Evaluation of e-commerce services quality using Fuzzy AHP and TOPSIS

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Abstract. Rapid technological developments require people to use information and communication technology to transact goods/services. Based on a survey by the Central Statistics Agency (BPS), of all data collection efforts, only 15.08% are e-commerce entrepreneurs. This shows that business conducted via the internet in Indonesia is still low. The low utilization of e-commerce can be caused by several obstacles, one of which is the customer trust that is built when customer satisfaction is met. This research was conducted to evaluate the quality of e-commerce services using Fuzzy AHP and TOPSIS. The determination of sub-criteria is done using the Delphi method. After that, the calculation of consistency is carried out using the AHP method. The results of calculations using Fuzzy AHP-TOPSIS show that the best e-commerce orders are Tokopedia (0.6206), Bukalapak (0.5208), Elevenia (0.2094) and Shopee (0.1910). Based on the research results, the recommendation for e-commerce with the best service quality is Tokopedia, this is because Tokopedia has the highest weight on the sub-criteria for product return services compared to other e-commerce. The results of this study can be used by other e-commerce companies to improve service quality based on criteria and sub-criteria that are considered important according to expert opinion.

1. Introduction

The rapid development of information and communication technology has an impact on changes in various fields, such as social, economic, political, and cultural, as well as an impact on changes in lifestyle, including consumption patterns and the way people sell and shop. In this era, people make use of information and communication technology to buy and / or sell goods and / or services via the internet. This phenomenon is known as e-commerce.

Based on a survey conducted by the Central Statistics Agency (BPS) with a sample of 3,504 Census Blocks spread across 101 districts/cities in all provinces in Indonesia in 2019, it shows that of all data collection efforts, only 15.08% of business was using e-commerce. In North Sumatra province alone, businesses that use e-commerce are only 12.34%, and those that do not use e-commerce are 87.66% [1].
Based on Figure 1, it can be seen that 87.66% of businesses in North Sumatra do not conduct e-commerce transactions, while 12.34% do. The main reason most businesses do not conduct e-commerce is because they are more comfortable selling directly (offline) as much as 79.49%. The recapitulation of reasons for business owners still not doing business online can be seen in Table 1.

### Table 1. Reasons Why Company Don’t Use E-commerce.

| 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          |

Based on this data, it can be seen that business actors are still comfortable doing business offline, this shows that consumers who transact offline are very large. Several things that make consumers reluctant to make transactions online, such as difficulties in making payments, customer trust, website quality, and so on. 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].

In fact, based on research by Riris and Yeny, it was found that the growth of e-commerce had a significant effect on the amount of taxes paid. The results of these studies prove that e-commerce has a significant effect on taxpayer compliance where the t statistic is 3.406 > 1.96 with a coefficient of 0.273. Where the tax itself has several functions, such as financing state expenditures, opening jobs, controlling the inflation rate, and so on [3].

In 2017, Sutami conducted a research entitled Evaluation of the quality of securities web services, where this study aims to compare the quality of 6 securities websites, namely Danareksa Sekuritas, Valbury Asia securities, Sucominvest Central Gani, Phintraco Securities, First Asia Capital, and OSO Securities. The criteria used in the assessment of securities websites are user ease, content, accuracy, timeliness of responses, and security. Of the five criteria, 20 sub-criteria are described that are used as an assessment. The results of calculations using the Fuzzy AHP-TOPSIS method show that Valbury Asia Securities is the best service, and this study also describes the advantages and disadvantages of each of these web securities, such as the Danareksa securities web, which has
advantages in the overview of the user experiences problems or questions. while the weakness of this web security is that it is not reliable under the actual conditions [4].

The general objective of this study is to rank e-commerce with the best service quality using the Fuzzy AHP and TOPSIS methods.

2. Materials and methods

2.1. E-commerce Classification

According to Dave Chaffey, the scope of electronic commerce (e-commerce) is narrower than digital business. Often considered simply referring to buying and selling using the Internet; people immediately thought of consumer retail purchases from companies like Amazon. But e-commerce must be considered because all transactions are electronically mediated between an organization and the third parties with whom it deals. By this definition, non-financial transactions such as customer support and requests for further information will also be considered part of e-commerce [5].

