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Fuzzy Tsukamoto and ITIL for Improvement Strategy on Incident Ticket Services

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Abstract*: Ticket Incident is a service provided to clients who work with Meraki Digital Indonesia. At present Ticket incident is a significant problem in terms of service, especially in handling correction software that has the highest number of tickets, because the software development planning is not optimal because the client needs software that is built because of the large number of ticket incidents that occur, so it is necessary to improve service to clients. So we need a way to improve incident ticket service using the ITIL method. This improvement method is following the purpose of assessment in each area service operation by using questionnaires, then to correct this problem another approach is needed with Fuzzy Tsukamoto to measure how many tickets need to be completed to improve the services provided. The results of this study based on the assessment using ITIL found Service Operation Processes and Organizing Service Operations as a weakness, and from the results of Fuzzy Tsukamoto with the calculation of 162 tickets that need to be appropriately resolved so that it becomes a reference for developing and improving services provided to clients.

***Index Terms*: Fuzzy Tsukamoto, ITIL, Service Operation, Ticket Incident.**

I. INTRODUCTION

The development of information technology [1] is increasing rapidly with the modernization [2] of the technology-based side of the business activities carried out in each company as a media of information that can help bring messages in real-time for the smooth running of the business in each company. Growth is essential, and a key to the survival of any business [3], accompanied by the rapid development of information technology requires the use of an optical system of various existing resources. The need for time and cost efficiency that causes every company to implement information technology for businesses to achieve strategic advantages compared, to their competition and how they can facilitate the movement of goods and services from producers to customers [4], Therefore many information technology service companies currently provide services and provision of information technology solutions that aim to help each company increase effectiveness and efficiency [5] to achieve strategic goals and offer a variety of needs which of course by utilizing information technology with an optical system, with the provision of software as a significant component in achieving excellence in competing in the business of information technology services. Meraki Digital Indonesia is one of the IT consulting companies that focuses on developing software and managing functions within the company, and it is necessary to carry out a strategy in managing incident ticket services. It show on figure 1.

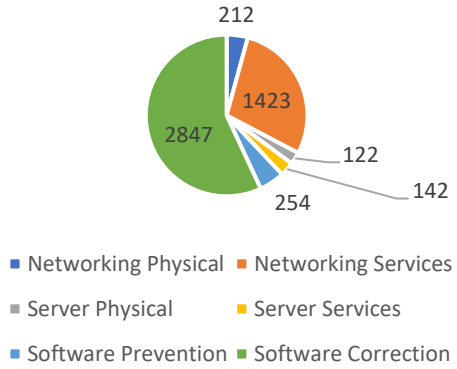

Fig 1. Ticket data for incidents in 2018

In figure 1, show ticket data for the incident in 2018 with common problems occurred among others regarding; physical network 212 tickets, Networking Services as many as 1423 tickets, 122 Physical Server tickets, 142 Server Services, 254 Prevention Software tickets, and 2847 Software Correction tickets. Seen many problems occur in software correction; this incident becomes the main problem in the services provided to the client. Software development planning is not optimal because the client needs for the software that is built is extensive. The incident is a disorder that is not planned for IT services or a decrease in the quality of IT services [6]. This case uses electronic Support Ticket Management System (E-TMS) for ticketing services. E-TMS is an issue tracking system for monitoring the support tickets on the web portal [7] and to provide excellent service using the ITIL method, as well and to provide excellent service using the ITIL method, as well as fuzzy Tsukamoto for determining the value to completing the incident ticket service.

II. STUDY LITERATURE AND PREVIOUS RESEARCH

A. ITIL V3

ITIL version 3, published in 2007 and later revised in 2011, explains in five volumes the various tasks an IT services supplier must perform [8]. The ITIL Version 3 Framework is an upgrade from ITIL Version 2 which consists of 2 domains, namely service delivery and service support. The ITIL Version 3 Framework is one of the good practices related to IT service management and has several processes.

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Currently the use of framework ITIL Version 3 is more widely used by several companies or organizations because it focuses on the IT service life cycle [9]. Sani [10] was explained ITIL is a general framework that describes best practices in IT service management. ITIL provides a framework for IT governance, which focuses on continuously measuring services from the business and customer perspective. Other definition ITIL is considered now as the de facto standard framework for IT Service Management (ITSM) in organizations which operate their business which is based on IT infrastructure and services [11].

