Analytic hierarchy process for evaluating the quality of courier services in e-commerce services from the perspective of Pos Indonesia Purwokerto

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Abstract — E-commerce became one of the technological developments in Indonesia in the fourth industrial revolution. Since then, the daily needs transaction process has become accessible through the e-commerce platform. The rapid development of e-commerce is predicted to increase and thus encourage the development of courier services over the past period, making courier services an essential element that affects customer satisfaction in e-commerce services. An analysis of customer satisfaction in several e-commerce service providers towards customer reviews on Google Play conducted by Sasmita and a statement by the Ministry of Trade through a consumer complaint report in 2021 stated that complaints about problems in the e-commerce sector have increased, which includes courier services incorporated with e-commerce service providers. Gulc argued that at least seven factors determine the quality of courier service based on the customer's perspective. The AHP method assists courier services affiliated with e-commerce services in recognizing which of these seven factors of courier service quality dimensions require attention to create a sustainable competitive advantage. This research aims to measure the priority level of criteria in determining the quality of courier services on e-commerce platforms, thus providing recommendations for the appropriate service priorities for courier service companies. The calculation results using AHP on the seven factors determining the quality of courier service according to the Manager Assistant of the Service Department at the Central Purwokerto Branch of the Pos Indonesia office show that the responsiveness criterion is more important than the other six criteria.

Keywords – analytic hierarchy process, courier, e-commerce, quality services

I. Introduction

Technology development since the beginning of the fourth industrial revolution is growing exponentially, and various kinds of renewable technologies are gradually being implemented [1]. E-commerce is related to business activities where the internet and technology are combined. These activities connect sellers and buyers of goods without considering distance and time. The significant development of e-commerce has risen over the years and has been a crucial part of the internet and technology [2]. It is mainly developed by various choices, for instance, price transparency across retailers, discounts, and increasing internet usage worldwide [3].

According to Indonesia.go.id [4], e-commerce in Indonesia is experiencing rapid development, predicted to increase by 33.2%. Bain & Company and Google Temasek released a report in October 2020 stating that during the Covid-19 pandemic, the usage time of people who joined the online trading platform, which was initially 3.7 hours/day, increased to 4.7 hours/day during the lock-down, and 4.2 hours/day after the lockdown ended. Bank Indonesia also projects e-commerce transactions to increase to IDR 337 trillion by 2021. According to Gulc [5], the high intention of e-commerce has been a crucial part of the courier service development today, making it an essential element that affects customer satisfaction and future goals, but also the success of e-retailers.

