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Decision Support Model for Evaluating of Customer Service Performance Using Mamdani and Multi-stage Rule Base

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Abstract. Employee performance evaluation is challenging, since it involves many parameters and uncertain conditions. Customer service (CS) holds a crucial role in the telecommunication industry. Nowadays, Indonesian telecommunication needs standard evaluation for employees in the customer service field. The decision support model (DSM) is reported to be suitable for measuring employee performance. The researcher combined DSM with fuzzy logic to have flexibility in evaluating performance and evading biased data parameters. The purpose of this research is to construct a DSM of customer service evaluation performance at Indonesian telecommunication companies. The researcher started by determining parameters, collecting data of assessments from current company and questionnaires, processing fuzzy logic using the Mamdani method, and evaluating the results. The model showed 13 parameters which consist of competence, compensation, training, discipline, motivation, teamwork, initiative, quality of work, responsiveness, tangible, assurance, reliability, and empathy. The evaluation of the model has been done and resulted in practical and in conclusion of theoretical implications as standard of telecommunication companies for customer service evaluation performance. The constructed model is proposed to assist the company as a strategic way for monitoring and evaluating employees with ranking and categories of performance. All categories can give quick action to assess employees' bad performance in improving and monitoring performance of customer service periodically as the standard assessment given to the company. The proposed method can be referenced as a novel multi-stage rule-based method.

Keywords: fuzzy logic; evaluation; decision support model, customer service; Mamdani; multi-stage rule base.

1. Introduction

The telecommunications industry is cultivating rapidly, which affects economic development, and encourages the progression of competition and quick response to market changing. Nowadays, businesses and customers interact frequently. Customer loyalty must be maintained and improved to sustain the company's strategy. Therefore, to be the leading companies, they need to enrich corporate image continually and assess their employee performance (Ju, 2022). The basic strategy of the competitive market is to survive and succeed by striving high-quality service to enhance employee performance (Beheshtinia & Farzaneh Azad, 2019). The improvement of employee performance has influenced the company's competitive advantage (Nguyen et al, 2021).

A national-scaled telecommunication company based in Indonesia uses customer service (CS) as a direct employee service in the branch office to increase service quality, customer loyalty, and company benefit. CS is the key person of customer interaction in the Branch that ensures company performance in the prominent industry and affects long-term trust positively. Customer service performance is a strategic quality to deliver assistance that increases employee capabilities and boosts competitive company value (Scheidt & Chung, 2019). The CS branch is in most of the Indonesia area. In addition, the other problem is the increase competition between companies in the same industry that requires maintaining and increasing customer satisfaction for both new and old customers, especially when customers visit the service office at the company. As the company does not have a standard procedure to assess CS employee performance, CS performance evaluation needs to be built to track individual achievement and improve other opportunities to recognize individual potencies and review achievement levels in performing excellent service of company's primary purpose. Studies related to assessment have been established to improve motivation and productivity for the employee at firms. However, it is hard to cogitate over numerous elements at a time due to accessibility personnel performance of an organization in overall.

The decision support model (DSM) has been widely used for performance evaluation. Several researchers have reported the results of DSM to assess performance as service excellence needed be delivered effectively and efficiently with objective results, supportive excellent service of quality, and improvement in employee performance. CS has a crucial function for employees that can directly support the strategy of company. The research that related to the performance's evaluation model to overcome difficulties in determining performance of organization has been done by using the Fuzzy Logic (FL) method (Gupta, 2018). In education field, DSM with Sugeno technique was successfully applied in giving the decision performance (Kurniawan & Utama, 2021). The model involved 17 relevant parameters that has been justified and verified as practical methods to evaluate performance of academics effectively. This approach could help academics to give the best recommendation and alert to monitoring, evaluating, and improving the quality of education. There was also a model to eliminate the subjectivity in evaluating the performance by using the DSM method. The DSM to determine the most exemplary performance output by using criteria of weight and fuzzy method based on indicator parameters (Izquierdo et al., 2018). Another DSM research used a fuzzy model for employee performance evaluation in appraisals that can determine the provision of incentives, promotions, and penalties (Zaaidatunni'mah et al., 2021). Employee performance evaluation in the telecom industry has been constructed with a classic statistical method (Kalyan & Pedirappagari, 2019).

The DSM with fuzzy logic is a well-known method to evaluate employee performance. Employee performance is the recent report of fuzzy logic that is able to determine decision parameter and value to give objective results. In the other hand, employee performance evaluation in the telecom industry using fuzzy logic has not been explored yet. Generally, the research employee performance evaluation assesses the appraisal in a common area and rarely specified which department or function to be assessed. As mentioned earlier, CS has an important employee position in telecommunication. Many parameters are involved when it comes to CS performance assessment. The discussion of Fuzzy logic

as a method to sense can bear in mind more than one entered parameter with the uncertainty of each factor. The study improves classical methods to define another approach of the performance assessment system, identify a new standard assessment of employees in service, and create a new method using multi-stage with fuzzy logic. It proposes a case study for measuring the overall performance assessment machine of CS personnel in a telecommunication corporation that degrees performance assessment standards calculated using fuzzy logic.

The aim of this paper is to identify and determine the performance assessment and build a model to support decisions of CS performance assessment (M-CSA) of an employee by using fuzzy Mamdani and multi-stage rule base. Furthermore, the assessment results can be valuable for the company in improving, monitoring and evaluating the CS employee performance in Branch. The paper is organized by several sections with details as follows: literature review in section 2 that gives more description in theoretical, section 3 as methodology research, section 4 which shows constructed algorithm model and discussion, and the last section of conclusion and future work.

2. Literature Review

2.1 Customer Service Performance

Performance needs to be implemented in the company to; 1) Conduct a systematic learning process to get a bandage on business processes and performance in the field, and 2) Management tools to improve competitiveness, quality, and productive performance (Pourjavad & Mayorga, 2019). In addition, CS performance assessment makes it easier to provide rewards that produce quality customer service, provide training to speed up the service process, and achieve customer satisfaction.

