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Abstract. The research objective was to analyze service quality management on customer satisfaction by utilizing decision support system (DSS) techniques in the completion process. The research data source is the Regional Drinking Water Company (abbreviated as PDAM) "Tirtauli" in Pematangsiantar city. The object of the research is the customers / users of PDAM services which are carried out by means of random observations and questionnaires. The DSS technique used is the analytic hierarchy process (AHP) method. The result of the method is a recommendation in the form of a ranking of service quality management on customer satisfaction. The criteria used to measure customer satisfaction in research are physical evidence (K1), reliability (K2), responsiveness (K3), assurance (K4), care (K5). The calculation results of the AHP method state that two very influential criteria in improving service quality management on customer satisfaction are assurance (K4) with a final value of 0.1929 and reliability (K2) with a final value of 0.1912. The results of the research are expected to provide information and input to the management of PDAM Tirtauli in improving service quality management in order to achieve customer satisfaction.

1. Introduction

Much of the most widely researched research in the world deals with the most widely researched variables in the world which are competitiveness, product knowledge, customer satisfaction and loyalty. From these studies, customer satisfaction is the most widely conducted research [1]. Customer satisfaction is one of the assessments of services that have been provided in accordance with what is expected [2]. Customer satisfaction is the benchmark for companies in running their business. If the quality of service provided by the company to customers is good, the customer thinks the company is professional in providing its services. Vice versa, if customers think the quality of service provided to customers is bad, then the customer thinks the company is less professional in providing service [3]–[5]. Therefore, in an effort to improve or maintain the quality of service it is necessary to conduct research based on customer assessment. Many artificial intelligence techniques can be used to solve complex problems [6] such as decision support systems [7]–[14], data mining [15]–[17], artificial neural networks [18] and others. There are various techniques to resolve inaccuracies in company

performance appraisals, one of which is a decision support system [19]. The method used is the analytic hierarchy process (AHP). The AHP method is a comprehensive decision-making model by taking into account qualitative and quantitative matters [20] so that it can measure and regulate the impact of an interacting component in a system on system errors [21]. Several studies were conducted on the level of customer satisfaction with service quality [22] using five criteria and fourteen sub criteria. The difference with the research that the author is currently doing is in the use of methods and sub-criteria. The method that I use is the AHP method. Where the advantages of the AHP Method are quite effective in simplifying and speeding up the decision making process by solving problems into their parts [23]. And the criteria that the authors use to determine the level of customer satisfaction with service quality, namely using five criteria and twenty five sub criteria. Based on these problems, we need a system that can solve problems of service quality management on customer satisfaction by utilizing the AHP method so that we can find out the priority criteria in improving service management to customers.

2. Methodology

The application of service quality management to customer satisfaction by utilizing the AHP method in the process of completion is a study whose data is sourced from PDAM Tirtauli, Pematangsiantar city. The data were obtained by making observations and questionnaires given randomly to customers or users of PDAM Tirtauli services. The results of observations and interviews were obtained using Microsoft Excel software before the analysis was carried out using the analytic hierarchy process method. Following are the customer satisfaction criteria used in the study, namely physical evidence (K1), reliability (K2), responsiveness (K3), assurance (K4) and care (K5). The following are the results of the customer satisfaction criteria values that have been processed with Microsoft Excel as shown in the following table:

Table 1. Data recapitulation of customer satisfaction criteria value

criteria	K1	K2	K3	K4	K5
K1	82	80	79	81	80
K2	80	81	79	82	78
K3	81	81	77	79	79
K4	82	81	81	82	79
K5	81	78	79	79	79

Source: processed data

The following is a flowchart of the analytic hierarchy process (AHP) method as shown in the following figure:

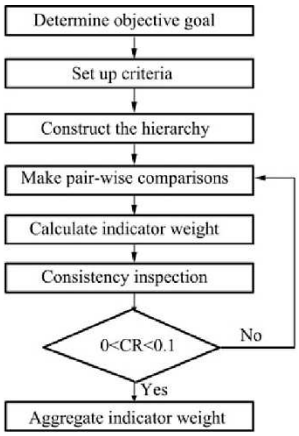

Figure 1. flowchart analytic hierarchy process (AHP) method

3. Results and Discussion

After determining the criteria and getting the average value of each criterion as shown in table 1, the next steps are:

a) Calculating the Pairwise Matrix Value (Pairwise Comparison Matrix) of each criterion as shown in the following table:

Table 2. Pairwise Comparison Matrix

criteria	K1	K2	K3	K4	K5
K1	1	1/2	1/2	1/3	2/1
K2	2/1	1	2/1	1/2	2/1
K3	2/1	1/2	1/1	1/2	2/1
K4	3/1	2/1	2/1	1	3/1
K5	½	0,5	1/2	1/3	1

The scale in table 2 is a comparison value between the criteria where the value of the scale can be seen from the following explanation:

1) Scale 1 = equal importance to one another.
2) Scale 3 = moderate category compared to other interests.
3) Scale 5 = strong category compared to other interests.
4) Scale 7 = very strong category compared to other interests.
5) Scale 9 = one interest is extremely stronger than the other.
6) Scale 2, 4, 6, 8 = The values between two values of adjacent considerations, this value is given when there are two compromises between the 2 options.

The following are the results of the pairwise comparison matrix normalization as shown in the following table:

Table 3. normalization of the pairwise comparison matrix

criteria	K1	K2	K3	K4	K5
K1	1,000	0,500	0,500	0,333	2,000
K2	2,000	1,000	2,000	0,500	2,000
K3	2,000	0,500	1,000	0,500	2,000
K4	3,000	2,000	2,000	1,000	3,000
K5	0,500	0,500	0,500	0,333	1,000
total	9,000	5,000	6,000	3,000	10,000

In table 3, the normalization of the matrix is by calculating the number of values for each predetermined criterion column.

b) Calculate the weight of the criteria (priority vector) by normalizing the value of each pairwise comparison matrix column by dividing each number of adjusted column values and calculating the average value of the sum of each row matrix. The following is the normalization of the values for each column of the pairwise comparison matrix.

$$\begin{bmatrix} 0{,}1111 & 0{,}1000 & 0{,}0833 & 0{,}1110 & 0{,}2000 \\ 0{,}2222 & 0{,}2000 & 0{,}3333 & 0{,}1667 & 0{,}2000 \\ 0{,}2222 & 0{,}1000 & 0{,}1667 & 0{,}1667 & 0{,}2000 \\ 0{,}3333 & 0{,}4000 & 0{,}3333 & 0{,}3333 & 0{,}3000 \\ 0{,}0556 & 0{,}1000 & 0{,}3333 & 0{,}1110 & 0{,}1000 \end{bmatrix}$$

Table 4. Average value

Average
0,1211
0,2244
0,1711
0,3400
0,0900

In table 4. The average is obtained from the results of the normalization of the value of each pairwise comparison matrix column then the average results are added. Then the criterion weight value (Wj) = (0.1211; 0.2244; 0.1711; 0.3400; 0.0900).

c) Find the Lamda Max (λmax) by switching the pairwise comparison matrix with the average priority value.
(1,000*0,1211 + 0,500*0,2244 + 0,500*0,1711 + 0,333*0,3400 + 2,000*0,0900) = 0,6121.
Then the following results are obtained:

$$\begin{bmatrix} 1{,}000 & 0{,}500 & 0{,}500 & 0{,}333 & 2{,}000 \\ 2{,}000 & 1{,}000 & 2{,}000 & 0{,}500 & 2{,}000 \\ 2{,}000 & 0{,}500 & 1{,}000 & 0{,}500 & 2{,}000 \\ 3{,}000 & 2{,}000 & 2{,}000 & 1{,}000 & 3{,}000 \\ 0{,}500 & 0{,}500 & 0{,}500 & 0{,}333 & 1{,}000 \end{bmatrix} \begin{bmatrix} 0{,}1211 \\ 0{,}2244 \\ 0{,}1711 \\ 0{,}3400 \\ 0{,}0900 \end{bmatrix} = \begin{bmatrix} 0{,}6121 \\ 1{,}1588 \\ 0{,}8755 \\ 1{,}7643 \\ 0{,}4615 \end{bmatrix}$$

