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Machine learning classification analysis model community satisfaction with traditional market facilities as public service

Hadi Syahputra[1]. Musli Yanto[1]. Muhammad Reza Putra[1]. Aulia Fitrul Hadi[1]. Selvi Zola Fenia[2]
[1]Faculty of Computer Science, Universitas Putra Indonesia YPTK, Padang, Sumatera Barat, Indonesia
[2]Faculty of Economics and Business, Universitas Putra Indonesia YPTK, Padang, Sumatera Barat, Indonesia

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ABSTRACT

Traditional markets are public service facilities that can be utilized by the community. The market function is used place where sellers and buyers meet in conducting transactions. This study aims to build a machine learning classification analysis model in measuring community satisfaction with traditional market facilities. The analytical methods used include Fuzzy. multiple linear regression (MRL), artificial neural network (ANN), and decision tree (DT). Fuzzy is used to generate a pattern of rules in determining the level of satisfaction. MRL serves to measure and test the correlation of rules that have been formed. The ANN method is used to carry out the classification analysis process based on learning. In the final stage. DT is used to describe the decision tree of the analysis process. This study presents the results of machine learning analysis which is very good in determining satisfaction with an accuracy rate of 99.99%. This result is influenced by fuzzy logic which can develop a classification rule pattern of 32 patterns. MRL also shows a significant correlation level of 81.1% based on the indicator variables. Overall, the machine learning classification analysis model can provide knowledge to be considered in the management of traditional markets as public service facilities.

Corresponding Author:

Hadi Syahputra
Department of Computer Systems, Universitas Putra Indonesia YPTK
Padang, Indonesia
Email: hadisyahputra@upiyptk.ac.id

1. INTRODUCTION

A public service is a form of activity carried out by individuals and government organizations in meeting needs [1]. These public services involve the provision of public service facilities such as goods and services [2]. The provision of these service facilities basically must meet the standards that have been set by the applicable rules [3]. With the standards that have been determined. all elements of society can use these facilities together to meet needs [4]. One form of public service that provides services in accessing buying and selling transactions is the traditional market [5]. The market concept is a facility built for the sale and purchase of goods and services [6].

To be able to measure the level of satisfaction with public services in traditional markets, an analytical process is needed [7]. The analysis process in measuring the level of satisfaction is used as input in management and evaluation [8]. This satisfaction analysis is also used as a process of identifying the quality assessment of a service that has an impact on sustainability [9]. The assessments include security, cleanliness, and access to public services [10]. The market service analysis orientation can provide the achievement of targets for satisfaction with public services [11]. The need for analysis is carried out to see the gaps that occur such as service, friendliness, and security in transactions [12]. These results can be used as an assessment of the

sustainability of a market so that people do not move to the modern market that is developing at this time [13]. The form of the analysis process that has been carried out in measuring the level of community satisfaction using the concept of machine learning [14]. This concept can also be used to extract knowledge from the community for consideration in decision-making [15]. Machine learning is a concept that is used to carry out the analysis process by presenting information output [16]. Machine learning can process large amounts of data to carry out classification and prediction analysis processes [17].

Research in analyzing the level of community satisfaction with traditional markets as public services shows that traditional markets can have an active role in the economic, environmental, political, and administrative fields [18]. The same study also carried out the process of analyzing community satisfaction with traditional market facilities using a dataset of 205 respondents presenting quite significant results [19]. Furthermore, the measurement of the level of community satisfaction with public services in traditional markets using the analytical hierarchy process (AHP) classification analysis presents a significant value in increasing transaction activities in traditional markets [20].

To improve the performance of the results of the classification analysis process, it is necessary to perform a method that can support the machine learning work process. Fuzzy logic can support machine learning performance in presenting rules in the classification process [21]. The results of the implementation of fuzzy logic in machine learning provide the maximum level of accuracy [22]. Fuzzy logic is also able to generate new feature sets and rules that can be used to perform the analysis process [23]. Not only fuzzy logic, the multiple linear regression (MRL) method is also capable of playing an active role in an analysis pattern [24]. MRL can maximize the analytical model in making predictions and classifications by measuring the correlation relationships that occur in the data patterns used [25]. MRL is also able to prove the performance of an analytical model based on the relationship between indicator variables and outputs in the classification process [26].

To maximize the classification analysis process, the decision tree (DT) method is used to describe the shape of the decision tree [27]. DT can present the rules in the form of a decision tree from the hidden knowledge of data [28]. DT is also a method that can describe a decision tree and is used to analyze the important variables involved in the analysis process [29]. DT method is a method adopted by machine learning to carry out the classification process [30].

