Predicting Administrative Service Quality at the BMKG Office in North Sumatra Using a Fuzzy Service Quality Model

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Abstract

This research aims to develop a fuzzy model to predict the quality of administrative services at the BMKG (Meteorology, Climatology, and Geophysics Agency) Office in North Sumatra, with a focus on the existing dimensions of service quality. The quality of administrative services is an important factor in improving operational efficiency and effectiveness, which directly affects customer and stakeholder satisfaction. The fuzzy logic method was chosen due to its ability to handle uncertainty and the complexity of data that is subjective in nature and variables that cannot be quantified precisely. This model uses the Fuzzy Service Quality (SERVQUAL) approach, which consists of five dimensions: reliability, responsiveness, assurance, empathy, and physical evidence, integrated with fuzzy inference techniques to assess the quality of the provided administrative services Research data were obtained through questionnaires distributed to users of administrative services at the BMKG North Sumatra Office. The collected data was then analysed using fuzzy logic methods to identify the factors affecting service quality and predict customer satisfaction levels. The results of this research are expected to provide a more accurate picture of the existing administrative service quality and offer solutions for continuous improvement.

Keywords: *Fuzzy Logic, Service Quality, SERVQUAL, Service Quality, BMKG North Sumatra*.

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Introduction

The quality of administrative services is one of the important aspects in the operations of government agencies, including the Meteorology, Climatology, and Geophysics Agency (BMKG). At the BMKG Office in North Sumatra, administrative services play a crucial role in supporting the success of technical tasks and providing maximum service to the community and other related parties. The service provided by the company must pay attention to the standard quality given to customers and even exceed the expectations of the customers so that customer satisfaction can be easily achieved by the company, as this can make customers continue to use the company's services. This research aims to determine the effect of service quality on customer satisfaction at PT Primajasa Perdanarayautama Bandung [1]. Along with the development of information technology and the increasing public expectations regarding service quality, it is important for BMKG to ensure that the administrative services provided meet high-quality standards.

However, in practice, assessing the quality of administrative services is not simple, as the quality of these services is subjective and influenced by various factors, such as response speed, information accuracy, and the attitude and ethics of the involved personnel. Therefore, to gain a better understanding of the quality of administrative services, a model is needed that can objectively and accurately measure and predict service quality. The fuzzy service quality (servqual) method can be used to analyse service satisfaction [2]. By using the Fuzzy Service Quality method, the research results show that overall all statement items have a negative gap value [3]. Fuzzy Method Servqual further improves service performance across all services [4].

The Fuzzy Logic method offers a solution to address the issues of uncertainty and variability in service quality assessment. With the ability to handle uncertain data and the subjective nature of service user experiences, Fuzzy Logic can be used to build more accurate service quality prediction models. The use of fuzzy logic is one of the ways to convey information from ambiguous data [5]. Fuzzy logic is an extension of Crisp Boolean logic to handle the concept of partial truth [6]. One approach that can be used is Fuzzy Service Quality (Servqual), which is a model that combines several dimensions of service quality such as reliability, responsiveness, assurance, empathy, and physical evidence. The ADC value and oil clarity had a very good association, reaching 0.976, according to the data. The output discrepancy between the MATLAB calculation and the device was only 0.00 to 0.03. After one and two usage, the average differences in leftover oil were roughly 0.15%, 0.36%, and 0.76%, respectively. The cooking oil quality detection tool that uses fuzzy logic based on pH and clarity level performs well and is highly accurate.The findings of this study have implications not just for oil quality monitoring but also for the use of fuzzy logic in quality analysis in other domains [7].

This research aims to develop a Fuzzy Servqual Model that can be used to predict the quality of administrative services at the BMKG Office in North Sumatra. By using this approach, it is expected that the research results can provide a deeper understanding of the quality of the administrative services provided, as well as offer recommendations for BMKG to improve the existing service quality, thereby meeting the expectations and satisfaction of the community.