There are three most visited e-commerce platforms in Indonesia as of the third quarter of 2021, including Tokopedia (158.1 million), Shopee (134.4 million), and Bukalapak (30.1 million) [6]. Based on reviews on the Google Maps and Google Play platforms, some
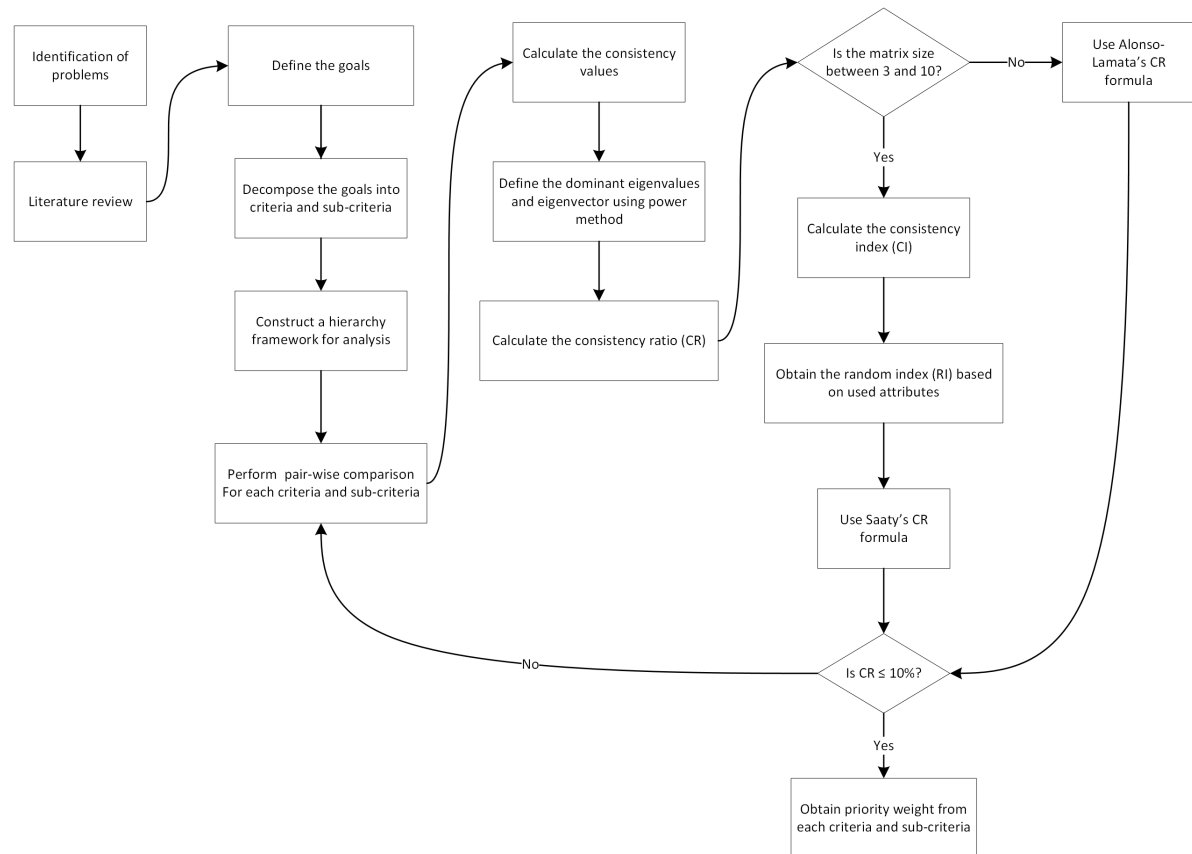
Fig. 1. Flow of research stage.

customers complain about courier expedition services incorporated with e-commerce platforms, including delays in goods, delivery addresses that do not match the receipt, and damage to goods. According to Sasmita [7], the results of customer satisfaction analysis using topic modeling and sentiment analysis conducted, show that the level of satisfaction in the fulfillment dimension (one of which consists of delivering products according to the promised time) on the e-commerce platform is still low and needs to be improved.

Several methods to measure service quality include Servqual, Servperf, Importance Performance Analysis (IPA), Critical Incident Technique, and Mystery Shopper [8]. The Servqual method is widely used to evaluate industrial service quality based on industry needs. However, the generalization of Servqual measuring instruments and dimensions has drawn criticism, which makes the dimensions and measuring instruments in Servqual must be changed based on the service sector to be applied [9]–[11].

The results of empirical findings and statistical analysis conducted by Gulc [5] using the exploratory factor analysis (EFA) method revealed the determinants of courier service quality in e-commerce based on customer perspectives and classified into seven dimensions, including reliability, visual identification, service complexity, relational capital, social responsibility, responsiveness, and technical quality.

Service quality can be defined as the customer's expectation of a service that exceeds their opinion. The service quality concept has been considered multi-dimensional, where its important characteristics need to be measured. Factors related to perceived service quality are associated with the culture of the country, and in each country, the results can be different because the national culture of each country is unique and not identical to other countries. The quality of courier services can be improved by evaluating services based on certain factors. This service improvement will increase user satisfaction and a wider customer reach [12], [13]. A customer who is satisfied with the service offered will be a primary source of competitive knowledge [14].