Thus. this study will present a discussion about carrying out an analytical process to measure community satisfaction with traditional markets as public facilities. The process is built into a classification model analysis using machine learning. The analytical model was developed using the fuzzy inference method in artificial neural network (ANN) learning. The results of the analysis will also measure the correlation using MRL to improve the performance of the model analysis in presenting the output. The final stage of the analysis process will also be able to describe the knowledge base formed on the decision tree. Thus, this study presents an analysis of the optimal novelty model to produce maximum analysis output. Thus, the results of this study can be used as supporting material for decision making in the process of managing public service facilities.

2. METHOD

The process of classification analysis in this research work was carried out in several stages. The stages of the process can be presented in a research framework by adopting ML performance consisting of fuzzy, ANN, MRL, and DT methods. The fuzzy method is used to generate classification pattern rules based on the parameters used. ANN has analytical performance in the form of network learning. The MRL method is used to measure the performance of the ANN classification analysis process to see the correlation relationship. The DT analysis stage is finally able to describe the output results and the pattern in conducting the analysis. The description of the research framework can be described in Figure 1.

Figure 1 describes the stages of analysis in classifying public satisfaction with public service facilities in traditional markets. These stages are presented in the analysis of the model developed using the ML concept. The analysis process is presented by making a pattern of classification rules based on indicator variables using fuzzy logic. The resulting rule pattern will be analyzed using ANN to present the output. The output results presented will then be measured by the correlation relationship formed between the variables and the output analysis. The final stage of the analysis process presents an overview of the classification analysis using the DT method. Overall, the results of the analysis carried out will provide maximum results in determining community satisfaction with public service facilities.

2.1. Fuzzy inference engine

Fuzzy Inference is a method used to analyze the uncertainty of data [31]. Fuzzy is also a logic developed in machine learning that can be used to generate rule patterns in classification [32]. Logical uncertainty can be used as a control process in conducting analysis [33]. Analysis rules are based on fuzzy sets and the rules that are formed [34]. The fuzzy logic can be seen in Figure 2 [35].