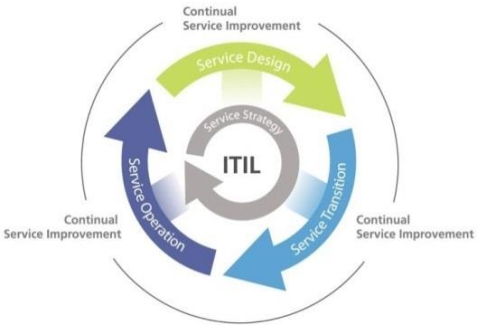

Fig 2. ITIL Service Cycle

Fig 2 show the current version, ITIL v3, the five components are made into different books, of which the five books describe in more detail in the manual section. The sixth book, which is an official introduction to ITIL Version 3, briefly explains the contents of the five books and introduces overall IT Service Management [12] . The ITIL framework focuses on different strategies for achieving high quality service, including a range of recommended techniques, methods, processes, activities and measurements [13].

B. Fuzzy Logic

Then definition Fuzzy Logic method is created because Boolean logic does not have high accuracy, only has 0 and 1 logic numbers. So to make a system with high accuracy, Boolean logic cannot be used. The terms used in fuzzy are as follows [14]. The term fuzzy logic is based on Boolean logic that is commonly used in computing. In summary, fuzzy theorems allow computers to "think" not only in white scale (0 and 1, dead or alive) but also in gray scale and in Fuzzy Logic a preposition can be represented in truthfulness or error (falsehood) certain [15].

C. Previous Research

Then there are several research related this research, first research [16] introduces functional, non-functional and fuzzy evaluation method for ITSM software selection. The presented ITIL based approach breaks down ITSM software selection criteria into two broad categories namely functional (service strategy, service design, service transition, service operation, continual service improvement according to ITIL V3) and non-functional requirements (quality, technical, vendor, implementation) including totally 46 selection criteria. Second research [17] is looking for a way to implement ITIL in an organization and also using Fuzzy Cognitive Maps (FCM) to model the problem for better understanding of environment. Third research [18] to offer the analytical means to support decision-making in the implementation sequence of Information Technology Infrastructure Library (ITIL) solution modules for supporting module sequencing decision along with fuzzy Technique for Order Preference by Similarity to Ideal Solution (FTOPSIS) method to be applied. Fourth Research [19] is applied to IT services company to select and acquire ITSM software, and the provided numerical example illustrates the applicability of the approach for this choice, A novel fuzzy superiority and inferiority ranking (FSIR) was developed and made applicable for ITSM software selection based on identified criteria.

III. METHOD

In this section, need Identification is the initial stage where the researcher collect several references, what methods should be used in obtaining data, to analyze data. In this study some identification of the need to obtain data was carried out.

A. Location Research and Data Source

The research was conducted at PT. Meraki Digital Indonesia, Centennial Tower 29 Floor. Jl. General Gatot Subroto No. 27, South Jakarta, Indonesia . Then the data sources in this research are two parts, primary data and secondary data.

1. **Primary Data** : Primary data is data obtained directly from the object research, in this case through interviews and questionnaire.

2. **Secondary Data** : Secondary data is data obtained from the object's internal data research, such as data obtained from books, journals, papers, addresses of reference websites that are related to the research title, strategic plan, Annual Financial Report, etc.

B. Data Collection

The data collection methods used in writing this research are as follows:

1. **Literature Study** : This research was carried out by searching and collecting data, sources of information and materials obtained from books, literature, articles related to research methods used, and so on.
2. **Field Study** : This study is done by getting data directly from object of research.
3. **Interview** : Conduct questions and answers with related parties to get information and data - data needed. Interviews were conducted both face to face and using e-mail, due to the busyness and high mobility of the speakers.
4. **Observation** : Make observations directly on the environment and the application of information systems to the company and the use of the system information by related users.
5. **Questionnaire** : Distributing questionnaires to Meraki Digital Indonesia employees for reference to the system maturity calculation there.

