

Analysis of Service Satisfaction Level at Batam Center International Port in Batam City Using the Fuzzy Mamdani Method

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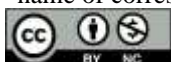
Abstract: A port is defined as a facility and system where a port is a work environment consisting of a land and water area equipped with berthing and mooring facilities for ships, a place for loading and unloading, and boarding and disembarking passengers from one mode of sea transportation to another mode of transportation. In carrying out activities at the port, apart from providing sufficient facilities and equipment, quality services cannot be neglected. This research aims to analyze and determine how much influence the level of service provided has on the satisfaction response of ship passengers at the Batam Center International Port, Batam City. To carry out this research, the study used a literature review, observation, and distribution of questionnaires using a Likert scale and the Fuzzy Mamdani method. However, several challenges were encountered during the study. First, there was a difficulty in obtaining a representative sample of passengers due to the variability in passenger traffic and schedules. Second, the subjective nature of satisfaction measurement posed challenges in ensuring the accuracy and consistency of responses. Third, integrating the qualitative data from the Likert scale with the quantitative Fuzzy Mamdani method required careful handling to avoid misinterpretation. The expected results from this research are the levels of satisfaction ship passengers feel regarding the dimensions of tangibles, reliability, responsiveness, assurance, and empathy. This will help determine whether passengers perceive themselves as satisfied or dissatisfied. Based on the analysis and discussion carried out with 50 respondents using the Likert scale method, the respondents stated that they were quite satisfied. This indicates that the Batam Center International Port, Batam City, is quite successful in providing satisfactory services to passengers. From the dimensions of reliability, responsiveness, assurance, empathy, and tangibles, overall consumers feel quite satisfied, with an average satisfaction percentage of 71% (35.5 out of 50 respondents). Similarly, the results obtained from the Fuzzy Logic Mamdani method show an output value for consumer satisfaction of 150 (within a range of 50–250), indicating that the level of consumer satisfaction with the services provided by the Batam Center International Port, Batam City, is quite satisfactory.

Keywords: Fuzzy Logic, Harbor, City of Batam, Responsiveness, Empathy.

INTRODUCTION

Batam Center International Port is a port located in Batam Center, Batam City, Riau Islands province. This port connects the city of Batam with ports in Singapore and Malaysia. Several types of ships operating at the International Batam Center port include MV. Dumai Express, MV. Batam Jet, MV. Marina Batam, MV. Mikonatalia, and so on. All of this is managed by various shipping companies,

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which are operators under the control of the port manager, harbormaster, and other related agencies in Batam. Quality service from the relevant agencies mentioned above, especially service from ship operators, is a basic factor that has a big influence on passengers in determining which ship to board according to the destination of prospective passengers, due to the existence of different ships serving the same shipping lines and destinations. So which company provides services that are considered more satisfactory as well as offering cheaper ticket prices is what many prospective ship passengers choose.

Prospective ship passengers, both departing and arriving, expect services from port managers and related agencies at the port. With the port support facilities provided by the port manager, good service can also be felt. Many potential passengers and smooth shipping flows every day show this. Service quality is not only a matter of controlling future quality but also of preventing poor quality from occurring in the first place. Ship passengers expect fast and good service, which also contributes to improving service quality. The satisfaction level of potential ship passengers is a great way to measure the quality and service they receive. Good service quality is when the service provider company can provide satisfactory service so that it meets customer requests and expectations.

The latest research includes a comparison of the results of Likert scale analysis with the results of fuzzy logic analysis to assess the level of passenger satisfaction with domestic port services at Batam International Port (Sari et al., 2018).

LITERATURE REVIEW

The Likert scale method is one of the most commonly used methods to measure the level of customer satisfaction. This method uses a series of statements that respondents must rate on a scale that usually ranges from "strongly disagree" to "strongly agree." The use of a Likert scale allows researchers to collect quantitative data that can be analyzed statistically to determine customer satisfaction levels. Research by (Almeida et al, 2023) shows that Likert scales are effective in capturing customer perceptions and preferences in various service contexts.

Fuzzy logic is an analysis method used to handle data that is uncertain or ambiguous. In the context of customer satisfaction assessment, fuzzy logic can process qualitative data that is difficult to measure directly into quantitative values that are easier to analyze. This method allows researchers to consider various levels of satisfaction that cannot be measured with conventional scales. According to research by (Chan et al, 2022), fuzzy logic is effective in providing a more detailed and accurate assessment of customer satisfaction compared to traditional methods.