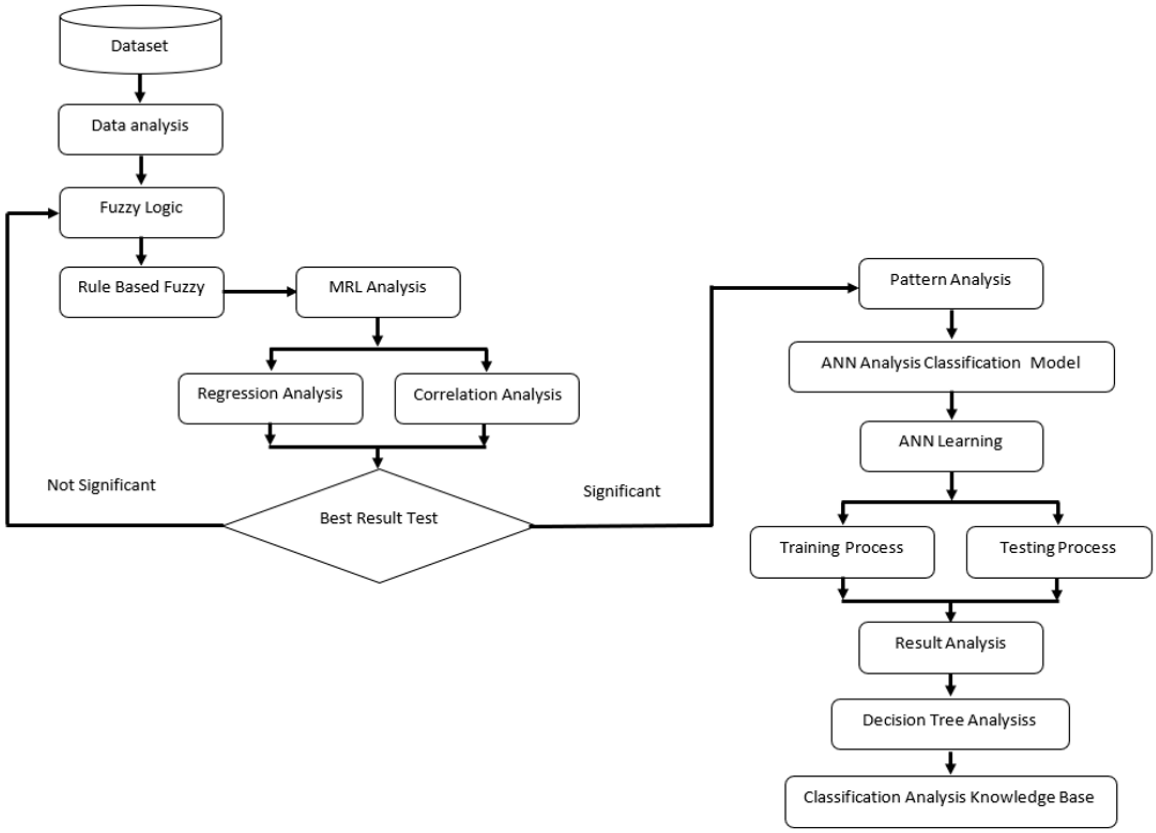


Figure 1. Research framework

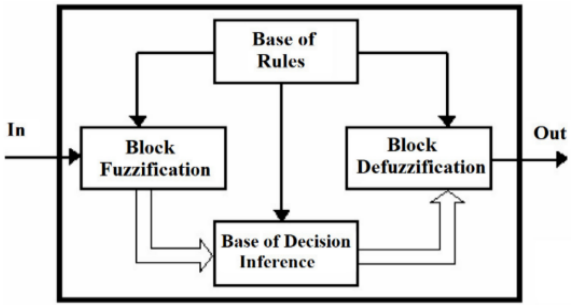


Figure 2. Structure fuzzy inference engine

Figure 2 presents the logic of logic in generating classification patterns. The fuzzy performance begins with the fuzzification process on the input variables. After the fuzzification process is carried out, it is continued in the formation of fuzzy rules which will later be tested on the inference engine process to see the performance of the rules formed. The final stage is the defuzzification process which can be used as a transformation process for the fuzzy output obtained. The pattern of analysis rules produced by fuzzy will later be faced in solving a problem [36], [37].

2.2. Artificial neural network (ANN)

ANN is a method based on the performance of the human brain in problem-solving [38]. ANN presents a systematic process in problem-solving to produce solutions [39], [40]. The ANN can be adopted in machine learning [41]. ANN can provide optimal results by presenting output with a fairly good level of accuracy [42]. ANN presents mathematical calculations that are modeled to produce the output [43]. ANN can work effectively and be presented in the form of an algorithm [44]. The output of ANN can be used as an alternative solution in decision making [45].

2.3. Multiple linear regression (MRL)

The MRL method is a method that has been used to measure the level of relationship between variables [46]. MRL has the performance to evaluate a model in conducting analysis [47]. MRL provides mathematical calculations on the parameters and outputs used in conducting the analysis [48]. The MRL results can prove the results of the analysis based on the correlation test in each indicator variable [49]. Overall MRL can see the relationship pattern data significantly [50]. The MRL equation can be expressed as (1) [50].

$$Yi = \beta 0 + \beta 1xi1 + \beta 2\, xi\, 2 + \beta 3xi\, 3 \ldots . \beta pxip \quad (1)$$

MRL analysis is able to test each indicator variable used. Constant values can form a regression model to present the output relationship from the analysis process. MRL is also used as a medium to measure an analysis pattern [51]. The regression analysis model aims to provide parameter levels based on variables (X) and (Y). This model can be proven by the regression equation presented in (2) [52].

$$Y = a + bX \quad (2)$$

In (2) explains that b is the direction of the coefficient and a is the value that represents the intersection. the equation also describes the equation of the line seen by the variable. Based on the performance of the results of the MRL classification analysis can present maximum results.

2.4. Decision tree (DT)

A decision tree is a method that can be used in solving classification problems that present output in the form of a decision tree [53]. DT is also a technique that adopts machine learning and can be implemented in the classification process [54]. DT performs a classification process by describing a decision tree consisting of nodes and nodes in describing information [55]. The DT method can be developed to carry out the validation process for an analysis model [56]. DT a performance by performing mathematical calculations and adopting a decision-making system [57]. The equations in the DT method can be expressed as (3) [58].

$$\text{Entropy(S)} = -\sum_{i=1}^{c} \text{PS(ci)}\log\text{PS(ci)} \quad (3)$$

In (3) presents the calculation process in the DT method. The entropy value is based on a set S [57]. The resulting entropy value will be the root of the decision tree image [59]. The results of the DT analysis process are finally able to present a form of analysis based on classification [60].

3. RESULTS AND DISCUSSION

The discussion of the process of analyzing the classification of public satisfaction with public facilities in traditional markets using the machine learning concept starts from the data analysis stage. Research data is sourced from market visitor respondents by assessing several predetermined indicators including market trader (X_1), market manager (X_2), market facilities (X_3), hygiene (X_4), and safety (X_5). The dataset obtained based on the results of the respondents' assessment can be presented in Table 1.