Mahir in 2015, classify the E-commerce business in Indonesia [6]. The results of the classification of e-commerce based on business models can be seen in table 2.

| No | Business Model       | E-commerce                     |
|----|----------------------|--------------------------------|
| 1  | Business to Business | Bibli.com                      |
| 2  | Business to Customer | OLX, Zalora.com, Lazada        |
| 3  | Customer to Customer | Tokopedia, Bukalapak, Elevenia, Shopee |
| 4  | Customer to Business | Kitabisa.com, wujudkan.com     |

2.2. Service Quality Dimension

According to parasuraman, there are 5 dimensions of service quality, which consist of [7]:

- Reliability, In connection with the company's ability to provide accurate services from the first time without making any mistakes and deliver services according to the agreed time.
- Responsiveness, With regard to the willingness and ability of employees to help customers and respond to their requests, as well as informing when services will be provided and then providing services quickly.
- Assurance, With regard to employee behavior, it can foster customer trust in the company and the company can create a sense of security for its customers. Assurance also means that employees are always polite and have the knowledge and skills needed to handle any customer service or problem.
- Empathy, means that the company understands the problems of its customers and acts in the best interests of the customers, while paying personal attention to customers and having comfortable hours of operation.
- Tangible, With regard to the attractiveness of physical facilities, equipment and materials used by the company, as well as the appearance of employees.

2.3. Purposive Sampling

Purposive sampling is a non-probability sampling method that uses specific people (specific target-groups) as a source of data / information. Certain people referred to here are individuals or groups who because of their knowledge, experience, position, etc. make the individual or group a source of information. This individual or group's name is immediately recorded as a respondent without going through a random selection process.
Purposive sampling technique, also called judgment sampling, is a deliberate choice of a participant because of the qualities the participant possesses. This type of sampling is a nonrandom technique that does not require an underlying theory or a number of participants. Simply put, the researcher decides what needs to know and sets out to find people who can and are willing to provide information based on knowledge or experience [8].

2.4. Delphi Method
The Delphi method is a modification of the brainwriting and survey techniques. In this method, panels are used in the movement of communication through several questionnaires contained in writing. The Delphi technique was developed in the early 1950s to elicit expert opinion. The object of this method is to obtain the most reliable consensus from a group of experts [9,10].

2.5. Analytical Hierarchy Process
The Analytical Hierarchy Process is a general theory of measurement. It is used to derive the ratio scale from both separate and continuous comparisons in a tiered hierarchical structure. These comparisons can be drawn from actual measurements or from fundamental scales that reflect the relative strengths of preferences and feelings. AHP is designed to tackle both rational and intuitive to select the best from several alternatives evaluated concerning multiple criteria. In this process, the decision-maker performs a simple pairwise comparison assessment which is then used to develop overall priorities for ranking alternatives.

The simplest form used to construct a decision problem is a hierarchy consisting of three levels: decision objectives at the top level, followed by a second level consisting of criteria by which alternatives, located at the third level, are evaluated. The hierarchical decomposition of complex systems appears to be the basic tool by which the human mind deals with diversity. One organizes the factors that influence decisions in gradual steps from the general, at the top level of the hierarchy, to the special, at the lower level. The purpose of this structure is to make it possible to judge the importance of elements at a certain level concerning some or all elements at adjacent levels above [11].

2.6. Fuzzy AHP
The observed values in real-world problems are often imprecise or vague. Imprecise or vague data may be the result of unquantifiable, incomplete, and non-obtainable information. They are often expressed with bounded intervals, ordinal (rank order) data, or fuzzy numbers.

To effectively handle subjective perceptions and imprecision, fuzzy numbers are integrated with AHP, allowing the appropriate expression of linguistic evaluation according to Calabrese et al. in 2016. Fuzzy numbers are also used to deal with uncertainties affecting subjective preferences in assessing real-world decision-making problems.