An analytic hierarchy process (AHP) approach was used to find the most critical dimensions of the model built by Gulc. AHP makes it possible to perform pairwise comparisons with other alternatives based on service dimensions, to make recommendations in determining the quality of courier services, and to create a sustainable competitive advantage [9]. This complex issue is broken down into a specific hierarchy structure to make dimension understandable [15]. AHP has a flow of thinking that is the same as human cognitive processes. The algorithm is also based on mathematics, so it is very efficient to use to solve various kinds of problems related to decision making [16].

Numerous researches have been done related to the Analytical Hierarchy Process. Battsengel Enkhbayar and Justin S. Chang, for instance, studied Identifying priority attributes for improving Ulaanbaatar bus services using the analytic hierarchy process'. This study focused on identifying the best bus services for Ulaanbaatar. The results revealed that the bus service was unsafe and inefficient in the bus route [17]. Other research is about analysing dimensions and indicators to design an energy education framework in Malaysia using the AHP by Zul Ilham. This study mainly aimed to evaluate the framework criteria selection, alternatives, and weight of energy education. The results showed that one dimension in the energy education framework is selected as the most important criterion, which is 'aim to minimize climate change [18].

Another study highlighted several categories for prioritizing software development challenges in an organization [19]. In the same line, the aim was to identify the success factors of CSDO. These factors were then prioritized using Analytical Hierarchy Process with industrial and academic experts [20]. Based on the literatures and problems above, this research aims to evaluate the quality of courier services based on the Pos Indonesia Purwokerto perspective with an analytical hierarchy process.

II. Research Method

The subject of this research is the Assistant Manager of the Service Section of the Central Purwokerto Branch of the Pos Indonesia Office. The object of this research is the prioritization of the quality of courier services incorporated with e-commerce based on the perspective of courier service experts. Fig. 1 is a research flow chart that illustrates the stages involved in this research. This research flow chart is divided into three main parts, namely input, process, and output.

A. Input

At this stage, there sub-stages are consisting of problem identification, literature study, and data collection. Problem identification is raised based on events in the courier service process in e-commerce companies. The flow of this sub-stage can be seen in Fig. 1.

The first sub-step in the input stage is to collect secondary data obtained from customer reviews or users of courier services on e-commerce platforms. The reviews are obtained from customers who provide reviews to e-commerce platforms and several courier service services incorporated in e-commerce through Google Maps and Google Play. Reviews consisting of e-commerce customers and courier service providers are then collected to identify customer problems. The results of the problem identification are then used as the basis for research.

After problem identification is determined, a literature study is carried out by conducting a gap analysis

to compare the identification of research problems to be carried out with previous research using the *3C+2S* technique (compare [looking for similarities between literature], contrast [looking for differences between literature], criticize [giving opinions on the literature read], synthesize [combining several literatures into an idea], and summarize [summary of the literature read]). Primary data is also obtained from several previous studies so from this sub-stage, further research is found from previous studies. If the literature study is in accordance with the case study, then a literature review will be conducted. The literature review is conducted to review the criteria used in the research. If the literature review produces criteria that are in accordance with the case study.

Data collection is carried out after the problem identification, literature study, and literature review sub-stages. In the third sub-stage in the input stage, a pairwise comparison is carried out by the assistant manager of the Service Department of the Central Purwokerto Branch of the Pos Indonesia office. If the comparison results are consistent, weighting will be carried out at the process stage. To determine the appropriate calculation method of the consistency of pairwise comparisons, (1) and (2) will be employed when dealing with matrix sizes ranging from 3 to 10 [21], [22].

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (1)$$

$$CR = \frac{CI}{RI} \quad (2)$$

The calculation index (CI) is found through λ_{max} and n values. N value is the total number of criteria in the study. However, if the matrix size is less than 3 and exceeds 10, the inconsistencies will be evaluated using (3) [21], [22].

$$CR = \frac{\lambda - n}{2.7699 * n - 4.3513 - n} \quad (3)$$

To ensure consistency, the Consistency Ratio (CR) is calculated. The final value of CR should be less than 0.1 (10%). Any value more significant than that, means the pairwise comparison process is inconsistent [23], [24].