Several works in performance evaluation with decision-support models have been reported. (Irfan Ramadhan et al., 2020) It Conducts a ranking process to increase employee performance using a hybrid method of fuzzy analytics. The results provide more selective and accurate weighting and ranking processes. (Mishra et al., 2020) A proposed framework to assess the best telecom service provider is based on the indicator of operational performance to improve service quality for customers. This research gives efficient, consistent, validated results.

Customer service as a frontline business of employees that establishes good interaction with the customer, effectively creates customer loyalty, and builds a good image for the company. The advantage of a positive image makes more appreciation, respect, and trust in good. CS, a service provider of employee in the telecommunication industry, provides direct interaction services with old and new customers regarding information needs about products, services, and complaints. Hence, CS must have good relations, provide satisfactory, excellent service, and communicate effectively with its customers to establish delivery service for attaining new, maintained, and extended customers. Therefore, CS has an essential role in the company and is required to build the ability to serve customers appropriately and to have critical practical communication skills.

2.2 Fuzzy Logic

Fuzzy Logic (FL) or bias logic is a method that provides more understanding of parameter descriptions with easy-to-understand parameter values (Utama, 2021), in mapping or processing data from input into output. This concept was introduced and published in 1965 by Lotfi A. Zadeh, a professor at the University of California in Berkeley. FL describes the variable's value by using the degree of membership as an expression language. The degree of membership of a matter is then used to determine the output based on a predetermined specification. The degree of membership or membership value or membership function is the main characteristic in the FL.

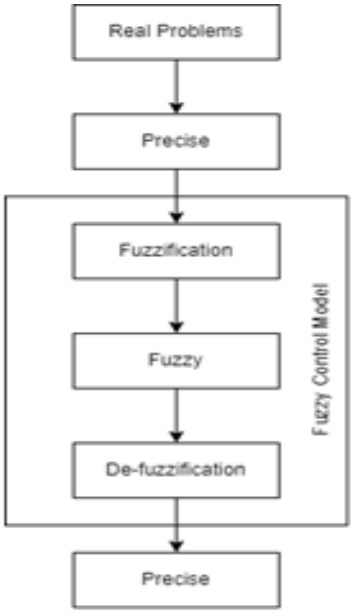

Fig. 1: FL Algorithm (Utama, 2021)

FL is described as an algorithm (Fig. 1) that is given crisp output as a precise value (Utama, 2021). First, fuzzification will be performed to convert data into fuzzy values. Second, it continues into the de-fuzzification procedure, which shifts the fuzzy results into a specific output (crisp output) to give the decision process for research. FL used as method for many fields for analyzing process, FL learned by (Wang et al., 2013) that successfully analyzed the classification of supply chain with incorporates of the decision preference into the optimization process.

2.3 Mamdani Method

The Mamdani is a popular method with the Max-Min concept, as the most commonly which is seen inference method. The inference method represents fuzzy structures that carry out fuzzy rules based on creating fast modeling (Pourjavad & Shahin, 2018).

Mamdani method produces an output consisting of (1) Determining the fuzzy set, the process of dividing universe data that is collected into several parts of linguistic variables using human language with easily understood. The MF function is a curve determining the value in crips inputs that mapped between 0 and 1. There are different forms of MFs, such as triangular, trapezoidal, Gaussian. This research used a triangular curve shown in Fig. 2. (2) In the rule evaluation, we use MIN as the inference algorithm that acquires the minimum membership degree of the input variables as the output variable. (3) The aggregation rule output, use maximum membership degree of each consequence in implicating the function for the entire conclusion, which aggregates end of each rule. Fuzzy area results gained as exposed in formula (1) and Fig. 3. Then, (4) Defuzzification; is made by transferring method to become output crisp from the fuzzy set. Fuzzy sets are the inputs of the defuzzification process, while the output is the number of those fuzzy domain sets. Defuzzification use centroid method that shown in formula (2).

$$\mu_{sf}(y) = \max(\mu_{sf}(y)) \qquad (1)$$

$$Z^* = \frac{\int z\mu(z)dz}{\int \mu(z)dz} \qquad (2)$$

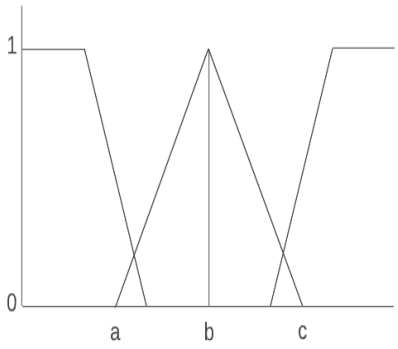

Fig. 2: Fuzzy Membership Function (Silvana et al., 2018)

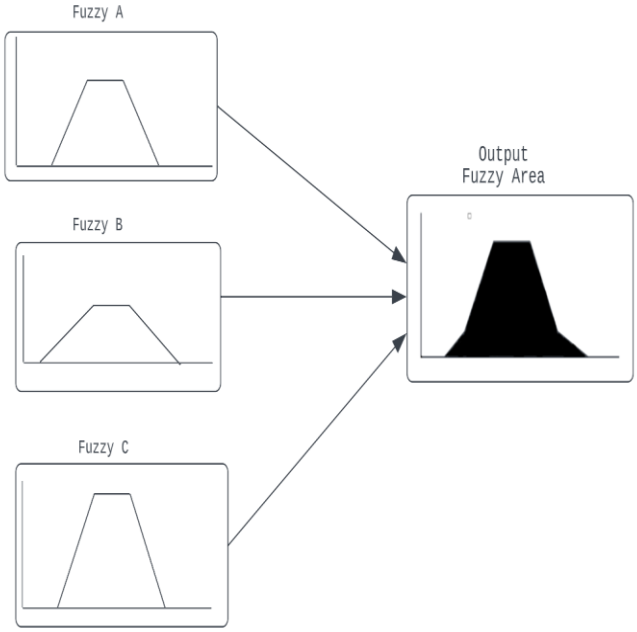

Fig. 3: Aggregation of Mamdani method

2.4 Study Limitation

This study is limited to 13 of decision parameters for model's making decision in customer service performance evaluation. The parameter has been justified from literature review and justification experts. However, the service quality performance is the added value among these parameters. The expectation of this model is to be guidance for further strategic evaluation of employee performance and objective results for the company, with the aim to monitor in periodically that gives evaluation process more effective and efficient.