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C. Data Sample

In this research using a method of collecting data from a number of respondents with a written list of questions, then processed to produce complete and valid information. Questionnaire was conducted to obtain data. Respondents on the research questionnaire This consists of 10 respondents, including: 1 Chief Finance Officer, 1 Information Technology Manager, 1 Hardware supervisor and 1 supervisor software, and 6 IT staff. This Research using the method of taking respondents with Purposive Sampling. The purposive sampling method is the determination of the sample by selecting certain samples that are considered appropriate and focused on the objectives or problems of this research within a population [20]. Arranging Needs is the second stage where researchers begin processing the data obtained in the method in the first stage. In this research carried out several phases in compiling needs:

1. **Performance Calculation** :Performance calculation is a calculation that corresponds to work results that have been achieved based on predetermined standards. As in general, performance calculations are carried out to evaluate work performance in order to reach the specified target. At this stage after the author gets the data and gives the value can be known how much the performance of the incident ticket service at Meraki Digital Indonesia.
2. **Target Definition for Progress**: Targets themselves have meaning where something you want to achieve can reach the desired target. At this stage, IT services are expected to have results that match the targets set.
3. **Gap Analysis and Progress Identification**: Gap analysis is a phase of transition from the old steps to the new steps. At this stage gap analysis is done by comparing actual performance with expected performance.

Information Technology Governance Design is the third stage where researchers began to design information technology governance in accordance with the results obtained at the second stage, compiling needs. In this study several phases were carried out in the design of information technology governance:

1. **Design of Information Technology Governance Based on ITIL Version 3**: At this stage, researchers design technology governance the information is in accordance with ITIL Version 3 standards. The design of information technology governance is carried out after the researcher has obtained the data according to his needs.
2. **Completing the IT Governance Design with service Operation**: At this stage the researcher completes the design based on ITIL Version 3 what has been done with Service Operation in it. So that later the design of information technology governance will be arranged based on ITIL Version 3 with the sub-domain Service Operation on information technology governance at Meraki Digital Indonesia.

Design testing is done with the purpose of what is the design of governance information technology made in accordance with what is expected and needed with the state of the incident ticket service in Meraki Digital Indonesia. The design testing is done in two ways:

1. **Credibility**: There are many ways that can be done in testing credibility. Testing credibility or can be called trust in the results of research is one of them by increasing perseverance in observation. In testing this design is given to related sources
2. **Confirmability**: Testing for confirmability can also be called testing objective. Because in this study using the best framework practice ITIL Version 3, then in design testing IT Governance also uses the ITIL Version 3 framework and is equipped with using ISO 20000. Where in the ITIL framework answers how to meet the desired demand in accordance with ISO 20000 framework. Furthermore in the Tsukamoto method, each rule is represented using fuzzy sets, with a monotonous membership function. To determine the exact crisp / yield output value (Z), it is sought by changing the input (in the form of fuzzy sets obtained from the composition of fuzzy rules) into a number in the fuzzy set domain. This method is called the defuzzification method (affirmation) [21]. In its inferiority, the Tsukamoto method uses the following stages:

1. **Fuzzification** : The fuzzification process is a process of converting non-fuzzy variables (numerical variables) into fuzzy variables (linguistic variables). Input values that are still in the form of numerical variables, before processing must be changed first into fuzzy variables. Through the membership function that has been compiled, from the input values into fuzzy information that is useful later for the processing process is also fuzzy. This process is called fuzzification.
2. Formation of fuzzy knowledge base (rule in the form of IF ... THEN)
3. **Inference Machine** : The inference engine uses the MIN implication function to get the a-predicate value on each rule (a1, a2, a3 ... an). Then each of these a-predicate values is used to calculate the output resulting from the explicit inference (crisp) of each rule (z1, z2, z3, ... zn).
4. **Defuzzification** : At the defuzzification stage, defuzzification uses the average method. Following is the equation of the average method.