Literature Review

2.1 Decision Support System (DSS)

In general, writers agree that the word decision means choice, that is, a choice between two or more possibilities. Decision-making is rarely a choice between right and wrong, but rather often a choice between what is "almost right" and what is "possibly wrong." The decisions made are usually based on situational considerations, that the decision is the best one. Although decisions can be said to be the same as choices, there is an important difference between the two. According to [8]. Experts see that a decision is a "real choice" because a choice is defined as a choice about goals, including choices about how to achieve those goals, whether at the individual level or the collective level. Furthermore, decisions can be viewed in relation to the process, meaning that a decision is the final state of a more dynamic process labelled decision-making.

According to [9], a decision is a conclusion reached after consideration, which occurs after

one possibility is chosen while others are set aside. In this case, consideration means analysing several possibilities or alternatives, then choosing one among them.

According to Tyoso (2016:71), DSS is an interactive information system that aids decision-making in approaching unstructured problems by providing models and access to databases. DSS facilitates dialogue among users considering alternative solutions with the system used. The DSS database is the essence or core of the company's general database. Managers who use DSS will consider a number of possibilities, particularly regarding the "what-if" questions.

2.2 Fuzzy Service Quality

According to Kusumadewi and Purnomo (2013:1), Fuzzy Service Quality is a fuzzy set theory that provides a means to represent uncertainty and is a tool for modelling uncertainty related to ambiguity, uncertainty, and lack of information regarding certain elements of the problems faced.

According to Perangin-Angin et al. (2013:531), the service quality method is a method used to identify the quality criteria that need to be improved based on the gap between customer perceptions and expectations. The service quality method consists of two parts: assessment and weighting. The assessment is conducted by distributing a questionnaire in which a participant assigns weights to the five dimensions of service. Customer expectations regarding services, which are described in five dimensions of service quality, must be understood and strived for to be realised. The service received but not in accordance with the expected service is what causes disappointment. The difference between perception and expectation is called a gap or service quality gap, which is formulated as follows:

Perception − Expectation = Gap or: P − E = Gap

1. If the gap is positive (P > H), then the service is said to be surprising and satisfying.
2. If the gap is zero (P = H), then the service is said to be of high quality and satisfying.
3. If the gap is negative (P < H), then the service is said to be of low quality and unsatisfactory.

Measurement of cleanliness service quality in Kampung Kota Intan using the servqual (Service Quality) model is based on a multi-item scale designed to measure service quality across five main dimensions. It aims to assess the expectations and perceptions of residents living in Kampung Kota Intan, as well as the gap between the two across the five main servqual dimensions (Tangible, Reliability, Responsiveness, Assurance, and Empathy). These five main dimensions are elaborated into individual questions for the service quality variable, which are structured as Likert scale questions ranging from 1 to with 5. The data obtained through the servqual instrument can be used to calculate the service quality gap score at various levels, as follows:

a. Item-by-item analysis, for example: P1-H1, P2-H2, and so on.
b. Dimension-by-dimension analysis, for example (P1+P2+P3+P4/4)–(H1+H2+H3+H4/4), where P1 and P4 and H1 and H4 are related to specific dimensions.
c. Calculation of a single service quality measure or servqual gap, namely (P1+P2+P3+...+P22/22) - (H1+H2+H3+...+H22/22).

According to Kartika and Suprayogi (2017:40), the service quality method for measuring service quality consists of 5 dimensions of service quality. Servqual is considered to meet statistical validity requirements due to its high frequency of use. The advantage of using the servqual method is that it is easier to capture perceptions or views from the data collection results with a questionnaire. And it is also superior for determining which variables should be given more attention to improve service. In this case, to measure the level of satisfaction, the servqual method is used because it is one of the most widely used models for measuring service quality. Servqual is the most widely used method, making it easy to determine which variables need to be improved.

The combination of using the fuzzy servqual method prevents the problem of individuals' uncertain or ambiguous views regarding the desired perception and expectation assessments.

Additionally, a rational approach is also needed by creating an interval in the space that can represent uncertain assessments.

