help customers in transactions            | 4 4 5 5     | 4.5     | 0.58               |
|    |           | Customer service can always handle customer complaints                        | 4 5 5 5     | 4.75    | 0.5                |
|    |           | Fast e-commerce response to customer complaints                               | 4 5 4 5     | 4.5     | 0.58               |
|    |           | E-commerce provides a sense of security and convenience in transactions      | 5 5 5 5     | 5       | 0                  |
|    |           | Transparency of costs paid by consumers                                      | 4 5 4 4     | 4.25    | 0.5                |
| 3  | Assurance| Giving guarantees to consumers if the product is damaged                     | 5 5 4 3     | 4.25    | 0.96               |
|    |           | Product return service if the product is not suitable                         | 5 4 4 5     | 4.5     | 0.58               |
|    |           | Confidentiality of customer data                                             | 5 5 5 5     | 5       | 0                  |
|    |           | Flexible customer service operating hours according to customer needs        | 4 4 4 5     | 4.25    | 0.5                |
| 4  | Empathy   | E-commerce understands the                                                  | 4 4 5 5     | 4.5     | 0.58               |
needs of its customers

| Feature                                           | Rating | Score |
|---------------------------------------------------|--------|-------|
| E-commerce provides personal attention to its customers | 3 4 4 5 4 | 0.82 |
| Free shipping according to the provisions          | 4 5 3 5 4.25 | 0.96 |
| User experience (ease of customer access to systems provided by e-commerce) | 5 4 5 5 4.75 | 0.5 |
| Ease of making payments                            | 5 5 5 5 5 | 0 |

Tangibles

| Feature                                           | Rating | Score |
|---------------------------------------------------|--------|-------|
| E-commerce has a beautiful and attractive visual appearance of websites and applications | 5 4 4 5 4.5 | 0.58 |
| A clear and complete product description          | 5 4 5 5 4.75 | 0.5 |
| Complete features provided by e-commerce          | 5 4 4 4 4.25 | 0.5 |

The hierarchical structure used in assessing the quality of e-commerce services can be seen in Figure 3.
Figure 3. Hierarchy of e-commerce service quality assessment
4.2. Fuzzy-AHP
Respondents in this study are researchers and practitioners in the field of quality e-commerce services. Through the AHP questionnaire given to respondents, consistency calculations were carried out. The results of the consistency calculation can be seen in table 7.

| Level | Element | Consistency Ratio | Information |
|-------|---------|-------------------|-------------|
| 2     | Criteria | 0.0069            | consistent  |
|       | Reliability | 0.0053           | consistent  |
|       | Responsiveness | 0.0111       | consistent  |
| 3     | Assurance  | 0.0081             | consistent  |
|       | Empathy    | 0.0158             | consistent  |
|       | Tangible   | 0.0199             | consistent  |
|       | E-commerce provides the right service | 0.0034 | consistent |
|       | E-commerce provides services according to the promised time | 0.0056 | consistent |
|       | E-commerce makes transactions accurately | 0.0047 | consistent |
|       | E-commerce tells you when the goods will be delivered | 0.0070 | consistent |
|       | Customer service is willing to help customers in transactions | 0.0046 | consistent |
|       | Customer service can always handle customer complaints | 0.0057 | consistent |
|       | Fast e-commerce response to customer complaints | 0.0016 | consistent |
|       | E-commerce provides a sense of security and convenience in transactions | 0.0022 | consistent |
| 4     | Transparency of costs paid by consumers | 0.0139 | consistent |
|       | Giving guarantees to consumers if the product is damaged | 0.039 | consistent |
|       | Product return service if the product is not suitable | 0.0028 | consistent |
|       | Confidentiality of customer data | 0.0218 | consistent |
|       | Flexible customer service operating hours according to customer needs | 0.0015 | consistent |
|       | E-commerce understands the needs of its customers | 0.0086 | consistent |
|       | E-commerce provides personal attention to its customers | 0.0074 | consistent |
|       | Free shipping according to the provisions | 0.018 | consistent |
|       | User experience (ease of customer access to systems provided by e-commerce) | 0.0011 | consistent |
|       | Ease of making payments | 0.0061 | consistent |
| 4     | E-commerce has a beautiful and attractive visual appearance of | 0.0169 | consistent |
websites and applications
A clear and complete product description 0.0439 consistent
Complete features provided by e-commerce 0.0236 consistent

After the consistency test is carried out, then the element weights of each level are calculated using Fuzzy AHP, the results of Fuzzy AHP calculations can be seen in Table 8.

Table 8. Fuzzy AHP weight calculation results of e-commerce service quality

| Alternative | Weight | Percentage | Rank |
|-------------|--------|------------|------|
| Elevenia    | 0.1394 | 13.94%     | IV   |
| Shopee      | 0.1735 | 17.35%     | III  |
| Tokopedia   | 0.3680 | 36.80%     | I    |
| Bukalapak   | 0.3190 | 31.90%     | II   |
| Total       | 1.0000 | 100%       |      |

5. Discussion
The determination of the criteria for evaluating the quality of e-commerce services is carried out using the Delphi method. By using the Delphi method, a consensus has been found from experts regarding the criteria for selecting e-commerce with the best service quality. The sub-criteria determination questionnaire was carried out 2 rounds, this is because in the first questionnaire respondents provided additional sub-criteria in assessing e-commerce, such as: product return services if not appropriate, fast e-commerce response to customer complaints, free shipping according to the provisions, guarantee of customer confidentiality, user experience and ease of payment. The total criteria and sub-criteria used in e-commerce selection are 5 criteria and 21 sub-criteria.

Based on the results of Fuzzy AHP calculations, Tokopedia was chosen as the e-commerce with the best service quality. This is because Tokopedia has a high weight on the product return service sub-criteria (0.3135) and the correct service delivery (0.5536). Where these sub-criteria are the most important sub-criteria according to experts on each of the criteria, namely Assurance and Reliability. Based on the comparison between the criteria, the assurance factor is the most important criterion according to experts among other criteria, followed by reliability, responsiveness, empathy and tangible.

6. Conclusion
The criteria for selecting e-commerce with the best service quality used in this study consisted of 5 criteria, namely reliability, responsiveness, assurance, empathy and tangible, where the sub-criteria used consisted of: E-commerce provides the right service, E-commerce provides appropriate services the promised time, e-commerce provides transaction accuracy, E-commerce notifies when the goods will be sent, Customer service is willing to help customers in transactions, Customer service can always handle customer complaints, e-commerce responds quickly to customer complaints, e-commerce provides a sense of security and comfort in transactions, transparency of costs paid by consumers, providing guarantees to consumers if the product is damaged, product return services if the product is not suitable, confidence of customer data, flexible customer service operating hours according to consumer needs, E-commerce understands the needs of its customers, E-commerce delivers personal attention to its customers, free shipping according to the provisions, user experience (easy customer access to systems provided by e-commerce), ease of making payments, e-commerce has a beautiful and attractive visual appearance of websites and applications, product descriptions clear and complete and completeness of the features provided by e-commerce.

Based on Fuzzy AHP processing, the best-service e-commerce sequences are Tokopedia, Bukalapak, Shopee and Elevenia.
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