Table 1. Respondent assessment dataset

Market trader (X_1)	Market manager (X_2)	Market facilities (X_3)	Hygiene (X_4)	Safety (X_5)
83	68	74	62	80
65	68	80	66	75
75	66	67	69	65
70	73	60	68	80
74	75	70	70	82
80	67	76	70	78
60	74	74	72	73
75	68	75	74	79
68	80	76	73	80
74	78	80	69	80
75	75	74	69	83
82	76	65	68	60
83	70	74	73	68
74	56	75	84	78
65	76	80	80	78
68	68	82	80	75

Table 1 presents a sample of respondents' assessment results of traditional markets as public facilities. The results of the respondents' assessments were used as an analytical research dataset of 203 data. After the research dataset, the next step is to carry out the analysis process using a fuzzy inference engine. The stages carried out in the fuzzy process include the process of fuzzification, rule formation, inference engine, and defuzzification. The results of the fuzzy analysis process can present the pattern of classification analysis rules which can be seen in Table 2.

Table 2. Results of fuzzy logic rules

Rule		Variabel fuzzy						Satisfaction results
		X1	X2	X3	X4	X5		
1	IF	Not friendly	Not good	Not good	Not hygiene	Not safety	THEN	Not satisfaction
2		Not friendly	Not good	Not good	Pretty hygiene	Not safety		Not satisfaction
3		Not friendly	Not good	Pretty good	Pretty hygiene	Not safety		Not satisfaction
4		Not friendly	Pretty good	Pretty good	Pretty hygiene	Not safety		Satisfaction
5		Friendly enough	Pretty good	Pretty good	Pretty hygiene	Not safety		Satisfaction
6		Friendly enough	Pretty good	Pretty good	Pretty hygiene	Not safety		Satisfaction
7		Friendly enough	Pretty good	Pretty good	Not hygiene	Not safety		Not satisfaction
8		Friendly enough	Pretty good	Not good	Not hygiene	Not safety		Not satisfaction
9		Friendly enough	Not good	Not good	Not hygiene	Not safety		Not satisfaction
10		Friendly enough	Pretty good	Pretty good	Not hygiene	Safe enough		Satisfaction
11		Friendly enough	Pretty good	Pretty good	Hygiene	Safety		Satisfaction
12		Friendly enough	Pretty good	Good	Hygiene	Safety		Very satisfaction
13		Friendly enough	Good	Good	Hygiene	Safety		Very satisfaction
14		Friendly	Good	Good	Hygiene	Safety		Very satisfaction
15		Friendly	Good	Good	Hygiene	Not safety		Very satisfaction
16		Friendly	Good	Good	Not hygiene	Not safety		Satisfaction
17		Friendly	Good	Not good	Not hygiene	Not safety		Satisfaction
18		Friendly	Not good	Not good	Not hygiene	Not safety		Not satisfaction
19		Friendly	Not good	Not good	Not hygiene	Safe enough		Not satisfaction
20		Friendly	Not good	Not good	Pretty hygiene	Safe enough		Satisfaction
21		Friendly	Not good	Pretty good	Pretty hygiene	Safe enough		Satisfaction
22		Friendly enough	Not good	Pretty good	Pretty hygiene	Safe enough		Satisfaction
23		Friendly enough	Pretty good	Good	Not hygiene	Not safety		Satisfaction
24		Friendly	Pretty good	Good	Not hygiene	Not safety		Satisfaction
25		Not friendly	Pretty good	Good	Not hygiene	Not safety		Satisfaction
26		Not friendly	Not good	Good	Not hygiene	Not safety		Not satisfaction
27		Not friendly	Pretty good	Good	Not hygiene	Safe enough		Satisfaction
28		Not friendly	Pretty good	Good	Pretty hygiene	Safe enough		Satisfaction
29		Not friendly	Good	Good	Pretty hygiene	Safe enough		Very satisfaction
30		Not friendly	Good	Good	Pretty hygiene	Safety		Very satisfaction
31		Not friendly	Good	Good	Hygiene	Safety		Very satisfaction
32		Not friendly	Pretty good	Good	Hygiene	Safety		Satisfaction

Table 2 is the result of fuzzy logic analysis which presents 32 patterns of classification rules. The pattern of the rules presents the level of satisfaction including not satisfaction, satisfaction, and very satisfaction. After the pattern analysis, it is continued with the making of a classification ANN analysis model. The ANN classification learning model adopts the application of multilayer backpropagation which consists of 5 input layers, 5 hidden layers (1), 5 hidden layers (2), and 1 output layer. The model will be carried out in the training and testing phase to find the best analysis model. The results of learning analysis using ANN can be presented in Table 3.