After getting the results of the average value, then look for the Lamda Max results:

$$\lambda_{max} = \frac{1}{5}\left(\frac{0{,}6121}{0{,}1211} + \frac{1{,}1588}{0{,}2244} + \frac{0{,}8755}{0{,}1711} + \frac{1{,}7643}{0{,}3400} + \frac{0{,}4615}{0{,}0900}\right) = 5{,}1305$$

d) Check that the decision maker is consistent in making comparisons. Since the matrix is of order 5 (5 columns), the Consistency Index (CI) value is:

$$\text{CI} = \frac{5{,}1305 - 5}{4} = 0{,}0326$$

e) In looking for the Consistency Ratio (CR), if CR ≤ 0.1 then the pairwise comparison value on the given criteria matrix is consistent, and if CR ≥ 0.1 then the pairwise comparison value on the given criteria matrix is inconsistent.
CR= 0,0326/1,12 = 0,0291
CR = 0,0291 ≤ 0,1 (Consistent)

f) Then calculate and determine the weighted value of the Comparison matrix based on each Criterion. The following are the results of the weighted comparison matrix for each criterion as shown in the following table:

1) Criteria for Physical Evidence (K1)

Table 5. Normalization of Pairwise Comparison Matrices

Criteria	K1	K2	K3	K4	K5
K1	1	82/80	82/81	82/82	82/81
K2	80/82	1	80/81	80/82	80/81
K3	81/82	81/80	1	81/82	81/81
K4	82/82	82/80	82/81	1	82/81
K5	81/82	81/80	81/81	81/82	1

Table 6. Pairwise Comparison Matrix Transformation

Criteria	K1	K2	K3	K4	K5
K1	1,000	1,0250	1,0123	1,0000	1,0123
K2	0,9756	1,000	0,9877	0,9756	0,9877
K3	0,9878	1,0125	1,000	0,9878	1,0000
K4	1,000	1,0250	1,0123	1,000	1,0123
K5	0,9878	1,0125	1,0000	0,9878	1,000
Total	4,9512	5,0750	5,0123	4,9512	5,0123

Table 7. Normalized Value and Average

Criteria	K1	K2	K3	K4	K5	Average
K1	0,2020	0,2020	0,2020	0,2020	0,2020	0,202
K2	0,1970	0,1970	0,1970	0,1970	0,1970	0,197
K3	0,1995	0,1995	0,1995	0,1995	0,1995	0,199
K4	0,2020	0,2020	0,2020	0,2020	0,2020	0,202
K5	0,1995	0,1995	0,1995	0,1995	0,1995	0,199

Then the weight value of physical evidence (K1) is known, namely: W {0.202; 0.197; 0.199; 0.202; 0.199}.

2) Criteria for Reliability (K2)

Table 8. Normalization of Pairwise Comparison Matrices

Criteria	K1	K2	K3	K4	K5
K1	1	80/81	80/81	80/81	80/78
K2	81/80	1	81/81	81/81	81/78
K3	81/80	81/81	1	81/81	81/78
K4	81/80	81/81	81/81	1	81/78
K5	78/80	78/81	78/81	78/81	1

Table 9. Normalized Value and Average

Criteria	K1	K2	K3	K4	K5	Average
K1	0,1995	0,1995	0,1995	0,1995	0,1995	0,199
K2	0,2020	0,2020	0,2020	0,2020	0,2020	0,202
K3	0,2020	0,2020	0,2020	0,2020	0,2020	0,202
K4	0,2020	0,2020	0,2020	0,2020	0,2020	0,202
K5	0,1945	0,1945	0,1945	0,1945	0,1945	0,194

Then it is known the weight value of reliability (K2), namely: W (0.199; 0.202; 0.202; 0.202; 0.194}.

3) Criteria for Responsiveness (K3)

Table 10. Normalization of Pairwise Comparison Matrices

Criteria	K1	K2	K3	K4	K5
K1	1	79/79	79/77	79/81	79/79
K2	79/79	1	79/77	79/81	79/79
K3	77/79	77/79	1	77/81	77/79
K4	81//79	81/79	81/77	1	81/79
K5	79/79	79/79	79/77	79/81	1

Table 11. Normalized Value and Average

Criteria	K1	K2	K3	K4	K5	Average
K1	0,200	0,200	0,200	0,200	0,200	0,200
K2	0,200	0,200	0,200	0,200	0,200	0,200
K3	0,1949	0,1949	0,1949	0,1949	0,1949	0,195
K4	0,2051	0,2051	0,2051	0,2051	0,2051	0,205
K5	0,200	0,200	0,200	0,200	0,200	0,200

Then we know the weight value of responsiveness (K3), namely: W {0.20; 0.20; 0.19; 0.20; 0.20}.