B. Process

In the process phase, attributes and AHP criteria will be weighed manually. AHP calculations are carried out based on the results of a consistent pair-wise comparison matrix. The result of the comparison is normalized in a matrix form. Then, compute the relative weights and rank all the criteria.

Table 1. The Scenario of Increasing Network Area

Decision Hierarchy		
Level 0	Level 1	Level 2
Priority Quality of Courier Service	Reliability	Timeliness of delivery
		Success of delivery attempts
		Appropriateness and completeness of delivery
		Little damage to the package
		Fast and efficient order handling
	Visual Identification	Aesthetic and neat courier appearance
		Signature trademarks and uniform colors
		Aesthetically pleasing and functional company branches and pick-up points
	Service Complexity	Wide range of additional services
		Service diversity
	Relational Capital	Positive experiences with courier services
		Positive feedback from other customers
		Positive image and brand of the courier company
		Experience and credibility of the courier company
		Knowledge and competence of employees
		Trust in the courier company
	Social Responsibility	Ecological technical solutions
		Courier company involvement in social action
	Responsiveness	Easy contact with courier companies
		Efficient communication with courier company employees
		Accurate and clear information regarding service provision conditions
		Efficient handling of returns
		Readiness to react quickly to reported problems and disruptions
		Flexibility (choice and change of service date and place)
	Technical Quality	Modern ecological solutions
		Service availability
		Choice of delivery method

Table 2. AHP with Respect to Goals

	1	2	3	4	5	6	7
1	1.00	1.00	1.00	0.58	1.00	0.33	0.41
2	1.00	1.00	0.69	0.58	0.84	0.41	0.34
3	1.00	1.44	1.00	1.00	0.84	0.24	0.36
4	1.71	1.71	1.00	1.00	0.62	0.36	0.52
5	1.00	1.19	1.19	1.61	1.00	0.84	0.52
6	3.00	2.47	4.22	2.76	1.19	1.00	1.44
7	2.47	2.92	2.76	1.91	1.91	0.69	1.00

Table 3. Priority Vector of Goals

No.	Criteria	Eigen vector	Priority vector	Rank
1	Reliability	0.334746	9.0 %	6
2	Visual identification	0.311672	8.3 %	7
3	Service complexity	0.348688	9.3 %	5
4	Relational capital	0.413616	11.1 %	4
5	Social responsibility	0.495469	13.3 %	3
6	Responsiveness	1	26.8 %	1
7	Technical quality	0.830396	22.2 %	2

Table 4. AHP with the Respect of Reliability

	1	2	3	4	5
1	0.2370	0.2525	0.1754	0.2311	0.3061
2	0.3152	0.3367	0.4333	0.3333	0.2577
3	0.2370	0.1380	0.1754	0.2311	0.1648
4	0.1137	0.1111	0.0842	0.1111	0.1475
5	0.0972	0.1616	0.1316	0.0933	0.1239

Table 5. Priority Vector of Reliability

No.	Sub criteria	Eigen vector	Priority vector	Rank
1	Timeliness of delivery	0,709517	23.9 %	2
2	Success of delivery attempts	1	33.7 %	1
3	Appropriateness and completeness of delivery	0,561838	18.9 %	3
4	Little damage to the package	0,33509	11.3 %	5
5	Fast and efficient order handling	0,360627	12.2 %	4

C. Output

The output of the process stage is a priority that can be used to evaluate and become a recommendation for courier service providers incorporated in e-commerce (Central Purwokerto Branch Pos Indonesia Office). This priority is based on the process of AHP calculation and pairwise comparison of expert representatives from the Indonesian post office branch Purwokerto

III. RESULT

The decision table based on the dimensions of courier service quality in e-commerce by Gulc [5]

is modeled as in Table 1. Then, a questionnaire was designed to be filled out by the respondents, as shown in Fig. 2. show the questionnaire format was prepared following the publication by Harputlugil [25].