Based on the training and testing of the ANN classification analysis model. the multilayer backpropagation algorithm can find the best ANN classification analysis model for measuring people's satisfaction with the traditional market as a public facility. The best analysis model adopts 5 input layers: 10 hidden layers (1), 10 hidden layers (2), 10 hidden layers (3), and 1 output layer. The best ANN model can be depicted in Figure 3.

Figure 3 is the result of the description of the best ANN classification analysis model obtained after network learning from the training and testing process. This model provides an output accuracy rate of 99.99% and an error rate performance of 0.00096225. These results have presented a fairly optimal output in conducting the classification analysis process. After the learning process presents the best ANN model output, then the analysis process is carried out with ANN by presenting the outputs which can be seen in Figure 4.

Table 3. Learning outcomes of ANN

Architecture	Training			Testing			Validation	
	Accuracy	MSE	Performance	Accuracy	MSE	Performance	Performance	Performance
5-5-5-1	99.87	0.1313	0.001313	99.99	0.0146	0.000146	99.93	0.07295
5-10-5-1	99.99	0.0066	0.000066	99.99	0.0066	0.000066	99.99	0.0066
5-10-10-1	99.98	0.0238	0.000238	99.99	0.0134	0.000134	99.98	0.0186
5-15-5-1	99.98	0.0158	0.000158	99.98	0.0158	0.000158	99.98	0.0158
5-15-10-1	99.99	0.0048	0.000048	99.99	0.0048	0.000048	99.99	0.0048
5-15-15-1	99.95	0.0451	0.000451	99.95	0.0451	0.000451	99.95	0.0451
5-20-10-1	99.96	0.036	0.00036	99.99	0.0047	0.000047	99.98	0.02035
5-20-15-1	99.98	0.0157	0.000157	99.98	0.0157	0.000157	99.98	0.0157
5-20-20-1	99.99	0.0062	0.000062	99.99	0.0062	0.000062	99.99	0.0062
5-5-5-5-1	99.96	0.0351	0.000351	99.99	0.000596	0.000006	99.98	0.01784795
5-10-5-5-1	99.99	0.0108	0.000108	99.99	0.0027	0.000027	99.99	0.00675
5-10-10-5-1	99.99	0.014	0.00014	99.99	0.0131	0.000131	99.99	0.01355
5-10-10-10-	99.99	0.0017	0.000017	99.99	0.000225	0.000002	99.99	0.00096225
5-15-10-5-1	99.99	0.0078	0.000078	99.99	0.0078	0.000078	99.99	0.0078
5-15-15-10-	99.96	0.0438	0.000438	99.99	0.009	0.00009	99.97	0.0264
5-15-15-15-	99.99	0.005	0.00005	99.99	0.005	0.00005	99.99	0.005
5-20-5-5-1	99.99	0.0128	0.000128	99.99	0.0042	0.000042	99.99	0.0085
5-20-10-5-1	99.99	0.0102	0.000102	99.99	0.0102	0.000102	99.99	0.0102
5-20-20-15-	99.99	0.0058	0.000058	99.99	0.0058	0.000058	99.99	0.0058
5-20-20-20-	99.99	0.0111	0.000111	99.99	0.0031	0.000031	99.99	0.0071