3. Research Methods

The study was made to determine the performance of customer service in the telecommunications industry. This research framework is depicted in Fig. 4. Problem analysis was carried out by conducting a study of previous literature papers on performance evaluation in various fields including hospitals, education, telecommunications industry, banking, air lines, logistics and transportation. Based on the summary in study of literature, it is necessary to develop a model using the concept of decision support in order to evaluate employee performance quickly and accurately. Later, the process continues by conducting the interview process to experts and studying literature related to customer service and

employee performance evaluation to determine the parameters related to this evaluation. Through the interview process, researchers found gaps in problems that can be researched and can be useful for companies, employees and researchers. Based on a literature study, the use of decision support models can be applied to solve problems in the company. Fig. 4 is a detail of the model framework to be built. The model is constructed to improve the evaluation process in service quality, especially the CS performance in improving individual and organizational/company performance. The last stage is to verify and validate the model using actual data. Data verification and validation were carried out to ensure the data valid and avoid errors or inaccurate data. Verification and validation were seen from actual data in the field. It is expected that the results of data comparisons provide a high level of accuracy, faster and more efficient in decisions.

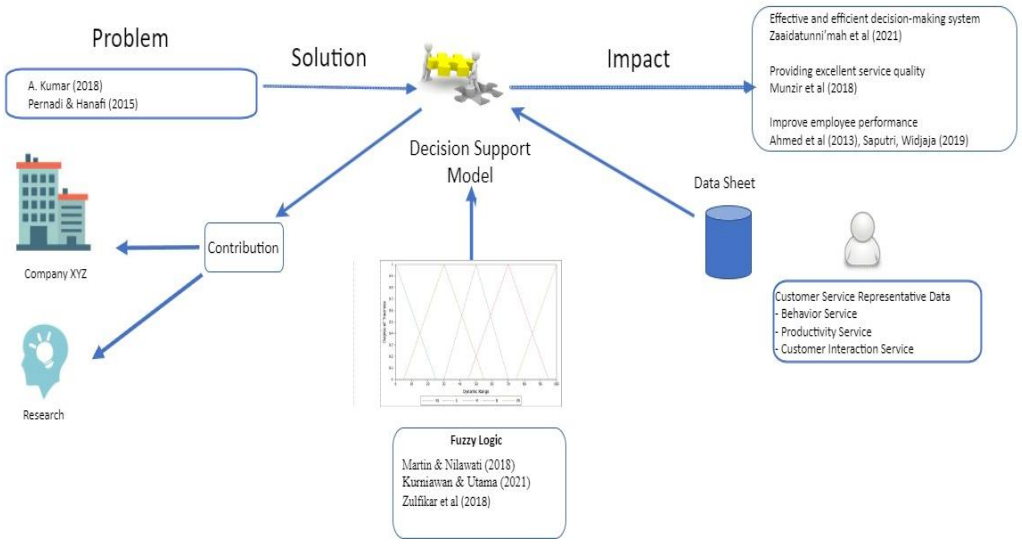

Fig. 4: The Research Framework

Then, Fig. 5 illustrates the stages of research from beginning to end. The stages are starting with the case of analyzing process, determining parameters, data collection, model construction and evaluation model.

4. Results

4.1 Selected Parameters

In using literature reviews and experts justification, parameterizing can be done. In this research. The amounts of parameters to use in the research for CS performance classification are 13 parameters. They consist of Compensation, motivation (Oktari & Suhardi, 2021) and training (Pramono & Prahiawan, 2021), teamwork(Ahmad & Manzoor, 2017), responsive, competence (Nwulu & Ateke, 2018), motivation, initiative, discipline (Permana et al., 2021) quality work (Azis et al., 2021), responsive, tangible, reliability, empathy, and assurance (Hussain et al., 2019). These parameters are grouped into three parts; they are productivity service, behaviour service, and customer interaction service. Group parameters are given the results of CS performance.