Respondents were then asked to rate the criteria and sub-criteria. AHP calculations were carried out using the power method [15] per node. The AHP calculation step is carried out in several stages. First, the matrix for each respondent is consolidated using the geometric mean method. Second, the initial eigenvector is determined by normalizing the pairwise comparison matrix. After the matrix is normalized, add up each row in the matrix, then divide by the size of the matrix. Third, the power method searches the dominant

4 JUDGEMENT

4.1 WITH THE RESPECT OF GOALS

No.	Factor A	9	7	5	3	1	3	5	7	9	Factor B
1	Reliability					✓					Visual identification
2	Reliability						✓				Service complexity
3	Reliability							✓			Relational capital
4	Reliability			✓							Social responsibility
5	Reliability						✓				Responsiveness
6	Reliability						✓				Technical quality
7	Visual identification						✓				Service complexity
8	Visual identification							✓			Relational capital
9	Visual identification				✓						Social responsibility
10	Visual identification						✓				Responsiveness
11	Visual identification							✓			Technical quality
12	Service complexity				✓						Relational capital
13	Service complexity			✓							Social responsibility
14	Service complexity							✓			Responsiveness
15	Service complexity				✓						Technical quality
16	Relational capital		✓								Social responsibility
17	Relational capital							✓			Responsiveness
18	Relational capital				✓						Technical quality
19	Social responsibility							✓			Responsiveness
20	Social responsibility								✓		Technical quality
21	Responsiveness				✓						Technical quality

4.2 WITH THE RESPECT OF TECHNICAL QUALITY

No.	Factor A	9	7	5	3	1	3	5	7	9	Factor B
1	Modern ecological solutions				✓						Service availability
2	Modern ecological solutions		✓								Choice of delivery method
3	Service availability				✓						Choice of delivery method

4.3 WITH THE RESPECT OF VISUAL IDENTIFICATION

No.	Factor A	9	7	5	3	1	3	5	7	9	Factor B
1	Aesthetic and neat courier appearance					✓					Signature trademarks and uniform colors
2	Aesthetic and neat courier appearance		✓								Aesthetically pleasing and functional company branches and pick-up points
3	Signature trademarks and uniform colors				✓						Aesthetically pleasing and functional company branches and pick-up points

Fig. 2. Respondent questionnaire.

eigenvector and eigenvalue after determining the initial eigenvector. Iterations are carried out a maximum of 20 times because it has reached an accepted approximation error of 10^{-7}; the last iteration is used to evaluate CR and priority vector; fourth, CR is determined using the Saaty method if the size of the matrix is between 3 up to 10, in addition to this size the Alonso and Lamata methods are used.

In the aggregate AHP calculation, eight AHP calculations were calculated manually, which consisted of calculating criteria based on objectives, then subcriteria analyses comprised of dimensions of reliability, visual identification, service complexity, relational capital, social responsibility, responsiveness, and technical quality as shown in Table 2 up to Table 17. Table 2 and Table 3 are the consolidated calculation of the entire matrix with CR value of 2.2 % (4).

$$CR = \frac{\lambda - n}{(n - 1)\, RI_n} = \frac{7.1725 - 7}{(7 - 1)\, 1.32} = 2.2\% \quad (4)$$

$$CR = \frac{\lambda - n}{(n - 1)\, RI_n} = \frac{5.0868 - 5}{(5 - 1)\, 1.12} = 1.9\% \quad (5)$$

Table 4 and Table 5 show the pairwise comparison from the assistant manager of Pos Indonesia Purwokerto judgement of the reliability aspect. In a courier service quality, reliability is an essential factor from the respondents' point of view. It presents in (5) that the consistency result is 1.9 %, which means that the reliability value is consistent.