In Tsukamoto's method, each rule is represented using a set of fuzzy associations, with a monotonous membership function. To determine the value of crisp output or firm result (Z), it is sought by changing the input (in the form of fuzzy set obtained from the composition of fuzzy rules) into a number in the fuzzy set domain. This method is called the defuzzification method. The defuzzification method used in the Tsukamoto method is a centralized defuzzification method (Center Average Defuzzyfier). For example there are 2 input variables, var-1 (x) and var-2 (y) and 1 output variable var-3 (z), where var-1 is divided into 2 sets namely A1 and A2 and var-2 is divided into set B1 and B2. While var-3 is also divided into 2 sets, namely C1 and C2 [21]. There are two rules that are used, namely: R1] IF (x is A1) and (y is B2) THEN (z is C1) [R2] IF (x is A2) and (y is B1) THEN (z is C2) [15].

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IV. RESULT AND DISCUSSION

Use In Chapter IV, we will discuss the results of the analysis in planning the Information Technology Infrastructure Service Operation Library domain at Meraki Digital Indonesia. The results obtained from each of these stages, requirements & strategies, implementation and on-going operations are as show on below.

A. Assessment Research

In this research there are several things discussed according to the domain service operation area, namely: Service Management Practice, Service Operation Principles, Service Operation Processes, Service Operation Common Operation Activities, Organizing Service Operation, Service Operation Technology Considerations, and Implementing Service Operations. All of these areas will be discussed in this study and provide assessment to respondents to identify the application of ITIL to Meraki Digital Indonesia companies and This research uses parameters in questionnaire distributed to 10 respondents.

B. Assessment Result

The following are some of the results of processing data through questionnaires that have been distributed to respondents, including discussing Service Operation Area Questionnaire, Service Operations Area responses all participants, Service Operation Area responses Average Score in ITIL Version 3 area. The following include:

Table 1. Service Operation Area Questionnaire Result

Participant	Service Operation Processes	Service Operation Technology Considerations	Organizing Service Operation	Implementing Service Operation	Service Design Process Implementation Considerations	Service Management as a Practice	Service Operation Principles
1	353	171	173	102	42	50	118
2	352	164	175	103	40	55	120
3	349	170	170	96	40	48	119
4	335	171	172	106	39	47	115
5	353	168	166	97	43	55	118
6	343	163	161	100	42	48	114
7	343	170	160	94	42	59	111
8	358	164	163	100	40	50	121
9	354	161	169	106	37	50	112
10	342	164	175	99	41	46	118

In table 1, explain there are 10 respondents who answered with an area service operation, including Service Management as a Practice with 19 questions, Service Operation Principles with 29 questions, Service Operation Processes with 87 questions, Common Service Operation Activities with 42 questions, Organizing Service Operation with 42 questions, Service Operation Technology Considerations with 25 questions, and Implementing Service Operation with 10 questions. By filling in each questionnaire based on the Initial parameter with the value 1, Repeatable with the value 2, defined the value 3, managed value 4, and optimizing the value 5. from the questions posed to all respondents, they have answered all items in the questionnaire without missing anything. Then in table 2, explain the number of each parameter that has been answered on the questionnaire by the respondents, so that it can be seen in each area of service operation that is carried out an assessment to be seen, corrected, and implemented based on the questionnaire that has been calculated.

Table 2. Service Operation Area responses all participants

Service Operation Area	Initial	Repeatable	Defined	Managed	Optimizing
Service Management Practice	0	0	60	30	40
Service Operation Principles	0	0	109	104	77
Service Operation Processes	0	0	286	318	266
Service Operation Common Operation Activities	0	0	133	139	148
Organizing Service Operation	0	0	157	131	132
Service Operation Technology Considerations	0	0	86	88	76
Implementing Service Operations	0	0	40	34	26

Then in table 3, explain the average in each area of service operation in the parameters that have been filled in the questionnaire. The results obtained include Service Management Practice with a value of 4.08, Service Operation Principles with a value of 3.98, Service Operation Processes with a value of 3.95, Service Operation Common Operation Activities with a value of 3.99, Organizing Service Operation with a value of 3.95, Service Operation Technology Considerations with a value of 4.04, and Implementing Service Operations with a value of 4.05.

If seen from the average score, the lowest value found in the area tested in Service Operation Processes and Organizing Service Operations as a weakness. This needs improvement in both fields. The process and organization of services carried out can be seen in operational ticketing data in 2018, to be able to be repaired, and they can use methods or algorithms to correct the problems encountered.