Despite the convenience of AHP in handling both quantitative and qualitative criteria of MCDM problems based on decision makers’ judgements, FAHP can reduce or even eliminate the fuzziness; vagueness existing in many decision-making problems may contribute to the imprecise judgements of decision makers in conventional AHP approaches [12–16].

2.7. TOPSIS
TOPSIS is a multi-criteria decision making method that was first introduced by Yoon and Hwang. TOPSIS uses the principle that the chosen alternative must have the closest distance from the positive ideal solution and the farthest from the negative ideal solution from a geometric point of view by using the Euclidean distance to determine the relative proximity of an alternative to the optimal solution. The ideal positive solution is defined as the sum of all the best values that can be achieved for each attribute, while the negative ideal solution consists of all the worst scores achieved for each attribute [16].
3. Results and discussion

3.1. Determination of sub-criteria

The determination of sub-criteria for evaluating the quality of e-commerce services is carried out using the Delphi method. First of all, the sub-criteria that will be used to assess e-commerce are determined, after which some sub-criteria suggested by experts are added, such as product return services if they are not suitable, e-commerce is quick to respond to customer complaints, free shipping according to conditions, guarantee of customer confidentiality, user experience and ease of payment. In the second round, the experts agreed on the sub-criteria used in the selection of e-commerce, which consisted of 21 sub-criteria and 5 criteria.

Hierarchical structure for evaluating the quality of e-commerce services can be seen on figure 3.

![Figure 3. Hierarchy of e-commerce service quality assessment.](image-url)
3.2. **Fuzzy AHP calculation results**

The results of the weight calculation for each criterion, sub-criterion, and alternative can be seen in table 3.

| Eigenvector                                                                 | Level 2                                          | Level 3                           | Level 4 |
|------------------------------------------------------------------------------|-------------------------------------------------|-----------------------------------|---------|
| Reliability                                                                  | 0.2290                                          | E-commerce provides the right service | 0.5536  | Elevenia 0.0953 |
|                                                                              |                                                 | E-commerce provides services according to the promised time | 0.1691  | Shopee 0.2261, Tokopedia 0.4721, Bukalapak 0.2065, Elevenia 0.0938, Shopee 0.2011, Tokopedia 0.2579, Bukalapak 0.4473, Elevenia 0.1733 |
| Reliability                                                                  | 0.2290                                          | E-commerce provides transaction accuracy | 0.2774  | Elevenia 0.1028, Shopee 0.1091, Tokopedia 0.5077, Bukalapak 0.2804, Elevenia 0.1448, Shopee 0.4092, Tokopedia 0.3204, Bukalapak 0.1256 |
| Responsiveness                                                               | 0.2214                                          | E-commerce tells when the goods will be delivered | 0.0744  | Shopee 0.1575, Tokopedia 0.3174, Bukalapak 0.3717, Elevenia 0.1289, Shopee 0.1858, Tokopedia 0.4587, Bukalapak 0.2266 |
|                                                                              |                                                 | Customer service is willing to help customers in transactions | 0.2960  | Elevenia 0.1474, Shopee 0.0597, Tokopedia 0.2691, Bukalapak 0.5238, Elevenia 0.0955, Shopee 0.1089, Tokopedia 0.4949 |
|                                                                              |                                                 | Fast e-commerce response to customer complaints | 0.1493  | Elevenia 0.1250, Shopee 0.1109, Tokopedia 0.2578, Bukalapak 0.5063, Elevenia 0.0862, Shopee 0.1442, Tokopedia 0.4023, Bukalapak 0.3672 |
| Assurance                                                                     | 0.3510                                          | E-commerce provides a sense of security and convenience in transactions | 0.0515  | Elevenia 0.1028, Shopee 0.1091, Tokopedia 0.5077, Bukalapak 0.2804, Elevenia 0.1448, Shopee 0.4092, Tokopedia 0.3204, Bukalapak 0.1256 |
|                                                                              |                                                 | Transparency of costs paid by consumers | 0.2511  | Elevenia 0.1474, Shopee 0.0597, Tokopedia 0.2691, Bukalapak 0.5238, Elevenia 0.0955, Shopee 0.1089, Tokopedia 0.4949 |
|                                                                              |                                                 | Giving guarantees to consumers if the product is damaged | 0.2324  | Elevenia 0.1250, Shopee 0.1109, Tokopedia 0.2578, Bukalapak 0.5063, Elevenia 0.0862, Shopee 0.1442, Tokopedia 0.4023, Bukalapak 0.3672 |
|                                                                              |                                                 | Product return service if the product is not suitable | 0.3135  | Elevenia 0.1250, Shopee 0.1109, Tokopedia 0.2578, Bukalapak 0.5063, Elevenia 0.0862, Shopee 0.1442, Tokopedia 0.4023, Bukalapak 0.3672 |
Confidentiality of customer data 0,1515
Elevenia 0,4983
Shopee 0,1417
Tokopedia 0,0798
Bukalapak 0,2803