Table 6. AHP with the respect of Visual Identification

	1	2	3
1	1.0000	1.0000	1.1200
2	1.0000	1.0000	0.5800
3	0.8900	1.7100	1.0000

$$CR = \frac{3.0441 - 3}{(3 - 1)0.57} = 3.9\% \quad (6)$$

$$CR = \frac{2.0031 - 2}{2.7699 * 2 - 4.3513 - 2} = -0.4\% \simeq 0\% \quad (7)$$

Table 7. Priority Vector of Visual Identification

No.	Sub criteria	Eigen vector	Priority vector	Rank
1	Aesthetic and neat courier appearance	0.9029	34.4 %	2
2	Signature trademarks and uniform colors	0.7255	27.6 %	3
3	Aesthetically pleasing and functional company branches and pick-up points	1	38.0 %	1

Table 8. AHP with the Respect of Service Complexity

	1	2
1	1.0000	0.7800
2	1.2900	1.0000

Table 9. Priority Vector of Service Complexity

No.	Sub criteria	Eigen vector	Priority vector	Rank
1	Wide range of additional services	0.777583625	43.7 %	2
2	Service diversity	1	56.3 %	1

Table 10. AHP with the Respect of Relational Capital

	1	2	3	4	5	6
1	1.0000	0.6900	0.8400	1.0000	1.0000	0.6900
2	1.4400	1.0000	0.6900	2.4700	1.2900	1.0000
3	1.1900	1.4400	1.0000	1.0000	0.8400	0.6900
4	1.0000	0.4100	1.0000	1.0000	1.4400	0.4800
5	1.0000	0.7800	1.1900	0.6900	1.0000	0.5800
6	1.4400	1.0000	1.4400	2.0800	1.7100	1.0000

Visual identification is related to the image of a provided company that shows its appearance, the characteristics, or office function. The consistency of this comparison is shown in Table 6 and Table 7. The result shows (6) that expert judgment is consistent with 3.9 %, less than 10 %.

Service complexity is closely related to courier service providers, including various services and coverage. In this section, respondents assess which is prioritized on the complexity of the service. Eq. (7) represents the consistent judgment as the value equal to 0. The results in Table 8 and Table 9 also show that service diversity was prioritized in the courier service while additional services were at the second level.

Table 10 and Table 11 provide the comparison of relational capital from expert judgment. This criterion focused on the company contribution between customers and providers. The result shows that respondents prefer trust from all criteria to be considered an ideal courier service. At the same time, the least important thing to consider is the positive experience of courier service. As presented in (8), the pairwise comparison is consistent with 2.6 %, which is less than 10 %.

$$CR = \frac{6.1640 - 6}{(6-1)1.24} = 2.6\% \qquad (8)$$

Table 12 and Table 13 show the pairwise comparison of expert judgment in social responsibility. This criterion focused on how the company is responsible for dealing with social action. For example, the company has policies regarding adequate packaging and transportation. From (9), the consistency ratio of the pair-wise comparison is 1.6 % which is less than 10 %, therefore, the respondent's judgement is consistent.

$$CR = \frac{1.9872 - 2}{2.7699 * 2 - 4.3513 - 2} = 1.6\% \qquad (9)$$

The result of the consistency ratio, as shown in (10) means that the pairwise comparison is consistent with 2.2 %, which is less than 10 %. It means that the comparison between the sub criteria of responsiveness

is valid to be considered a consistent expert judgment. It shows in Table 14 and Table 15 that six sub-criteria of responsiveness related to efficiency of communication between company employee, quick response, excelent response, and disturbance handling. Whilst Table 16 and Table 17 show the last criterion of quality courier service, which is technical quality.

$$CR = \frac{6.1353 - 6}{(6-1)1.24} = 2.2\% \qquad (10)$$

$$CR = \frac{2.9953 - 3}{(3-1)0.57} = -0.4\% \simeq 0\% \qquad (11)$$

From (11), the responsiveness dimension is more prioritized than other dimensions. In the responsiveness dimension, the priority order of each sub-criterion in this dimension is as follows: accurate and precise information regarding the conditions of service provision, efficient handling of returns, readiness to react quickly to reported problems and disruptions, easy contact with the courier company, efficient communication with courier company employees, and flexibility (choice and change of service dates and places).