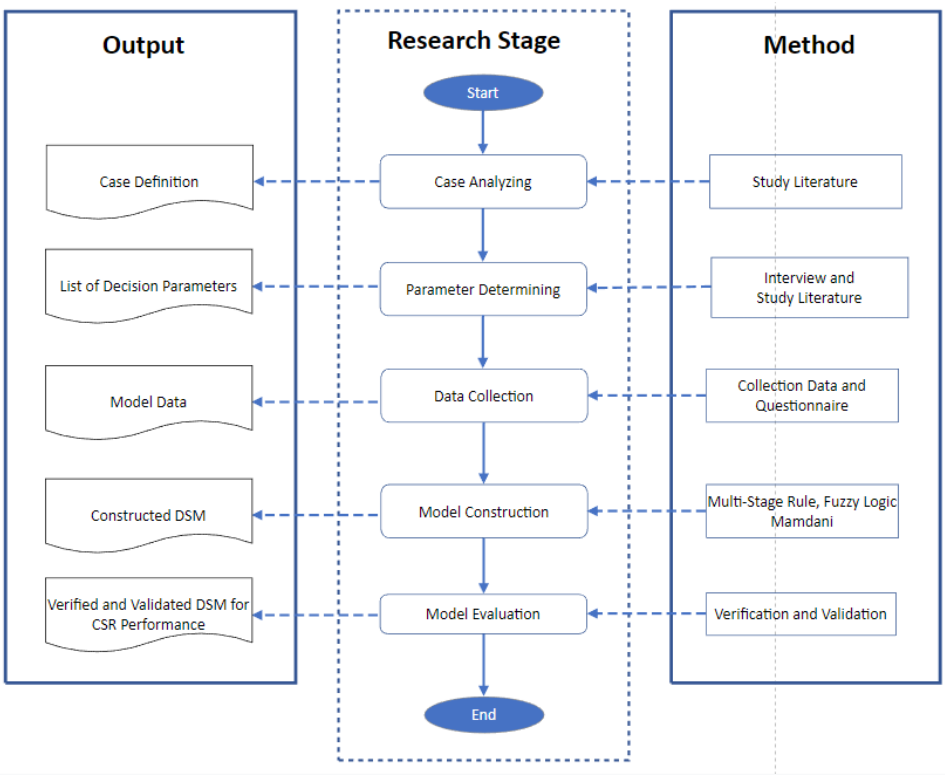

Fig.5: Research stages

Productivity service is a measurement parameter for CS to improve employees' skills directly. This results service for final indicator performance of classical assessment in existing calculating method consists of competence, training, and compensation. This output can be referenced to the company as a measurement of indicator knowledge that develop supporting service quality. Another group parameter is a behaviour service as a measurement attitude of the employee in his habit activity as a personal employee. This service needs evaluation periodically because it can influence employee productivity that consist of motivation, initiative, teamwork, discipline, and quality work. Finally, the last group of parameters is customer interaction service, which is most important in assessing CS to serve the customer. The service process can be measured with customer interaction because it will be given customer satisfaction and it consist of responsive, tangible, reliability, empathy, and assurance.

The group parameters for the model can easily create CS performance classification, which can provide an early warning for bad performance and assign a reward for the best employee as CS. After data is obtained, the next stage recapitulates for further fuzzy processing. The initial stage is a fuzzy set based on each parameter's fuzzy parameters and linguistic variables. These parameters have previously determined that the effect of customer service performance. The MF is then made by visualization in the form of a graph with the final LV output of the CS performance consisting of Bad, Moderate and Good.

Influence diagrams are used to analyse problems and related factors directly or indirectly. All these parameter factors have a particular effect on the model. Therefore, this diagram is increasingly known and popular among researchers because it is easy to use in evaluating systems, and the results of information can be processed with more capable approach. Influence diagram is used to identify a correlation between method and parameters that is constructed model for this research (Fig. 6).

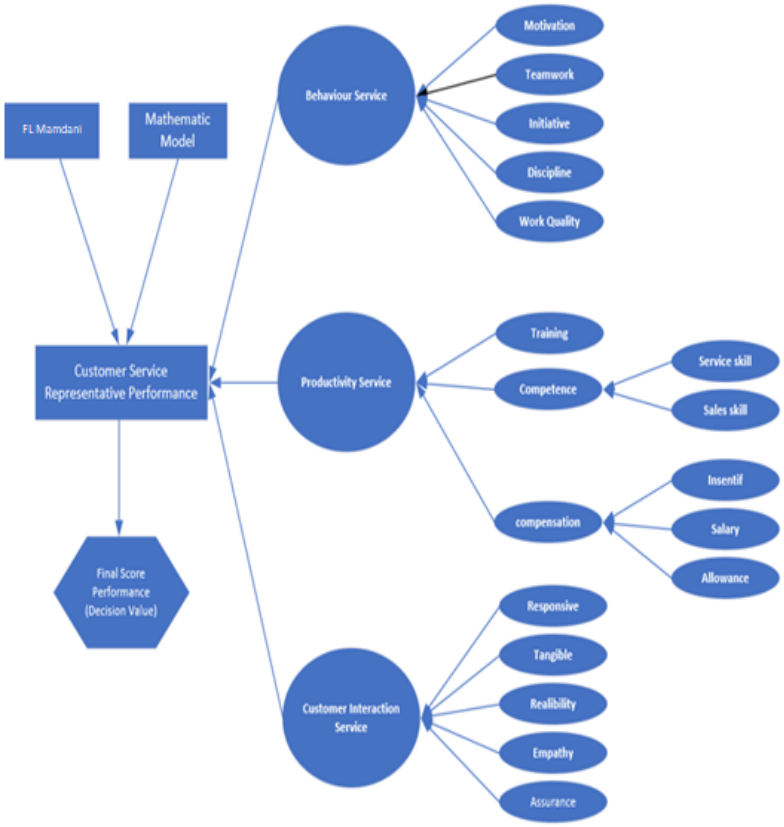

Fig. 6: Influence Diagram to Determine Parameters and Sub Parameters

All parameters are designed by FL. Each MF and LV is dedicated for each parameter. The parameter of salary (K1_1) has limit values: (1000000, 1000000, 2000000, 35000000), (2000000, 3500000, 4500000) and (3500000, 5000000, 5500000, 5500000), that is distributed into three LV that are Low, Moderate and High as shown in Fig. 7. Furthermore, allowance (K1_2) and incentive (K1_3) of parameters have limit values: (0, 0, 100000, 200000), (100000, 250000, 350000) and (300000, 400000, 500000, 500000), consist of Low, Moderate, High that is shown in Fig. 8. Parameter compensation (K1) is allocated into 3 LV that namely Low, Moderate, and High, with the limit values: (20, 20, 40, 50), (40, 60, 80) and (75, 90, 110, 110), these MF shown in Fig. 9.

Parameter traning (K3) is allocated into 2 LV that namely Seldom and often, they have triangular bounds: (0.0,0.0,2,4) and (2,4,6,6), shown in Fig. 10. Another parameters of motivation (K4), teamwork (K5), initiative (K6), discipline (K7), quality work (K8), responsive (K9), tangible (K10), reliability (K11), empathy (K12), and assurance (K13) divided into five LV low, medium, high, very high with limit values: (0.0,0.0,20,40), (20,40,60), (40,60,80), and (60,80,100,100), shown in Fig. 11.