Comparisons between the Likert scale and fuzzy logic methods have been carried out in various studies to evaluate the effectiveness of the two methods in measuring customer satisfaction. Research by (Wang et al, 2017) revealed that although Likert scales provide results that are easy to understand and interpret, fuzzy logic offers greater flexibility in dealing with uncertain data and provides deeper insights into customer perceptions. The results of this research show that the combination of the two methods can provide a more comprehensive picture of customer satisfaction levels.

Much research has been carried out regarding assessing passenger satisfaction at ports to understand the factors that influence passenger satisfaction and experience. A study by (Mardiana and Syamsudin, 2018) highlighted the importance of service quality, facility comfort, and operational efficiency in determining passenger satisfaction at ports. This research emphasizes the need for accurate and comprehensive assessment methods to improve service quality at ports.

Ghosh dan Ray (2021) menggunakan teknik logika fuzzy untuk menilai kualitas layanan di pelabuhan maritim, menemukan bahwa pendekatan ini meningkatkan akurasi dan keandalan evaluasi dibandingkan metode tradisional (Ghosh & Ray, 2021). Batam International Port is one of the main ports in Indonesia and serves domestic and international routes. Research on passenger satisfaction at this port highlights the challenges and opportunities in improving passenger services. The study by (Sari et al, 2018) identified the main factors that influence passenger satisfaction at Batam International Port, such as quality of facilities, speed of service, and comfort of waiting areas. This research suggests using more sophisticated analysis methods, such as fuzzy logic, to obtain more accurate results.

METHOD

Figure 1 shows the results of research conducted on the analysis of the level of service satisfaction at the Sekupang domestic port, Batam city, using a Likert scale and fuzzy logic method.