Table 11. Priority Vector of Relational Capital

No.	Sub criteria	Eigen vector	Priority Vector	Rank
1	Positive experiences with courier services	0.6117	13.7 %	5
2	Positive feedback from other customers	0.9052	20.2 %	2
3	Positive image and brand of the courier company	0.7439	16.6 %	3
4	Experience and credibility of the courier company	0.6000	13.4 %	6
5	Knowledge and competence of employees	0.6191	13.8 %	4
6	Trust in the courier company	1	22.3 %	1

Table 12. AHP with the Respect of Social Responsibility

	1	2
1	1.0000	0.1900
2	5.1300	1.0000

Table 13. Priority Vector of Social Responsibility

No.	Sub criteria	Eigen vector	Priority vector	Rank
1	Ecological technical solutions	0.19243	16.1 %	1
2	Courier company involvement in social action	1	83.9 %	2

IV. Discussion

This study is subjective and only takes samples based on the decisions of three respondents of the service assistant of the Central Purwokerto Branch of the Pos Indonesia Office. It would be better if the respondents' population were broad to provide more objective results. The development suggestion is to expand the respondents to more than one area, not only from Purwokerto.

The data obtained could be from all over Indonesia. Therefore, a study to seek expert opinion to evaluate several criteria and sub-criteria is needed. Expert opinion from various e-commerce services in Indonesia towards the area of services needing improvement on a priority basis. The results of this study also need to be confirmed. Some methods, such as confirmatory factor analysis (CFA) , can be used in further studies. However, the CFA was used before the AHP calculation to ensure that the result of the questionnaire was valid.

V. Conclusion

This study examines the prioritization of the determinants of courier service quality in collaboration with e-commerce service providers. This study used MCDM with the AHP method to analyze the problem. With the criteria and sub-criteria based on Gulc's research, the AHP method can be used to prioritize the quality of courier services that join e-commerce services.

The results of group decisions obtained based on the perspectives of the three Manager Assistants of Service Department Officers of the Central Purwoketo Branch of the Pos Indonesia Office show that the responsiveness dimension is the most prioritized compared to other dimensions. Besides, the instrument and result in this study can be used to measure the service quality perceived by the assistant manager who is involved with the customer a lot. This study will assist Pos Indonesia Purwokerto in prioritizing areas of service that need improvement and to help them strengthen their competitive standing in the global market.

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Table 14. AHP with the Respect of Responsiveness

	1	2	3	4	5	6
1	1.0000	0.7800	0.5800	0.8200	0.5800	2.0800
2	1.2900	1.0000	0.4800	0.6900	0.6900	1.4400
3	1.7100	2.0800	1.0000	0.8400	2.0800	2.0800
4	1.2200	1.4400	1.1900	1.0000	1.0000	1.4400
5	1.7100	1.4400	0.4800	1.0000	1.0000	2.0800
6	0.4800	0.6900	0.4800	0.6900	0.4800	1.0000

Table 15. Priority Vector of Responsiveness

No.	Sub criteria	Eigen vector	Priority vector	Rank
1	Easy contact with courier companies	0.564514	14.0 %	4
2	Efficient communication with courier company employees	0.550446	13.7 %	5
3	Accurate and clear information regarding service provision conditions	1	24.8 %	1
4	Efficient handling of returns	0.77616	19.2 %	2
5	Readiness to react quickly to reported problems and disruptions	0.746621	18.5 %	3
6	Flexibility (choice and change of service date and place)	0.394275	9.8 %	6

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Table 16. AHP with the Respect of Technical Quality

	1	2	3
1	1.0000	1.7100	1.9100
2	0.5800	1.0000	1.1900
3	0.5200	0.8400	1.0000

Table 17. Priority Vector of Technical Quality

No.	Sub criteria	Eigen vector	Priority vector	Rank
1	Modern ecological solutions	1	47.5 %	1
2	Service availability	0.595647	28.3 %	2
3	Choice of delivery method	0.511384	24.3 %	3

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