The last parameter of Compensation (K1), competence (K2), behavior service (BS), productivity service (VS), CI Service (CI), CS Performance (PS) distributed in three LV Bad, Moderate, Good. These have limit values: (20, 20, 40, 50), (40, 60, 80) and (75, 90, 110, 110), these MF shown in Fig. 12.

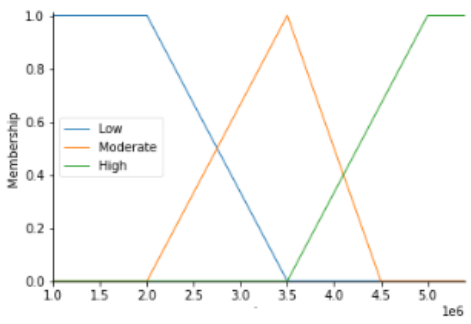

Fig.7: The graph of MF for parameter K1_1

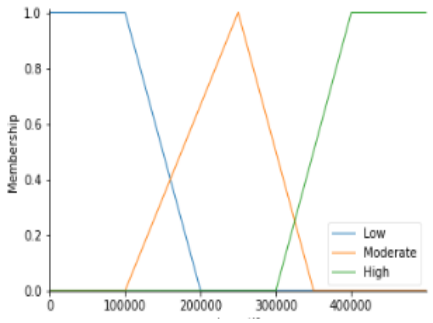

Fig. 8: The graph of MF for parameter K1_2 and K1_3

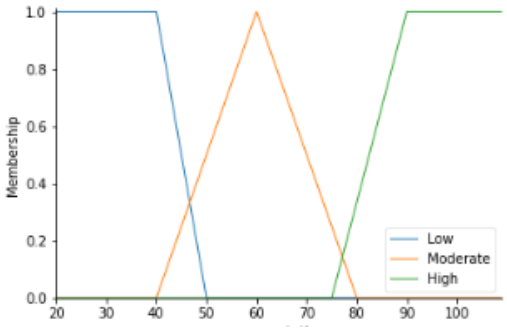

Fig. 9: The graph of MF for parameter K1

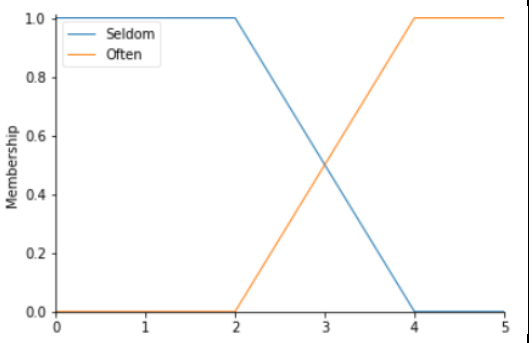

Fig. 10: The graph of MF for Parameter K3

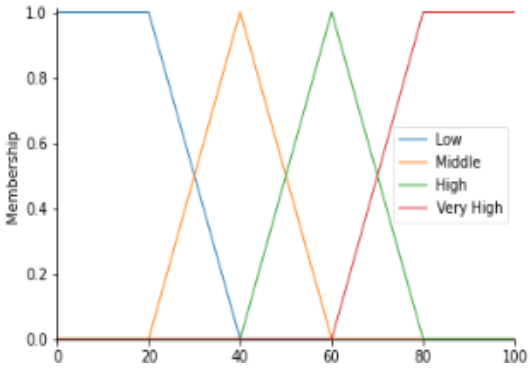

Fig. 11: The graph of MF for parameter K4, K5, K6, K7, K8, K9, K10, K11, K12, and K13

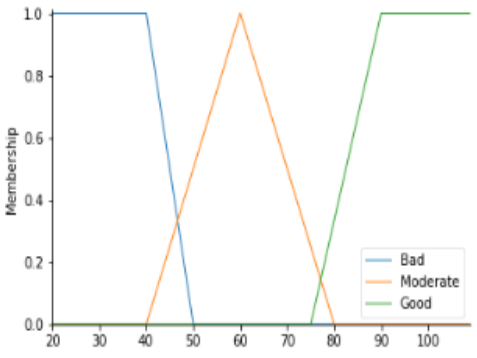

Fig. 12: The graph of MF for parameter K2, BS, VS, CI, and PS

4.2 The Constructed Multi-stage Rule Base

The component describes the rule base is implemented into the M-CSA system or model with justification experts. The hierarchy assessment consists of several parameters represented in layers: stage 1, stage 2, and stage 3. Rule base stage 1 has three input parameters (K1_1, K1_2, K1_3) for establishing output K1, as shown in Table 1. Then, Table 2-4 are depicted the stage of rule 2, which is divided from stage 2.1, which provides output PS with three-parameter inputs (K1, K2, K3), and stage 2.2 is shown output BS with five parameter inputs (K4, K5, K6, K7, K8). Next, Stage 2.3 is delivered output CI with five parameter inputs (K9, K10, K11, K12, K13). Finally, the last stage is shown in Table 5, given the ruling stage for output decision CS performance.

The multi-stage rule base, known as the multi-layer model, built on rules from each input that can be analyzed more efficiently and denote human judiciousness (Hraiz et al., 2019). FL has supported to provide consistency and flexibility implemented in various field systems. The results for M-CSA will be a proposed objective and credible assessment and evaluation model.