Table 3. Average Score Service Operation Area

Service Operation Area	Average Score
Service Management Practice	**4.08**
Service Operation Principles	**3.98**
Service Operation Processes	**3.95**
Service Operation Common Operation Activities	**3.99**
Organizing Service Operation	**3.95**
Service Operation Technology Considerations	**4.04**
Implementing Service Operations	**4.05**

Interpretation can be seen by using radar to clarify areas that are weak and need to be improved. The presentation can be seen by using radar in figure 2 and chart at figure 3 to illuminate areas that are weak and need to be adjusted.

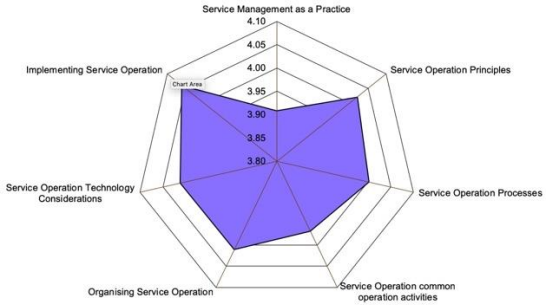

Fig 2. Service Operation Readiness Score (average)

In figure 2, the radar displayed based on the tested area can be seen in the lowest value and the radar leads to Service Operation Processes and Organizing Service Operations as a weakness, while the highest leads to Service Operation Processes and Organizing Service Operations as a weakness, Implementing Service Operations, and Service Operation Technology Considerations.

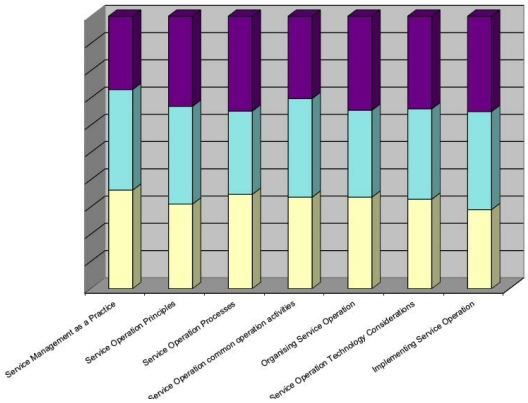

Fig 3. Summary of all Responses per Service Operation area

In figure 3, the chart displays colors in each area. Purple indicates optimizing, blue indicates manage, and yellow color signifies defined. Now what needs to be considered is to reduce the yellow color to be increased to blue or purple. The necessary improvements are based on the values that are weaknesses in each item for optimization. Then for in managing incident ticket services, the process in fuzzy formation is used to calculate the membership value, which consists of several inputs, namely variables that affect the calculation. Thus the assessment compositions are request, completion and unresolved variables, data based on operational ticketing data in 2018. The demand data variable is divided into two fuzzy associations, namely: High (H) and Low (L). Low and large sets use a low linear curve, while the collection is using a triangle shape curve.

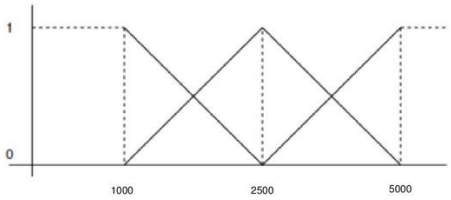

Fig 4. Variable request curve

Based on Figure 4, fuzzy set equations can be shown in equation (1) for the low category, equation (2) for the high.

$$\mu \text{ Request Low } [x] = \{(1, x \leq 1000), ((5000-x)/2500, 1000 \leq x \leq 5000), (0, x \geq 5000)\} \quad (1)$$

$$\mu \text{ Request High } [x] = \{(0, x \leq 1000), ((x -1000)/2500, 1000 \leq x \leq 5000), (1, x \geq 5000)\} \quad (2)$$

The Membership Value, based on equation (1) the result μ Request Low (2500) $= (5000-2500)/2500 = 0$ (3)

and based on equation (2) μ Request High (2500) $= (2500-1000)/2500 = 0.6$ (4)