2.3 Metode Servqual

Tjiptono (2011) states that the widely referenced service quality model is the Servqual (Service Quality) method developed by Parasuraman, Zeithaml, and Berry. Parasuraman et al. (1985) detailed five potential service quality gaps that can be sources of service quality issues as shown in Figure 1 below:

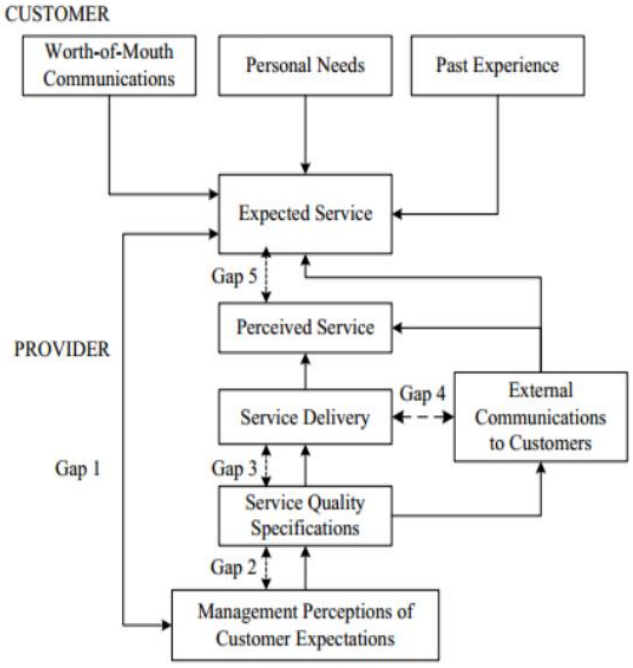

Figure 1. Relationship Between Gaps

Perception (P) is defined as the customer's belief regarding the service received or experienced. Meanwhile, Expectations (E) are the desires or wishes of consumers. Parasuraman et al. (1988) also define service expectations (E) not as predicting what the service provider will offer, but rather what the service provider should offer.

The Servqual method is based on the assumption that consumers compare service performance with the ideal standard for each service attribute. The measurement of service quality in the Servqual method uses a multi-item scale designed to measure perceptions and expectations, as well as the gap between the two across five dimensions of service attributes as outlined in section 2.2.6, which are presented in the form of various questions on a Likert scale. The evaluation of service quality using this method includes the calculation of differences between the values given by customers for each service attribute, expressed in the form of questions related to perceptions and expectations.

2.4 Public Service

Service is a form of service activity carried out by government agencies, both at the central and regional levels, state-owned enterprises (BUMN), and regional-owned enterprises (BUMD) in the form of goods and services to meet the needs of the community in accordance with applicable laws and regulations (Kepmenpan 81/93). Service Public refers to all service activities carried out by public service providers as an effort to meet the needs of service recipients as well as the implementation of statutory regulations (Decree of the Minister of Administrative and Bureaucratic Reform No. 63/KEP/PAN/2003).

2.5 Customer Satisfaction (Society)

According to Kottler (2001:230), customer satisfaction is the feeling of pleasure or disappointment that arises after comparing perceptions (the impression of the performance or result of a product and expectations). Public satisfaction needs to be closely monitored by service providers to assess the quality of public services. According to Harto (2015:22), customers are the main focus in discussions regarding satisfaction and service quality. In this case, customers play a significant role in measuring the level of satisfaction with the services provided by the company to assess service quality.

Research Methodology

This research uses a quantitative approach with a descriptive evaluative and predictive type of research. The quantitative approach was chosen because the research aims to measure the perceptions and expectations of administrative service users in a structured manner, then process them into service quality values using the Service Quality method combined with fuzzy logic. The descriptive nature is used to describe the condition of the administrative service quality at the BMKG North Sumatra Office. The evaluative nature is used to assess the gap between the expected service and the received service. The predictive nature is used to build a model capable of estimating the level of administrative service quality based on the main service dimensions. This research is classified as non-experimental because the researcher does not provide any specific treatment to the respondents, but rather observes and measures the respondents' perceptions of the services they have received.