Table 1: Rule Base Stage 1

Rule 1	IF K1_1=Low AND K1_2=Low AND K1_3=Low THEN K1=Low
Rule 2	IF K1_1=Low AND K1_2=Low AND K1_3=Moderate THEN K1=Low
…	…
Rule 24	IF K1_1=High AND K1_2=Moderate AND K1_3=High THEN K1=High
Rule 25	IF K1_1=High AND K1_2=High AND K1_3=Low THEN K1= High
Rule 26	IF K1_1=High AND K1_2=High AND K1_3=Moderate THEN K1= High
Rule 27	IF K1_1=High AND K1_2=High AND K1_3= High THEN K1= High

Table 2: Rule Base Stage 2.1

Rule 1	IF K1=Low AND K2=Bad AND K3=Seldom THEN VS=Bad
Rule 2	IF K1=Low AND K2=Bad AND K3=Often THEN VS =Bad
	….
Rule 17	IF K1=High AND K2=Good AND K3=Seldom THEN VS=Good
Rule 18	IF K1=High AND K2=Good AND K3=Often THEN VS=Good

Table 3: Rule Base Stage 2.2

Rule 1	IF K4=Low AND K5=Low AND K6=Low AND K7=Low AND K8=Low THEN BS =Bad
Rule 2	IF K4=Low AND K5=Low AND K6=Low AND K7=Low AND K8=Moderate THEN BS=Bad
	…...
Rule 1023	IF K4=Very High AND K5=Very High AND K6=Very High AND K7=Very High AND K8=Moderate THEN BS=Good
Rule 1024	IF K4=Very High AND K5=Very High AND K6=Very High AND K7=Very High AND K8=High THEN BS=Good

Table 4: Rule Base Stage 2.3

Rule 1	IF K9=Low AND K10=Low AND K11=Low AND K12=Low AND K13=Low THEN CI = Bad
Rule 2	IF K9=Low AND K10=Low AND K11=Low AND K12=Low AND K13=Moderate THEN CI =Bad
	….
Rule 1022	IF K9=Very High AND K10=Very High AND K11=Very High AND K12=Very High AND K13=Middle THEN CI =Good
Rule 1023	IF K9= Very High AND K10= Very High AND K11= Very High AND K12= Very High AND K13=High THEN CI =Good
Rule 1024	IF K9=Very High AND K10=Very High AND K11=Very High AND K12=Very High AND K13=Very High THEN CI=Good

Table 5: Rule Base Stage 3

Rule 1	IF PS=Bad AND BS=Bad AND CI=Bad THEN PS=Bad
Rule 2	IF PS=Bad AND BS=Bad AND CI=Moderate THEN PS=Bad
….	…..
Rule 25	IF PS=Moderate AND BS=Moderate AND CI=Bad THEN PS= Moderate
Rule 26	IF PS=Good AND BS=Good AND CI=Good THEN PS=Moderate
Rule 27	IF PS=Good AND BS=Good AND CI=Very Good THEN PS= Good

4.3 The Algorithm of the Constructed Model

The model is built using DSM to assess employee performance appraisal using the FL Mamdani method. This strategy is often used in previous studies to improve assessment based on DSM theory. The resulting decisions provide convenience for management in evaluating quick decisions with complex problems in the company. In addition, it performs fuzzy reasoning in formulating problems to provide efficient and optimal results. The work process is thoroughly illustrated in the activity model on the class diagram and activity diagram.

Fig. 13 is a class diagram with five classes: CS performance, CS competence, membership function, fuzzy logic, limit value, and fuzzy rule base. CS performance is worked to designate the attribute of each CS based on identified parameters to assess CS performance as a model to be formed for the company. The CS Competence is a class using the mathematical method to perform calculations on sales and service. Furthermore, FL correlates with membership function, limit value, and rule base classes to produce the process of fuzzyfy(), inferenceRule(), and defuzzy().

Fig. 14 is an activity diagram that begins with determining the value of competence by calculating service skill and sales skill parameters. Within them, activities are carried out in reading fuzzy rules for compensation activities that produce crisp output compensation as the first stage. The activity is then construing fuzzy rules activities of productivity service, the activity of reading fuzzy behavior service rules and customer interaction service. These three activities produce productivity service (VS), behavior service (BS) and customer interaction service (CI) of output value, where these three activities enter the second stage of fuzzy rules. The last stage is the activity of generating CS performance output

final by reading fuzzy performance service (PS) rules.

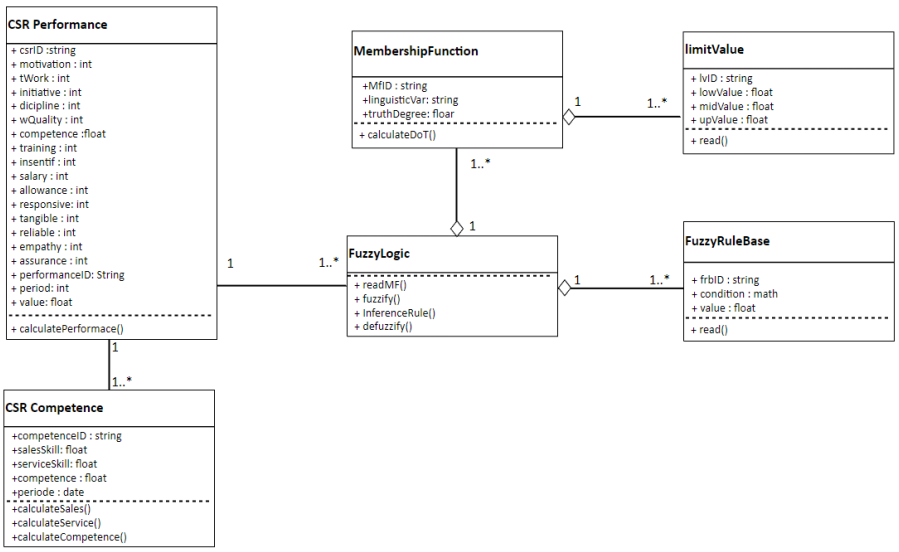

Fig. 13: Class Diagram for Assessing CS Performance Model

The Mamdani fuzzy process goes through several stages: fuzzy, inference, and defuzzy. Each phase is based on fuzzy rules from experts or literature studies that give output continuously. In addition, the rules generate multi-stage basic rules from fuzzy input parameters. Finally, The FL Mandani method is used in decisions to assess CS performance.

The conclusive results of the customer service performance devises the purpose of the domain value for assessment output. The good performance conditions have a scope value of 80 - 100, moderate conditions have scope value 40 - 79 and then the bad performance criteria have a scope value of fewer than 40. The outcomes from our computations are presented in Fig. 15.