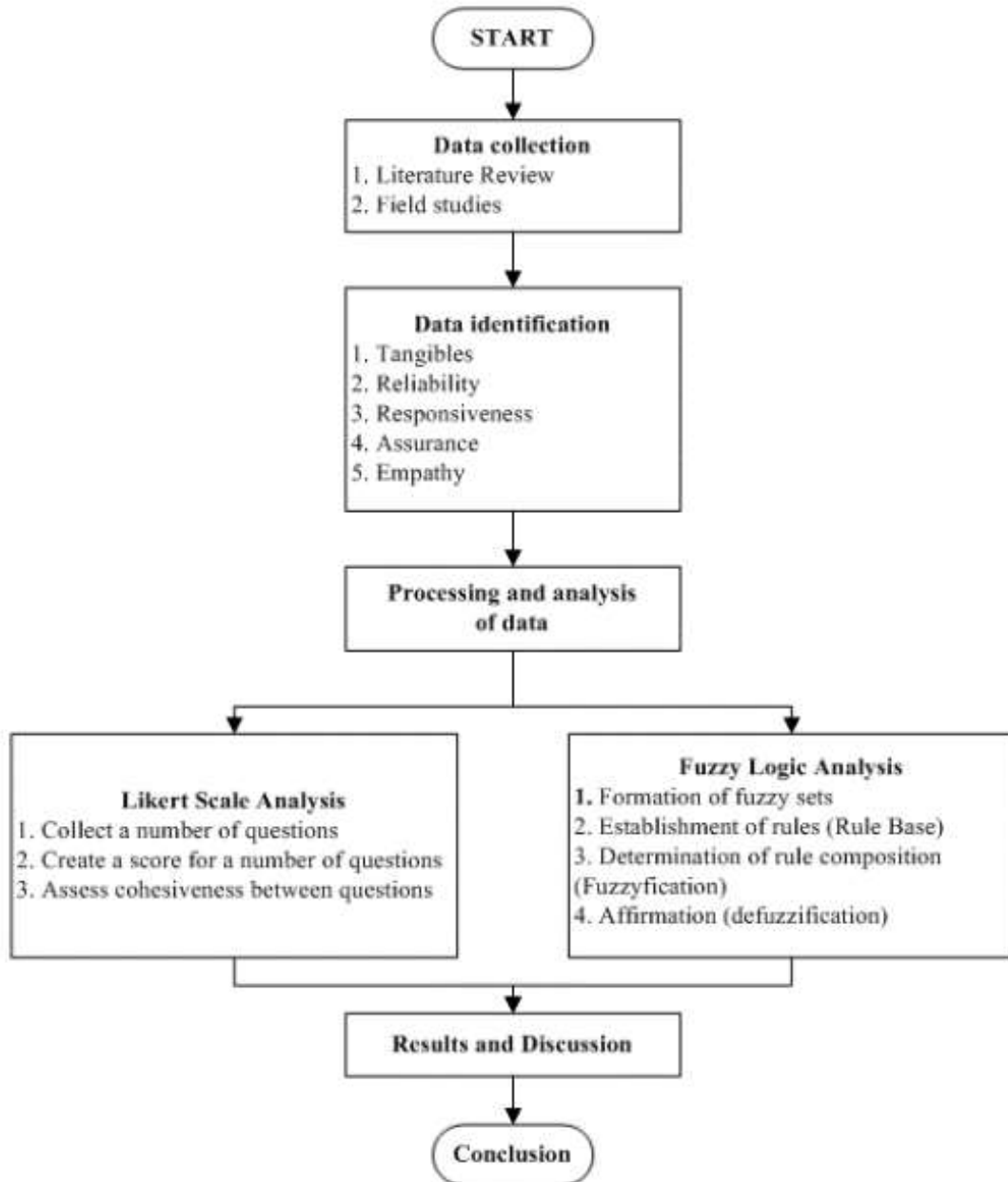


Figure 1: Flow diagram of service satisfaction level analysis at Batam Center International Port

Data collection

The sources used in this research are as follows:

- a. Literature review:
Data collection was carried out by reading and analyzing theoretical books that were relevant to the method discussed.
- b. Field Study:
Questionnaires were distributed to fifty respondents, who were customers who planned to board a ship at the Batam International port.

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Data Identification

To meet the needs for calculations and problem analysis, data identification is carried out. The data collected from the questionnaire includes the following elements:

1. Tangibles
2. Reliability
3. Responsiveness
4. Assurance
5. Empathy

The five components or dimensions mentioned above are evaluated using assessment categories:

1. Category 1: Very Dissatisfied (VD)
2. Category 2: Dissatisfied (D)
3. Category 3: Fairly Satisfied (FS)
4. Category 4: Satisfied (S)
5. Category 5: Very Satisfied (VS)

Data analysis method

Two different types of analysis are used to demonstrate the hypotheses that have been created, namely:

1. Likert Scale Analysis

The steps taken to carry out Likert Scale Analysis, according to Almada, R (2022:28), are as follows:

- a. Collect a number of questions that are relevant to the problem to be researched. After respondents choose one of the various answer categories available, each answer is given a special value.
- b. Add up the scores for each answer to produce a total score for each person.
- c. Checking the cohesiveness between questions.

2. Fuzzy logic analysis through Mamdani Method.

The data processing process is carried out using the Matlab.8.0 tool and the Fuzzy Toolbox facility, according to the following procedure:

a. Formation of fuzzy sets

In this step, linguistic and numerical values are determined to form a fuzzy set based on the results of parameter data analysis.

b. Establishment of rules (Rule Base)

This method is used to find fuzzy output values from fuzzy input. The fuzzy values obtained from the fuzzification process are then entered into the rules that have been created to make them fuzzy.

c. Determination of rule composition (Fuzzyfication)

The process of changing crisp values into fuzzy variables (linguistic variables which will later be grouped into fuzzy sets) is described by determining the composition of rules.

d. Affirmation (defuzzification)

The defuzzification process produces a fuzzy set from the composition of fuzzy rules, and the output is a number in the fuzzy set domain. In other words, if a fuzzy set is given in a certain range, then certain crisp values must be taken as the output.

DISCUSSIONS

Likert scale analysis

To collect data, this research was carried out by distributing questionnaires to fifty respondents who represented various characteristics that had been previously determined in accordance with the research objectives. The following is a description of the general characteristics of respondents collected from the questionnaire.

1. Gender

Questionnaires were distributed to 50 people, consisting of 30 respondents (60%) women and 20 respondents (40%) men.

2. Age

The research questionnaire on age shows that respondents aged < 18 years have a percentage of 6%, aged 18–25 years have a percentage of 20%, aged 26–35 years have a percentage of 39%, aged 36–

45 years have a percentage of 17%, aged 46–55% years have a percentage of 13%, ages 55–65 have a percentage of 3%, and ages > 65 years have a percentage of only 2%.

3. Employment

The research questionnaire on employment showed that the percentage of respondents was: students with a percentage of 5%, students with a percentage of 4%, civil servants with 14%, entrepreneurs with 25%, BUMN with 1%, and housewives (and others) with the largest percentage, namely 36%.