4) Criteria for Assurance (K4)

Table 12. Normalization of Pairwise Comparison Matrices

Criteria	K1	K2	K3	K4	K5
K1	1	81/82	81/79	81/82	81/79
K2	82/81	1	82/79	82/82	82/79
K3	79/81	79/82	1	79/82	79/79
K4	82/81	82/82	82/79	1	82/79
K5	79/81	79/82	79/79	79/82	1

Table 13. Normalized Value and Average

Criteria	K1	K2	K3	K4	K5	Average
K1	0,2010	0,2010	0,2010	0,2010	0,2010	0,201
K2	0,2035	0,2035	0,2035	0,2035	0,2035	0,206
K3	0,1960	0,1960	0,1960	0,1960	0,1960	0,196
K4	0,2035	0,2035	0,2035	0,2035	0,2035	0,206
K5	0,1960	0,1960	0,1960	0,1960	0,1960	0,196

Then it is known the weight value of the guarantee (K4), namely: W {0.20; 0.20; 0.19; 0.20; 0,196}

5) Critria for Care (K5)

Table 14. Normalization of Pairwise Comparison Matrices

Criteria	K1	K2	K3	K4	K5
K1	1	80/78	80/79	80/79	80/79
K2	78/80	1	78/79	78/79	78/79
K3	79/80	79/78	1	79/79	79/79
K4	79/80	79/78	79/79	1	79/79
K5	79/80	79/78	79/79	79/79	1

Table 15. Normalized Value and Average

Criteria	K1	K2	K3	K4	K5	Average
K1	0,2025	0,2025	0,2025	0,2025	0,2025	0,202
K2	0,1975	0,1975	0,1975	0,1975	0,1975	0,198
K3	0,200	0,200	0,200	0,200	0,200	0,200
K4	0,200	0,200	0,200	0,200	0,200	0,200
K5	0,200	0,200	0,200	0,200	0,200	0,200

Then it is known the weight value of care (K5), namely: W (0.202; 0,198; 0,200; 0,200; 0,200}.

g) Then do the calculation of the multiplication value of the criteria weights that have been calculated

$$\begin{bmatrix} 0,202 & 0,199 & 0,200 & 0,201 & 0,202 \\ 0,197 & 0,202 & 0,200 & 0,206 & 0,198 \\ 0,199 & 0,202 & 0,195 & 0,196 & 0,200 \\ 0,202 & 0,202 & 0,205 & 0,206 & 0,200 \\ 0,199 & 0,194 & 0,200 & 0,196 & 0,200 \end{bmatrix} \begin{bmatrix} 0,1211 \\ 0,2244 \\ 0,1711 \\ 0,3400 \\ 0,0900 \end{bmatrix}$$

Then the following results are obtained:

$$\begin{bmatrix} 0,0245 & 0,0447 & 0,0342 & 0,0683 & 0,0182 \\ 0,0239 & 0,0453 & 0,0342 & 0,0700 & 0,0178 \\ 0,0241 & 0,0453 & 0,0334 & 0,0666 & 0,0180 \\ 0,0245 & 0,0453 & 0,0351 & 0,0700 & 0,0180 \\ 0,0241 & 0,0435 & 0,0342 & 0,0666 & 0,0180 \end{bmatrix} \begin{bmatrix} 0,1899 \\ 0,1912 \\ 0,1874 \\ 0,1929 \\ 0,1864 \end{bmatrix}$$

Then the following is a ranking table as follows:

Table 16. Results of Ranking Between Criteria

No	Criteria	Final score	Rank
1	Physical Evidence (K1)	0,1899	3
2	Reliability (K2)	0,1912	2
3	Responsiveness (K3)	0,1874	4
4	Assurance (K4)	0,1929	1
5	Care (K5)	0,1864	5

From the results of the analysis in table 16, each criterion has its final value. According to calculations carried out by AHP that the highest value on customer satisfaction with service quality at PDAM Tirtauli is Guarantee (K4) with a final score of 0.1929 and reliability (K2) with a final value of 0.1912.

4. Conclusion

Based on the research results, it can be concluded that the application of the AHP (AnalyticalHierarchy Process) method in improving service quality management towards customer satisfaction can be applied and used as a solution. The calculation results of the five assessment criteria obtained by two criteria that are very influential on customer satisfaction, namely Guarantee and reliability. This proves the applicability and potential of the AHP (AnalyticalHierarchy Process) method to solve complex problems.

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