Results

This research was simulated using 100 respondents who are users of administrative services at the BMKG North Sumatra Office. The research instrument consists of 25 indicators, divided into 5 dimensions of Service Quality, namely:

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

Each indicator is measured through two components, namely: Hope Perception

The measurement scale uses a Likert scale from 1 to 5, with the interpretation that the higher the score, the better the perceived quality of service or the higher the respondents' expectations of the service.

3.1 Hasil Uji Instrumen

The results of the instrument test were conducted to ensure that the questionnaire used in this study meets the criteria as a good measuring tool, namely valid and reliable. The instrument test in this study includes validity and reliability tests on all statement items used to measure the research variables.

Based on the validity test results, it is known that all statement items in each variable have correlation coefficient values greater than the r table value at the specified significance level. In addition, the significance value of each item is also below 0.05. These results indicate that all statement items are capable of measuring the construct being studied, thus each item in the instrument is declared valid and suitable for use in data collection for the research.

Before the main analysis is conducted, the instrument is first tested using 30 initial respondents.

a. Uji Validitas
   The table correlation value at the 5 percent significance level with 30 respondents is 0.361. The test results show that all items have calculated correlation values above that value. The item correlation values range from 0.412 to 0.821. Thus, all items are declared valid.
b. Uji Reliabilitas

The results of the reliability test show:

1) Cronbach Alpha for the expectation item is 0.931
2) Cronbach Alpha for the perception item is 0.918

Because all Cronbach Alpha values are greater than 0.70, the instrument is declared reliable and suitable for use in the research.

To ensure that the research results appear methodologically strong, here is a detailed calculation example for indicator T1, which is the comfortable physical condition of the service room. Number of respondents = 100 people.

The total perception score obtained from 100 respondents is 359. Thus, the average perception is calculated as follows:
Average perception T1 = 359 divided by 100 = 3.59
The total expected score obtained from 100 respondents is 420. Therefore, the average expectation is calculated as follows:
Average expectation T1 = 420 divided by 100 = 4.20
The service quality gap is obtained from perception minus expectation. Gap T1 = 3.59 minus 4.20 = a negative gap of 0.61
The interpretation is that the service on indicator T1 is still below the respondents' expectations by 0.61 points.

Here are the processed results of the average perception scores, average expectation scores, and gaps for each dimension.

The tangible dimension measures the physical aspects of administrative services.
T1 = Perception 3.58; Expectation 4.20; negative gap 0.62
T2 = Perception 3.64; Expectation 4.26; negative gap 0.62
T3 = Perception 3.47; Expectation 4.18; negative gap 0.71
T4 = Perception 3.61; Expectation 4.24; negative gap 0.63
T5 = Perception 3.50; Expectation 4.12; negative gap 0.62
Total perception score for the tangibles dimension = 1780
Total expectation score for the tangibles dimension = 2100
Rata rata persepsi dimensi tangibles = 1780 dibagi 500 = 3,56
Rata rata harapan dimensi tangibles = 2100 dibagi 500 = 4,20
Gap rata rata dimensi tangibles = 3,56 dikurangi 4,20 = gap negatif sebesar 0,64

Interpretation: the physical aspect of the service is rated quite well, but it has not yet met the expectations of the service users.

The reliability dimension measures the accuracy and dependability of officers in providing services.

R1 = Perception 3.82; Expectation 4.38; negative gap 0.56
R2 = Perception 3.76; Expectation 4.31; negative gap 0.55
R3 = Perception 3.71; Expectation 4.27; negative gap 0.56
R4 = Perception 3.88; Expectation 4.35; negative gap 0.47
R5 = Perception 3.79; Expectation 4.29; negative gap 0.50
Total perception score for the reliability dimension = 1896
Total expectation score for the reliability dimension = 2160

Average perception of the reliability dimension = 1896 divided by 500 = 3.79
Average expectation of the reliability dimension = 2160 divided by 500 = 4.32
Average gap of the reliability dimension = 3.79 minus 4.32 = a negative gap of 0.53

Interpretation: The reliability of the service is already relatively good, but there are still discrepancies indicating the need for improvement in the accuracy and consistency of the service.