The results show that prospective ship passengers see the Batam international port in Batam as users of the following services:

Analysis Results Based on a Likert Scale

From the results of the analysis that has been carried out, if seen from several dimensions, it shows the level of satisfaction, namely:

a. Tangible Dimension

In the tangible dimension, the majority stated that they were quite satisfied, namely with an average percentage of 66% and an average value of 165.4%.

b. Reliability Dimension

In the reliability dimension, the majority stated that they were quite satisfied, namely with an average percentage of 67% and an average value of 168.

c. Responsiveness Dimension (Responsiveness)

In the responsive data dimension, the majority stated that they were quite satisfied, namely with an average percentage of 80% and an average value of 80.2%.

d. Assurance Dimension (Certainty)

In the dimension of certainty, the majority stated that they were quite satisfied, namely with an average percentage of 78% and an average value of 117.

e. Emphaty Dimension (Empathy)

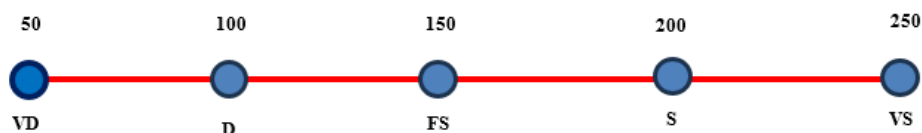
In the empathy dimension, the majority stated that they were quite satisfied, namely with an average percentage of 71% and an average value of 178.

Overall, the level of satisfaction of Batam International Port passengers in Batam City using the Likert scale method states that they are quite satisfied. The average percentage value is: $77.6\% + 72\% + 68\% + 66.4\% + 73.2\% = 357.2\% / 5 = 71.44\%$ (35.5 out of 50 respondents).

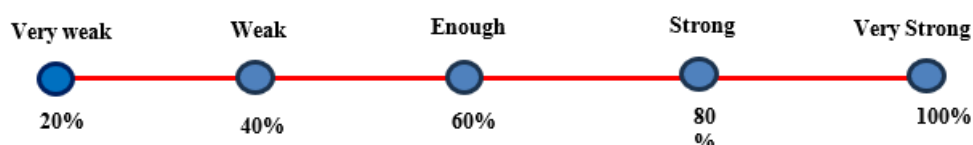
The ideal score for each item from question No.1 to question No.20 (highest score) = $5 \times 50 = 250$ (SP). The number of low scores for each item from question No.1 to question No.20 (lowest score) = $5 \times 1 = 250$ (STP).

Based on data (item No.1 to item No.20) obtained from 50 respondents, then

A scale for fuzzy logic analysis is created which can be seen, as below:



The percentage of respondent groups for each item from question No. 1 to question No. 20 can be seen below:



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Description: Numerical Score Interpretation Criteria

- 0% - 20% = Very Weak Number
- 21%- 40% = Weak numbers
- 41% - 60% = Quite a number.
- 61%- 80% = Strong number.
- 81%-100% = Very strong

Fuzzy Logic Analysis

Fuzzy logic analysis begins with questionnaire data filled in by passengers. The questionnaire filled in by passengers will be a determining factor in the quality of port services. Questionnaire data is used to determine fuzzy logic variables, and then the fuzzy set is formed. For details, see Figure 2.

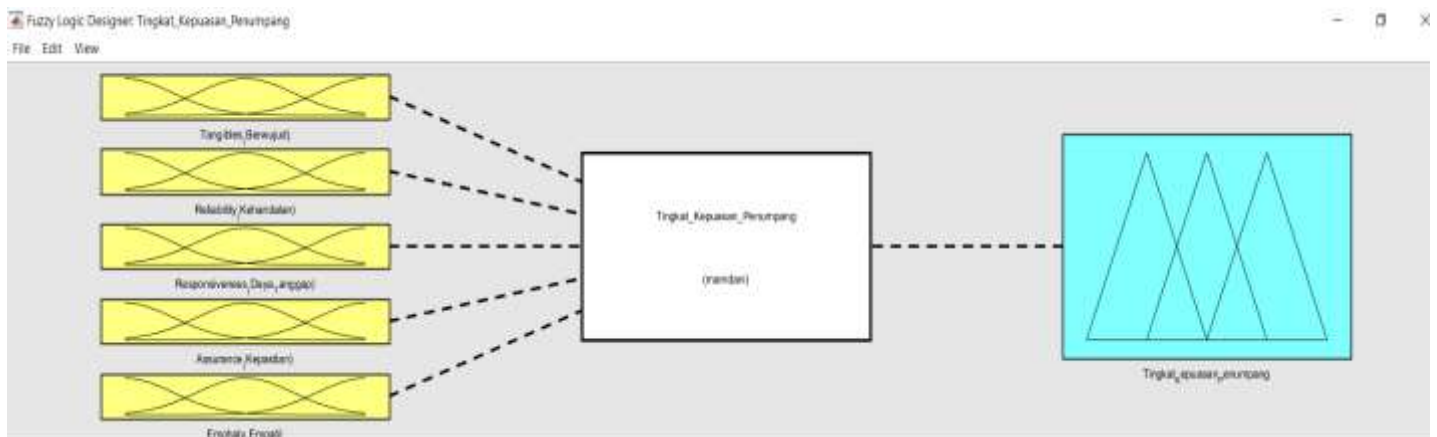


Figure 2: Fuzzy Logic Diagram

Data Collection and Processing

Determination of the variables used in this research can be seen in table 1.