Flexible customer service operating hours according to consumer needs 0,0958
Elevenia 0,0860
Shopee 0,1446
Tokopedia 0,3007
Bukalapak 0,4687

E-commerce understands the needs of its customers 0,0739
Elevenia 0,0898
Shopee 0,1486
Tokopedia 0,4896
Bukalapak 0,2720

E-commerce provides personal attention to its customers 0,1974
Elevenia 0,0617
Shopee 0,1456
Tokopedia 0,5029
Bukalapak 0,4467

Free shipping according to the provisions 0,0492
Elevenia 0,0820
Shopee 0,3138
Tokopedia 0,4467
Bukalapak 0,4467

User experience (ease of customer access to systems provided by e-commerce) 0,2884
Elevenia 0,0814
Shopee 0,1563
Tokopedia 0,2867
Bukalapak 0,4756

Ease of making payments 0,2953
Elevenia 0,0956
Shopee 0,1350
Tokopedia 0,3300
Bukalapak 0,4394

E-commerce has a beautiful and attractive visual appearance of websites and applications 0,4090
Elevenia 0,1053
Shopee 0,3328
Tokopedia 0,3801
Bukalapak 0,1817

Tangible 0,0559

A clear and complete product description 0,4529
Elevenia 0,1005
Shopee 0,5176
Tokopedia 0,2144
Bukalapak 0,2144

Complete features provided by e-commerce 0,1381

The results of ranking the quality of e-commerce services using fuzzy AHP can be seen in table 4.

Table 4. The rank of e-commerce based on their service quality using fuzzy AHP method.

| Alternative   | Weight | Percentage | Rank |
|---------------|--------|------------|------|
| Elevenia      | 0,1394 | 13,94%     | IV   |
| Shopee        | 0,1735 | 17,35%     | III  |
| Tokopedia     | 0,3680 | 36,80%     | I    |
Based on the table above, it can be seen that Tokopedia is 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 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 criteria, the assurance factor is the most important criterion according to experts among other criteria, followed by reliability, responsiveness, empathy, and tangible.

3.3. Fuzzy AHP-TOPSIS calculation results
The results of calculations using FAHP-TOPSIS can be seen in table 5.

| Alternatives | Preference Value | Rank |
|--------------|------------------|------|
| Elevenia     | 0.2094           | III  |
| Shopee       | 0.1910           | IV   |
| Tokopedia    | 0.6206           | I    |
| Bukalapak    | 0.5208           | II   |

The ranking results show that the selected alternative is based on calculations with the TOPSIS method which is e-commerce with the best service quality with a preference value of 0.6206.

Based on the research above, it appears that Tokopedia can be a recommendation for business owners and users to transact online. Where the growth of e-commerce will have a significant effect on the amount of tax paid, and the tax itself is used to finance state expenditures, create jobs, control the inflation rate, and so on.

4. 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, Guarantee to consumers if the product is damaged, product return service if the product is not suitable, confidentiality 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 the processing carried out by the Fuzzy AHP method, it was found that Tokopedia was chosen as the e-commerce with the best service quality with a weight of 0.3680. Then followed by Bukalapak, Shopee and Elevenia.

Based on the processing carried out by the TOPSIS method, it was found that Tokopedia was also selected as the e-commerce with the best service quality with a weight of 0.6206. Then followed by Bukalapak, Elevenia and Shopee.
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