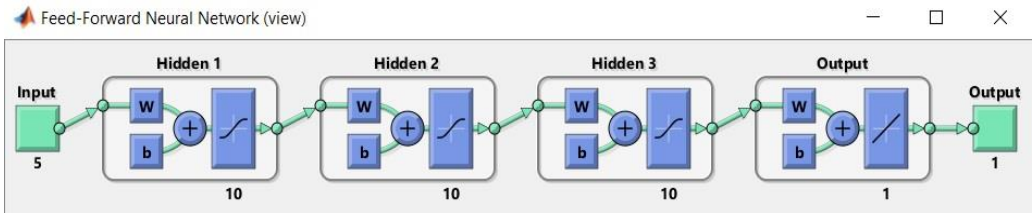


Figure 3. The best ANN analysis model

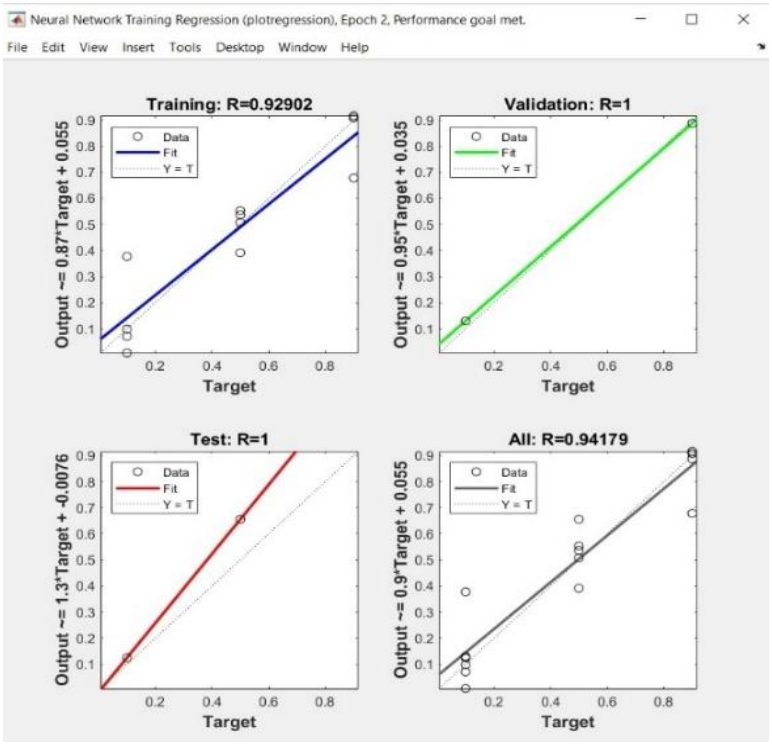


Figure 4. ANN analysis results of community satisfaction

After the ANN analysis process is presented in Figure 4. the work will continue by measuring the level of regression and correlation from the previous analysis rules. This measurement is carried out to see the parameter indicators that affect the results of the analysis obtained. The results of MRL analysis can be presented in Tables 4 to 6.

Table 4. Results of analysis regression

Model Summary									
Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R square change	F Change	df1	df2	Sig. F change
1	0.882[a]	0.779	0.221	0.74976	0.779	0.448	5	26	0.811

a. Predictors: (Constant). Safety. Market_Manager. Market_Trader. Market_Facilities. Hygiene

Table 5. Results of analysis of variance

ANOVA[a]						
	Model	Sum of squares	df	Mean square	F	Sig.
1	Regression	0.189	5	0.221	0.448	0.811[b]
	Residual	14.616	26	0.221		
	Result	15.875	31			

a. Dependent variable: Satisfaction

b. Predictors: (Constant). Safety. Market_Manager. Market_Trader. Market_Facilities. Hygiene

Table 6. Results of analysis coofecien correlation

Coefficient correlations[a]							
Model			Safety	Market_Manager	Market_Trader	Market_Facilities	Hygiene
1	Correlations	Safety	1.000	0.665	0.725	0.717	0.840
		Market_Manager	0.665	1.000	0.686	0.680	0.773
		Market_Trader	0.725	0.686	1.000	0.865	0.815
		Market_Facilities	0.717	0.680	0.865	1.000	0.725
		Hygiene	0.840	0.773	0.815	0.725	1.000
	Covariances	Safety	0.009	0.000	0.002	0.002	0.005
		Market_Manager	0.000	0.006	0.002	0.001	0.001
		Market_Trader	0.002	0.002	0.008	0.004	0.001
		Market_Facilities	0.002	0.001	0.004	0.010	0.003
		Hygiene	-0.005	0.001	0.001	-0.003	0.010