Table. 1: Fuzzy Set

Function	Variable Name	Universe of Conversations
Input	Tangibles	[50 250]
	Reliability	[50 250]
	Responsiveness	[50 250]
	Assurance	[50 250]
	Emphaty	[50 250]
Output	Consumer Satisfaction Level	[50 250]

From the variables that have emerged, a fuzzy set domain is arranged as shown in Table 2.

Table. 2: Fuzzy Set Domains

Variabel	Fuzzy Set Name	Domain
Tangibles	Very Dissatisfied (VD)	[50 - 100]
	Dissatisfied (D)	[50 - 150]
	Fairly Satisfied (FS)	[100 - 200]
	Satisfied (S)	[150 - 250]
	Very Satisfied (VS)	[200 - 250]

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Reliability	Very Dissatisfied (VD)	[50 - 100]
	Dissatisfied (D)	[50 - 150]
	Fairly Satisfied (FS)	[100 - 200]
	Satisfied (S)	[150 - 250]
	Very Satisfied (VS)	[200 - 250]
Responsiveness	Very Dissatisfied (VD)	[50 - 100]
	Dissatisfied (D)	[50 - 150]
	Fairly Satisfied (FS)	[100 - 200]
	Satisfied (S)	[150 - 250]
	Very Satisfied (VS)	[200 - 250]
Assurance	Very Dissatisfied (VD)	[50 - 100]
	Dissatisfied (D)	[50 - 150]
	Fairly Satisfied (FS)	[100 - 200]
	Satisfied (S)	[150 - 250]
	Very Satisfied (VS)	[200 - 250]
Emphaty	Very Dissatisfied (VD)	[50 - 100]
	Dissatisfied (D)	[50 - 150]
	Fairly Satisfied (FS)	[100 - 200]
	Satisfied (S)	[150 - 250]
	Very Satisfied (VS)	[200 - 250]
Consumer satisfaction level	Very Dissatisfied (VD)	[50 - 100]
	Dissatisfied (D)	[50 - 150]
	Fairly Satisfied (FS)	[100 - 200]
	Satisfied (S)	[150 - 250]
	Very Satisfied (VS)	[200 - 250]

RESULT

Fuzzy logic analysis results

1. Input, including:

a. Tangibles

obtained a real number of 150, which is membership in the domain set of satisfied fuzzy numbers [150–250], which means that the Tangibles (Tangible) variable can be said to provide good service.

b. Reliability

The real number obtained is 150, which is membership in the domain of the satisfied fuzzy number set [150–250], which means that the reliability variable can be said to provide satisfactory service.

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- c. responsiveness,
The real number obtained is 150, which is membership in the satisfied fuzzy number set domain [150–250], which means that the responsiveness variable can be said to be able to provide responsive service.
- d. Assurance,
The real number obtained is 150, which is membership in the satisfied fuzzy number set domain [150–250], which means that the assurance variable can be said to be knowledgeable, polite, and trustworthy in service.
- e. Emphaty,
The real number obtained is 150, which is membership in the satisfied fuzzy number set domain [150–250], which means the variable emphaty (empathy). It can be said that the service provides ease in communication, personal attention, and understanding customer needs well.

2. Output:

There is only one output, namely: the level of consumer satisfaction obtained by a real number of 150, which is membership in the domain of the set of satisfied fuzzy numbers [150–250], which means that the variable level of consumer satisfaction can be said to be satisfied, namely reaching 150.

CONCLUSION

Using the Likert scale method, fifty people surveyed stated that they were quite satisfied. This shows that the Sekupang port of Batam City is quite successful in providing the best or quite satisfactory service to passengers from all dimensions: reliability, responsiveness, assurance, empathy, and tangibility. The research results showed that an average of 71% (35.5 out of 50 respondents) felt satisfied. Meanwhile, the Mamdani Fuzzy Logic method trial also showed the same results. The output value for customer satisfaction is 150 (in the range of 50 to 250), indicating that customers are quite satisfied with the services provided by the Batam Center International Port, Batam City.

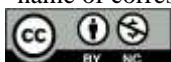
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