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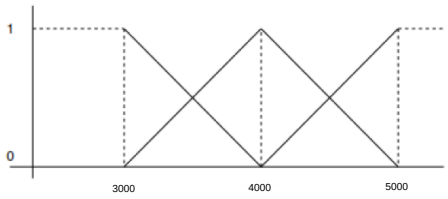

Fig 5. Variable Completion Curve

μ Completion Less [x] = {(1, x ≤ 3000), ((5000-x)/4000, 3000 ≤ x ≤ 5000), (0, x ≥ 5000)}
(5)

μ Completion Many [x] = {(0, x ≤ 3000), ((x -3000)/4000, 3000 ≤ x ≤ 5000), (1, x ≥ 5000)}
(6)

The Membership Value Based on equation (3) the result μ Completion Less (4000) = (5000-4000)/4000 = 0.25
(7)

and based on equation (4) μ Completion Many (4000) = (2500-1000)/2500 = 0.6
(8)

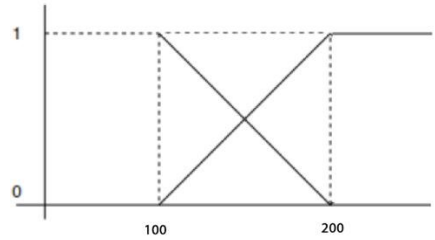

Fig 6. Variable Unresolve Curve

μ Unresolved Decrease[z] = {(1, z ≤ 100), ((200 – z)/150, 100 ≤ z≤ 200), (0, z ≥ 200)}
(9)

μ Unresolved Increase[z] = {(0, z ≤ 100), ((z-100)/150, 100≤ z ≤ 200), (1, z ≥ 200)}
(10)

The Membership Value Based on equation (5) the result μ Completion Low (150) = (200-150)/150 = 0.33 (11)

and based on equation (6) μ Completion High (150) = (150-100)/150 = 0.33
(12)

Now we look for the z value for each rule using the MIN function in the implication function:

[Logic 1] If Request LOW and Completion MANY then Unresolved DECREASE
α-Logic 1 = Min (μ Request Low (3) , μ Completion Many (8))
So based on α-Logic 1 = 0.6 (13)
For value completion Many, equation (9) = equation (13) then the result is 110
(14)

[Logic 2] If Request LOW and Completion LESS Then Unresolved DECREASE
α-Logic 1 = Min (μ Request Low (3), μ Completion Less (7))
So based on (7) α-Logic 1 = 0.25 (15)
For value completion Many, equation (9) = equation (15) then the result is 238
(16)

[Logic 3] If Request HIGH and Completion MANY Then Unresolved INCREASE
α-Logic 1 = Min (μ Request High (4) , μ Completion Many(8))
So based on (7) α-Logic 1 = 0.6 (17)
For value completion Many, equation (10) = equation (17) then the result is 190 (18)

[Logic 4] If Request HIGH and Completion LESS Then Unresolved INCREASE

α-Logic 1 = Min (μ Request High (4), μ Completion Less(7))
(7)
So based on (7) α-Logic 1 = 0.25 (19)
For value completion Many, equation (10) = equation (19) then the result is 138 (20)

After we get the result all of the logical then value of Z = 162, this value is for completing the incident ticket for developing and improving services

V. CONCLUSION

From the research, which includes of assessments and calculations to improve incident ticket services, conclusions can be described as follows:

1. The use of the ITIL framework in the company is one of them applied in conducting assessments, which is the initial stage of managing IT services at the company. Through this assessment, users can find out how far their company has implemented the ITIL framework on their existing systems in managing IT services. After knowing its position, companies can quickly implement ITIL in their IT service management, which is known to need improvement in their management still.
2. Based on the discussion, there are three variables used request, completion, and unresolved variables. The data used uses incident ticket data in 2018. From the calculation of Z = 162, this value is for completing the incident ticket for developing and improving services

Based on the conclusions above, suggestions can be given to be better is:

1. The developer should coordinate further with the client to get complete and comprehensive application needs
2. Coordinate with the client to obtain valid and extensive data sources. This will strengthen the technical application testing.

3. It is expected to find other objects to deepen the method of fuzzy Tsukamoto.
4. For further research, it is likely to combine with different ways to get better results.
5. Add fuzzy rules to the inferences, so that the results obtained are more accurate.

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