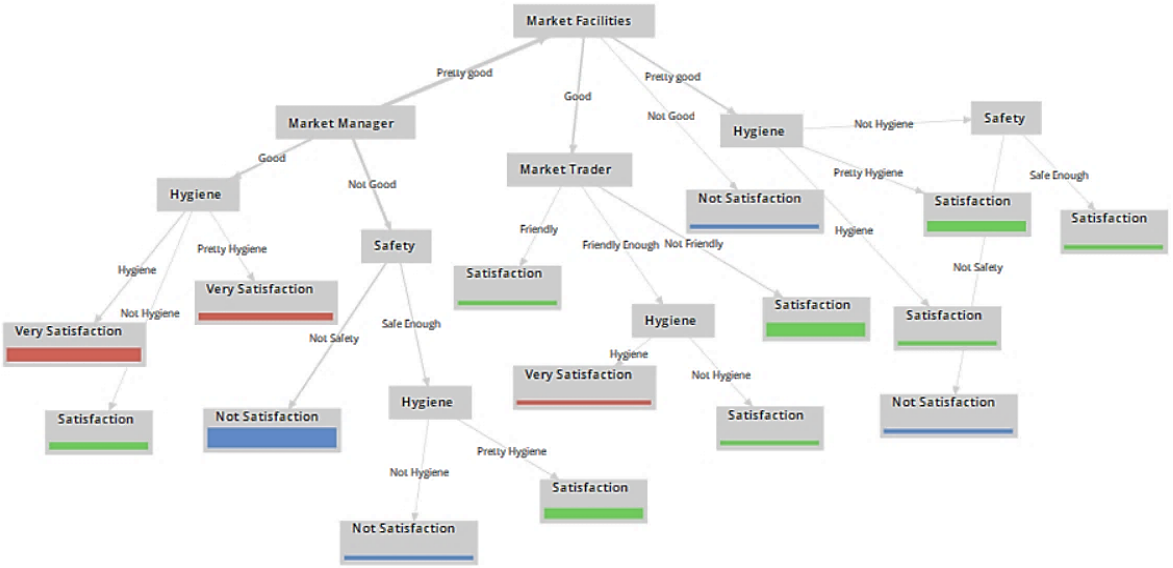
a. Dependent Variable: Satisfaction

Based on the MRL analysis test, Table 4 presents the regression analysis of the classification analysis pattern with a significant value of 81.1%. These results have been able to prove that the pattern of rules formed based on the fuzzy process provides a fairly optimal output in classifying. Table 5 also presents the results of the analysis of variance (ANOVA) with a Sum of Squares value of 0.189. These results are an affirmation that the regression relationship formed between the variables with the output provides a mutually significant level of relationship. Table 6 presents the results of measuring the coefficients and correlations of each indicator variable. These results present that the correlation relationship is formed from each variable that occurs above 0.60. This value is the basis that the correlation formed between the patterns of classification analysis rules has a very good relationship to measure people's satisfaction with traditional markets as public facilities.

After the MRL analysis process proves the regression relationship and the correlation of the classification pattern, it is continued by conducting a classification analysis using the DT. The DT analysis process can present the output in the form of a decision tree to describe knowledge in the classification process. The results of the DT analysis process can be presented in Figure 5.

Figure 5 is the result of the DT analysis in presenting the output in the form of a decision tree. These results can describe the knowledge-based pattern of classification rules to be taken into consideration in decision-making. Overall, the classification analysis process produces an output that is optimal enough to measure people's satisfaction with traditional markets as public facilities.

Based on the discussion that has been done, the analysis process using machine learning produces maximum output. These results are obtained based on the classification rule pattern that has been developed based on fuzzy logic and tested using the MRL method. The output of the analysis using ANN can present a very good level of accuracy of 99.99%. With the results of the analysis presented, the update of this study presents an optimal analysis model based on the output of the analysis process that has been carried out. Based on this update, this research can provide an effective and efficient analytical model in the process of planning and managing traditional markets as public service facilities.



Tree

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Market Manager = Good
|   Hygiene = Hygiene: Very Satisfaction {Not Satisfaction=0, Satisfaction=0, Very Satisfaction=4}
|   Hygiene = Not Hygiene: Satisfaction {Not Satisfaction=0, Satisfaction=2, Very Satisfaction=0}
|   Hygiene = Pretty Hygiene: Very Satisfaction {Not Satisfaction=0, Satisfaction=0, Very Satisfaction=2}
Market Manager = Not Good
|   Safety = Not Safety: Not Satisfaction {Not Satisfaction=6, Satisfaction=0, Very Satisfaction=0}
|   Safety = Safe Enough
|   |   Hygiene = Not Hygiene: Not Satisfaction {Not Satisfaction=1, Satisfaction=0, Very Satisfaction=0}
|   |   Hygiene = Pretty Hygiene: Satisfaction {Not Satisfaction=0, Satisfaction=3, Very Satisfaction=0}
Market Manager = Pretty good
|   Market Facilities = Good
|   |   Market Trader = Friendly: Satisfaction {Not Satisfaction=0, Satisfaction=1, Very Satisfaction=0}
|   |   Market Trader = Friendly Enough
|   |   |   Hygiene = Hygiene: Very Satisfaction {Not Satisfaction=0, Satisfaction=0, Very Satisfaction=1}
|   |   |   Hygiene = Not Hygiene: Satisfaction {Not Satisfaction=0, Satisfaction=1, Very Satisfaction=0}
|   |   Market Trader = Not Friendly: Satisfaction {Not Satisfaction=0, Satisfaction=4, Very Satisfaction=0}
|   Market Facilities = Not Good: Not Satisfaction {Not Satisfaction=1, Satisfaction=0, Very Satisfaction=0}
|   Market Facilities = Pretty good
|   |   Hygiene = Hygiene: Satisfaction {Not Satisfaction=0, Satisfaction=1, Very Satisfaction=0}
|   |   Hygiene = Not Hygiene
|   |   |   Safety = Not Safety: Not Satisfaction {Not Satisfaction=1, Satisfaction=0, Very Satisfaction=0}
|   |   |   Safety = Safe Enough: Satisfaction {Not Satisfaction=0, Satisfaction=1, Very Satisfaction=0}
|   |   Hygiene = Pretty Hygiene: Satisfaction {Not Satisfaction=0, Satisfaction=3, Very Satisfaction=0}
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Figure 5. Results of DT analysis process