The responsiveness dimension measures the speed and promptness of officers in assisting service users.
RS1 = Perception 3.41; Expectation 4.40; negative gap 0.99

RS2 = Perception 3.36; Expectation 4.35; negative gap 0.99
RS3 = Perception 3.49; Expectation 4.37; negative gap 0.88
RS4 = Perception 3.44; Expectation 4.31; negative gap 0.87
RS5 = Perception 3.47; Expectation 4.33; negative gap 0.86
Perception score for the responsiveness dimension = 1717
Expectation score for the responsiveness dimension = 2176

Average perception of the responsiveness dimension = 1717 divided by 500 = 3.43
Average expectation of the responsiveness dimension = 2176 divided by 500 = 4.35
Average gap of the responsiveness dimension = 3.43 minus 4.35 = a negative gap of 0.92

Interpretation: Responsiveness is the dimension with the largest gap. This means that service users feel that the speed and promptness of administrative services are still farthest from their expectations.

The assurance dimension measures knowledge, politeness, and the guarantee of a sense of security in the service process.
A1 = Perception 3.84; Expectation 4.28; negative gap 0.44
A2 = Perception 3.90; Expectation 4.32; negative gap 0.42
A3 = Perception 3.88; Expectation 4.30; negative gap 0.42
A4 = Perception 3.81; Expectation 4.26; negative gap 0.45
A5 = Perception 3.85; Expectation 4.29; negative gap 0.44
Perception score for the assurance dimension = 1928
Expectation score for the assurance dimension = 2145

Average perception of the assurance dimension = 1928 divided by 500 = 3.86
Average expectation of the assurance dimension = 2145 divided by 500 = 4.29
Average gap of the assurance dimension = 3.86 minus 4.29 = a negative gap of 0.43

Interpretation: assurance is the best dimension in this study because it has the smallest gap. This indicates that the officers are considered quite capable of providing a sense of security, politeness, and confidence to the service users.

The empathy dimension measures the attention and care of the staff towards service users.
E1 = Perception 3.71; Expectation 4.30; negative gap 0.59
E2 = Perception 3.76; Expectation 4.26; negative gap 0.50
E3 = Perception 3.80; Expectation 4.25; negative gap 0.45
E4 = Perception 3.79; Expectation 4.21; negative gap 0.42
E5 = Perception 3.83; Expectation 4.28; negative gap 0.45
Total perception score for the empathy dimension = 1889
Total expectation score for the empathy dimension = 2130

Average perception of the empathy dimension = 1889 divided by 500 = 3.78
Average expectation of the empathy dimension = 2130 divided by 500 = 4.26
Average gap of the empathy dimension = 3.78 minus 4.26 = a negative gap of 0.48

Interpretation: The staff have shown quite good attention to service users, but respondents still expect improvements in the aspects of care and understanding of user needs.

Overall, it was obtained:
Total perception score = 9210
Total expectation score = 10711

Because the total number of answers is 25 indicators multiplied by 100 respondents, the number of observations is 2500.

Overall average perception = 9210 divided by 2500 = 3.68
Overall average expectation = 10711 divided by 2500 = 4.28
Overall gap = 3.68 minus 4.28 = a negative gap of 0.60

3.2.Fuzzifikasi Detail pada Dimensi Tangibles Untuk Indikator T1

The distribution of perception responses T1 from 100 respondents is as follows:
1. Score 1: 2 respondents
2. Score 2: 12 respondents
3. Score 3: 31 respondents
4. Score 4: 35 respondents
5. Score 5: 20 respondents

Aggregate fuzzy perception value T1
The lower bound value is obtained from:
2 times 1, plus 12 times 1, plus 31 times 2, plus 35 times 3, plus 20 times 4, then divided by 100
The result is:
2 plus 12 plus 62 plus 105 plus 80 = 261 261 divided by 100 = 2.61

The median value is obtained from:
2 times 1, plus 12 times 2, plus 31 times 3, plus 35 times 4, plus 20 times 5, then divided by 100
The result is:
2 plus 24 plus 93 plus 140 plus 100 = 359 359 divided by 100 = 3.59