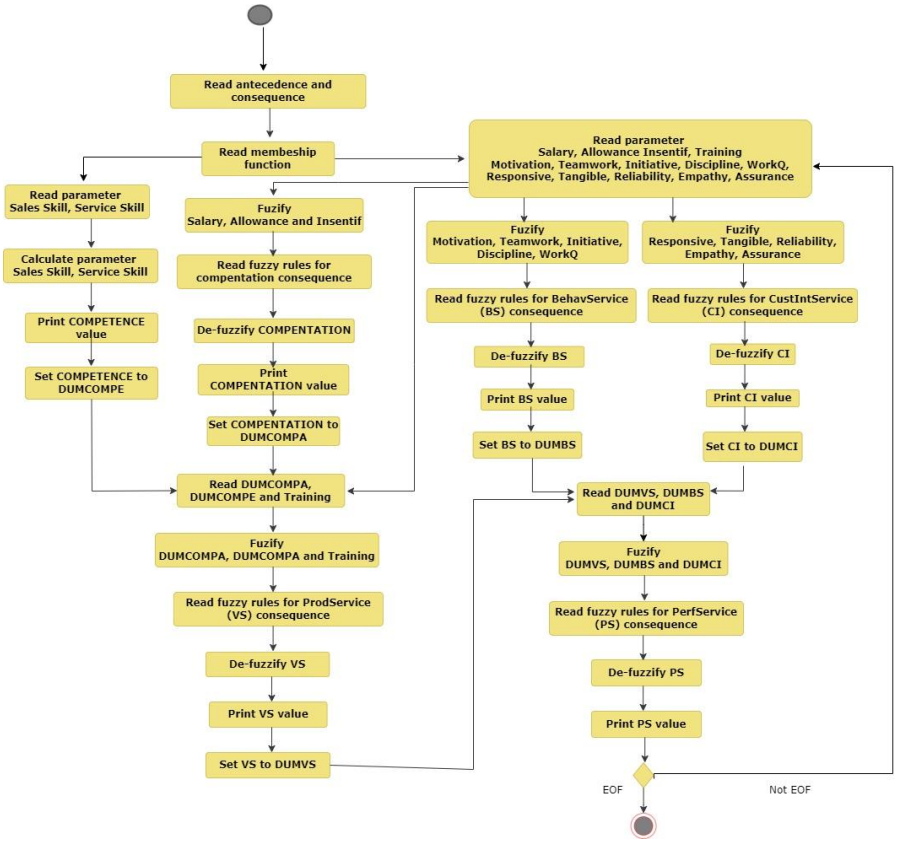

Fig. 14: Activity Diagram for Assessing CS Performance Model

Fig. 15 exhibits the final results of the 15 data presented. Although the visualization results show the test results with the highest performance score data with a score of 95.4 and the lowest score with a score of 93.07, the results of customer service performance give an average value of 94.01. Additionally, Fig. 16 shows the dashboard on CSR performance, the final value that uses color differences as a classification of bad, moderate and good, while Fig. 17 is a dashboard that displays the ranking of CSR performance. This dashboard is made using PHP and Codeigniter version 4.

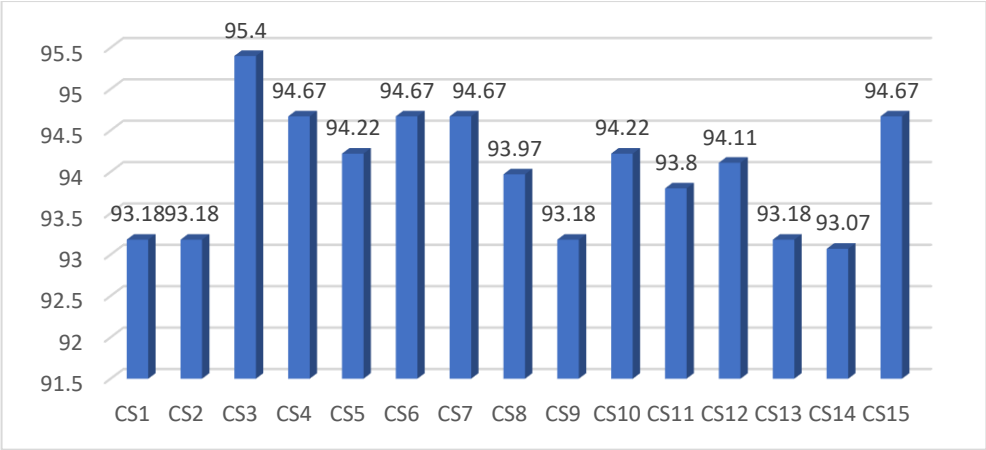

Fig. 15: Result of Assesing for Customer Service Performance

Furthermore, The process of validating the model is carried out to determine the degree of truth of a model by comparing the theory used with the model that has been built (Utama et al., 2017). The procedure of verification to prove the truth in the theory of variables, formulas, calculations, and

calculation procedures. The 1.0 degree in result of the truth indicates that the model is verified and validated. Otherwise, the model is not feasible to build because it is not verified. Table 6 show the results of verification model with result 1.0 degree value.

Moreover, after verification model then we need the data of validation stage is carried out. The model validation process determines the degree of truth of the model data that compares to the data in the field. A summary of data validation can be seen in Table 7. The final validation result is 1.00 so that the model built is validated.