4. CONCLUSION

The machine learning classification analysis model in measuring people's satisfaction with traditional market facilities provides maximum output. These results are based on the pattern of classification rules formed from the fuzzy process as well as the measurement of regression and correlation using the MRL method. Based on the results of MRL measurements, shows that the results of the regression and correlation relationships are quite significant so that the performance of ANN in the network learning process provides the maximum level of accuracy. Not only that, but the performance role of the DT method also presents results that are quite good in describing information and knowledge-based in the form of a decision tree. Overall, this research can present a structured and systematic analytical model with the updates presented to develop a pattern of classification analysis rules. Based on the results of this study, the classification analysis model can be used as a basis for decision-making for the government for the traditional market management process.

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BIOGRAPHIES OF AUTHORS

Hadi Syahputra a graduate of Putra Indonesia University YPTK. In 2013 he obtained a Master's Degree in Computer with a concentration in Information Technology. His career as a lecturer at Putra Indonesia University YPTK began in 2013 until now. 2015 until now he has been trusted as a sports coach at Putra Indonesia University YPTK. Working in the field of networking and Micro Controllers with several published articles. Monitoring DNS Query with Pi-Hole Firewall Using Raspberry B+ Integrated with Mikrotik Router RB 931-2nd is an article that has been published in an international journal in 2021. He can be contacted at email: hadisaputra@upiyptk.ac.id.

Musli Yanto Born in Jakarta on July 7. 1989. A lecturer at the Putra Indonesia University YPTK Padang. The educational history of the Informatics Engineering undergraduate program was completed in 2012 and the Informatics Engineering Masters program in 2014. His areas of expertise include Artificial Intelligence (AI). Expert Systems (ES). Data Mining (DM). Decision Support Systems (DSS). He could be contacted via email: musli_yanto@upiyptk.ac.id.

Muhammad Reza Putra graduated from YPTK. Putra Indonesia University. In 2013 he obtained a Master's in Computer with a concentration in Information Technology. His career as a lecturer at YPTK Putra Indonesia University began in 2013 until now. From 2020 until now he has been entrusted with being the Head of the Secretariat at Putra Indonesia YPTK University. Working in the field of deep learning. and machine learning with several published articles. Prediction of Drug Needs to be Based on Deep Learning Approach and The Classification Model is an article published in an international journal in 2023. He can be contacted via email: muhammad_reza@upiyptk.ac.id.

Aulia Fitrul Hadi Educational History Bachelor of Computer Th. 2013 and Master of Computer Th. 2015. Field of Expertise Programming Languages. Operating Systems. Computer Networks. and Network and Database Security The theme of the focus of research that has been carried out in Decision Support Systems. Expert Systems. Augmented Reality. Management Information Systems. Expert Systems. Artificial intelligence. and Multimedia. He can be contacted at email: fitrulhadi@upiyptk.ac.id.

Selvi Zola Fenia Selvi Zola Fenia. was born in the city of Padang. West Sumatra. Alumni of Putra Indonesia University YPTK Padang. Completed his undergraduate education in Psychology in 2010 and continued his career as a Counseling Guidance Teacher at SMPN 24 Padang until 2011. In 2011 he taught at the Apikes Iris Medical Record Study program and was appointed Deputy 1 (Curriculum Sector) from 2014 to 2018. The 2013 Master's Degree study program obtained a Master of Management degree from UPI YPTK Padang. In 2018 he was chosen as SPMI Facilitator at Apikes Iris Padang. Since 2018 until now he has taught at the Faculty of Economics and Business. Management Studies Program at UPI YPTK Padang. She could be contacted via email: selvizolafenia.szf@gmail.com.