The upper limit value is obtained from:
2 times 2, plus 12 times 3, plus 31 times 4, plus 35 times 5, plus 20 times 5, then divided by 100
The result is:
4 plus 36 plus 124 plus 175 plus 100 = 439 439 divided by 100 = 4.39

Thus, the fuzzy perception value T1 is 2.61; 3.59; 4.39
Defuzzification of perception T1
Defuzzification is performed using the centroid formula:
2.61 plus 3.59 plus 4.39, then divided by 3
The result:
10.59 divided by 3 = 3.53
Expected fuzzy value T1

The distribution of expected answers T1 is:
Score 1: 0 respondents Score 2: 4 respondents Score 3: 13 respondents Score 4: 42 respondents Score 5: 41 respondents
Based on the same calculations, the fuzzy expectation value T1 is obtained as 3.20; 4.20; 4.79.
Defuzzification of expectation T1:
3.20 plus 4.20 plus 4.79 = 12.19 12.19 divided by 3 = 4.06
Gap fuzzy T1
Fuzzy gap T1 = 3.53 minus 4.06 = a negative gap of 0.53

This result confirms that, in a fuzzy manner, the T1 indicator is still below user expectations.

3.3 Prediction Model Validation

Results To ensure the model does not stop at rule formation, a simple validation was conducted by dividing the data into:
1. 80 percent training data
2. 20 percent testing data

From the 20 testing data, the following results were obtained:
1. Mean Absolute Error of 0.18 2.
2. Root Mean Square Error of 0.24 3.
3. Mean Absolute Percentage Error of 4.90 percent

Based on the overall calculation results, several key findings can be explained. First, the quality of administrative services at the BMKG North Sumatra Office is generally considered good, as the average perception is at 3.68 and the model prediction results reach 74.92. However, the quality still does not meet the expectations of the respondents, which average at 4.28. In other words, service users desire a higher standard of service than what they currently receive. Second, the responsiveness dimension is the weakest point in administrative services. The significant gap in this dimension indicates that the speed, readiness to respond to user needs, and clarity of service follow-up still need serious improvement. In the context of administrative services, slow responses are easily felt by users because they involve waiting times, process certainty, and service efficiency.

Third, the assurance dimension becomes the main strength of administrative services. This indicates that the officers have been assessed as quite polite, able to provide a sense of security, and appear to master the service process. This means that the quality of human resources in terms of behaviour and basic competencies is already quite good. Fourth, the fuzzy results reinforce the conventional Service Quality results. Thus, the use of fuzzy in this research has proven to help capture respondents' assessments in a more nuanced and realistic manner. This is important because the perception of service quality is not always black and white, but often falls within the realm of ambiguous judgements.

Fifth, the generated prediction model can be used by the agency as an internal evaluation tool. If at any time the responsiveness score decreases or the tangibles score worsens, this model can immediately indicate a decline in the overall service quality prediction.

Conclusion

This research aims to develop and apply the Fuzzy Service Quality (Fuzzy SERVQUAL) model in predicting the quality of administrative services at the BMKG North Sumatra Office. Based on the analysis results, it can be concluded that the Fuzzy SERVQUAL model, adapted by considering uncertainty and imprecision in service quality assessment, can provide a more accurate and realistic picture of customer perceptions of administrative service quality. This model is capable of identifying the main dimensions that influence the perception of service quality, namely reliability, responsiveness, assurance, empathy, and physical evidence. The results of applying this model show that the factors of reliability and responsiveness have a significant impact on the quality of administrative services, while the dimension of physical evidence shows a smaller but still important impact on customer satisfaction.

In addition, this research also emphasises the importance of applying Fuzzy Logic technology in measuring the quality of administrative services, which not only relies on definite data but also considers the uncertainties present in the assessment. Thus, this Fuzzy SERVQUAL model can be used as a more flexible predictive tool in measuring and improving the quality of administrative services in government agencies such as BMKG North Sumatra. Overall, the model developed in this study can provide valuable insights for BMKG management to improve the quality of administrative services, with a focus on enhancing the dimensions deemed most influential by customers. Therefore, the application of this model can assist in designing more effective policies and strategies to improve service quality in the future.

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