Fig. 16: Customer Service Performance Dashboard

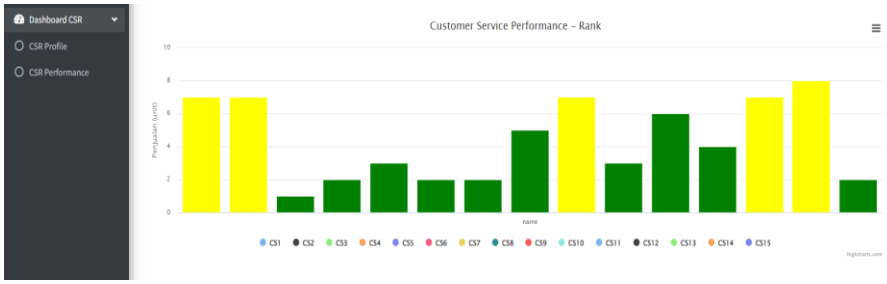

Fig. 17: Customer Service Performance Dashboard - Ranking

Table 6: Verfication Model of M-CSA

Sub-Model	Element	Model	References	Verification Value
Fuzzy Logic	Σ Variable	13	13	1.00
	Procedure	V	V	
	Formula	V	V	
	Result	30 -96	30 - 96	
Mathematical Method	Σ Variable	2		
	Procedure	V	V	
	Formula	V	V	
	Result	0 -100	0 – 100	

Table 7: Validation Model of M-CSA

Sub Model	Parameter	Model	Field	Variable		Value		Validation Value
				T	F	T	F	
M-CSA	**Salary** Low Moderate High	2000000 – 5000000	2000000 – 5000000	1		1		1.00
	….	….	….	….		…		
	CS Performance Bad Moderate Good	30 - 96	30 - 96	1		1		

4.4 Discussion

The following step-by-step is to determine CSR performance by using the mathematical and fuzzy logic method that is described in Fig. 14. Mathematical method is used for calculating sales and service competence, as figured in Table 8. The next step is using a fuzzy process based on a multi-stage rule base with the de-fuzzification process to give crisp output using the centroid method in formula 2 (Table 9 – 13), which consists of compensation, productivity, behavior, Interaction and final output of CSR performance. The final output of CSR performance is categorized to be good, moderate, and bad, and then ranked as shown in Table 14.

Table 8: Calculate competence

Name	Sales Competence	Service Competence	Competence
CS1	88.07	100.00	94.03
CS2	92.00	93.00	92.50
….	…	…	…
CS14	94.17	93.00	93.58
CS15	94.87	93.00	93.93

Table 9: Result De-fuzzification Process for Compensation

Name	Salary	Allowance	Incentive	Compensation
CS1	4,750,000	50,000	50,000	95
CS2	3,800,000	50,000	150,000	56
….	…	…	…	…
CS14	5,500,000	450,000	450,000	95
CS15	4,750,000	50,000	250,000	95

Table 10: Result De-fuzzification Process for Productivity Service

Name	Competence	Compensation	Training	Productivity Service
CS1	94.03	95	5	95.04
CS2	92.50	56	5	94.79
….	….	….	….	….
CS14	93.58	95	5	95.40
CS15	93.93	95	5	95.40

Table 11: Result De-fuzzification Process for Behavior Service

Name	Motivation	Discipline	Teamwork	Initiative	Quality	Behavior Service
CS1	81.33	80	80	80	76	94.79
CS2	72.00	76	72	80	80	79.84
….	….	….	….	….	….	….
CS14	77.33	80	80	80	84	89.09
CS15	86.67	80	80	80	84	95.40

Table 12: Result De-fuzzification Process for Customer Interaction Service

Name	Responsive	Tangible	Reliability	Empathy	Assurance	Customer Interaction Service
CS1	88	72	80	88	92	79.84
CS2	84	80	100	100	96	95.40
….	….	….	….	….	….	….
CS14	68	80	76	88	88	74.17
CS15	84	76	96	92	80	86.43

Table 13: Result De-fuzzification Process for Performance CSR

Name	Productivity Service	Behavior Service	Interaction Service	Performance CSR
CS1	95.40	94.79	79.84	93.18
CS2	94.79	79.84	95.40	93.18
….	….	….	….	….
CS14	95.40	89.09	74.17	93.07
CS15	95.40	95.40	86.43	94.67

Table 14: Category & Rank of CSR Performance

Name	Performance CSR	Category	Ranking
CS1	93.18	Good	7
CS2	93.18	Good	7
….	…	…	…
CS14	93.07	Good	8
CS15	94.67	Good	2

The results of performance score usually operate classical method in evaluation field that acquires at the last studying period. Accordingly, it has been implemented by (Kurniawan & Utama, 2021) to develop classical method. Besides, this research creates results score in service field to evaluation customer service performance that compare between classical model and fuzzy logic process as shown in Table 15.

Table 15: Comparison with Classical Model Result

Name	CS Performance final (FL Mamdani Method)	CS Performance final (Classical Method)
CS1	93.18	94.03
CS2	93.18	92.50
CS3	95.40	87.48
CS4	94.67	88.23
CS5	94.22	88.93
..	..	..
CS11	93.80	84.52
CS12	94.11	91.17
CS13	93.18	87.40
CS14	93.07	93.58
CS15	94.67	93.93

The customer service performance model constructs the final score in Table 14. It built can be a model solution for practical and reliability concepts in the firm. In addition, these outcomes can provide convenience for policymakers as an optimal evaluation process with scientific and contextual practice. The conclusion of the assessment decision uses various input parameters that affect internal employee factors and service interaction with adding another parameter, behavior and productivity service, for measuring service performance. This model was developed with enrichment by using a multi-stage rule base.

5. Conclusions & Future Work

A smart decision support model was successfully developed. It delivered a recommendation for the company based on performance in service. The researcher used thirteen parameters, i.e., compensation, competence, training, motivation, teamwork, initiative, discipline, quality work, responsive, tangible, reliability, empathy, and assurance. Fuzzy logic and Mamdani method were built to construct this model. Parameter defined with related CS performance, and then determine classification performance with specific criteria. This model can run efficiently and optimally for the company to provide the best decision.

More study is required to achieve the best outcomes, review other parameters that correlate with assessing performance and implement another parameter that can give the optimum result and the best recommendation for the company. Likewise, other machine learnings or deep learning algorithms would be allegedly able to be gained in the subsequent work. Additionally, an enormous number of respondents is intended for the representative result to engage in the advanced work.

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