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Implementation of the fuzzy logic for measuring instrument evaluation results in Information Security Index

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Implementation of the fuzzy logic for measuring instrument evaluation results in Information Security Index

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Abstract. Information security in an organization is very important and should be a major concern. The government designed and made an application of security standards for the application of information security in Indonesia. This Information Security Index is an application that is used as a tool to analyze and evaluate the level of readiness ,completeness and maturity of the application of information security in an organization in accordance with the criteria in SNI ISO / IEC 27001 and COBIT. Fill in the index instrument is expected to be easier and faster in using the application. In its development, there is a method that will be applied to this application, namely fuzzy logic. Fuzzy logic is implemented in the Information Security index application in this case serves to predict the final result. In this study, the prediction results using the Mamdani fuzzy method get the percentage of MAPE error 19.17%, so that the accuracy of the implementation of the Mamdani fuzzy method in the security index application is 80.83%.

1. Introduction

Information security in an organization is very important and should be a major concern. In fact, the higher the use of electronic devices as a medium for exchanging information, the higher the risk of threats that lie in the way. The threat is not solely done by humans themselves, but can also with unexpected circumstances, such as natural disasters [1]. It is very important to pay more serious attention to organizations or agencies that use information technology, so that they do not suffer losses in the future [1]. Therefore, the government designed and made an application as a benchmark for implementing information security criteria for organizations in Indonesia.

Benchmarks in the information security implementation criteria are the Information Security index. The form of evaluation applied in the Information Security index is designed to be used by government agencies of various levels, sizes, and levels of importance in the use of ICT in supporting the implementation of existing main tasks and functions. The data used in this evaluation will provide an overview of the preparedness index in terms of the completeness and maturity of the information security framework that is applied and can be used as a comparison in order to develop corrective steps and determine priorities [2].

Fuzzy logic is one of the methods or algorithms of decision making systems. The concept of fuzzy algorithm was first introduced by Professor Lotti A. Zadeh from the University of California in 1965. Fuzzy logic is a generalization of classical logic (crisp set) which only has two membership values, namely 0 and 1. In fuzzy logic the truth value of a statement ranges from completely right until completely wrong. Fuzzy logic will be implemented in the Information Security index application in the final result prediction function. This prediction will help the assessor know the estimated results of the user assessment [2]. Therefore this research is considered important because it deals with measuring the value of information security.

2. Literature review

Information Security Index is an application that is used as a tool to analyze and evaluate the level of readiness, completeness and maturity for the application of information security in an organization in accordance with the criteria in SNI ISO / IEC 27001, namely: governance, risk management, frameworks, asset management, technology [3].

The information security index is not intended to analyze the feasibility or effectiveness of existing forms of security, but rather as a tool to provide Leaders with an overview of the readiness of the information security framework. Information security index implementation is carried out by public service providers electronically through Technical Guidance, Assessment and Consultation [3].

Information security index is an implementation of Policy Governance Application / Information Security Management Systems (ISMS) for Electronic System Operator for public services. ISMS are applied for the purpose of risk management for the creation of good IT governance (good IT Governance). The index requires targeting security controls that includes 11 information security areas. The controls are simplified to be scope documents are generally constructed as the completeness of the information security framework [4]. As explained in the picture below:

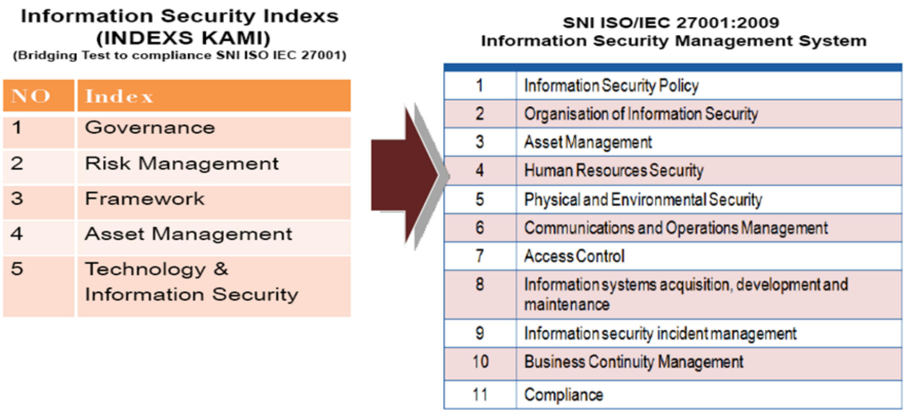

Figure 1. Information Security Index mapping into ISMS ISO 27001.

Fuzzy is a control system for solving computer based problems in data acquisition. Fuzzy logic has two possibilities such as 1 or 0, "true" or "false". Although the membership value is the same, but fuzzy is able to distinguish the value of the membership from the weight held. Fuzzy is able to model non-linear functions that are very complex and have a tolerance of incorrect data using natural language so that it is easy to understand [5].

Fuzzy logic is one of the founders of soft computing. Fuzzy logic was first introduced by Prof. Lotfi A. Zadeh in 1965. The basis of fuzzy logic is fuzzy set theory. In fuzzy set theory, the role of the degree of membership as a determinant of the existence of elements in a set is very important. In this study, data collection was carried out directly to the relevant agencies based on systematic procedures so as to obtain good and correct data using the following data collection methods:

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2.1. Fuzzy association
In classical set theory, the value of membership of an object in a set has only two possibilities, namely one (1), which means that an object is a member of a set, or zero (0), which means that an object does not become a member in the set. In fact, due to a lack of inaccurate and incomplete knowledge or data, it is not always clear whether an object is a member of a particular set or not [6].

2.2. Fuzzy inference system
Fuzzy inference system is a calculation framework based on the concepts of fuzzy set theory, fuzzy if-then rules, and fuzzy thinking. There are several fuzzy inference systems that are well known, namely fuzzy Mamdani, fuzzy tsukamoto, and fuzzy Sugeno [6].

3. Methodology
In this study, data collection was carried out directly to the relevant agencies based on systematic procedures so as to obtain good and correct data using the following data collection methods:

3.1. Literature review
Done by collecting written data through a literature review in the form of books, articles, journals, related to the object of research [7].

3.2. Systems development method
The method in developing software that is applied is *prototype*, because this method is quite supportive in the process of making an application as well as in its development and the client can interact during the process of making the application. The process model in the prototype model development system *consists of communication, quick plan, quick design modeling, construction of prototype, delivery delivery & feedback* [8].

4. Results and discussion

4.1. Fuzzyfication
Fuzzyfication is the process of converting firm values (crips) to blurred values (Fuzzy). In the fuzzyfication process, the first thing to do is to create a set of fuzzy and fuzzy inputs. In this study, the fuzzyfication process has five input data namely governance variables, risk variables, framework variables, asset management variables, and technology variables. Whereas the output has one output, the final evaluation result.

$$\mu(low) = \begin{cases} 1 & x \leq bb \\ \dfrac{ba - x}{k}, & bb \leq x \leq ba \\ 0 & x \geq ba \end{cases}$$

$$\mu(high) = \begin{cases} 1 & x \leq bb \\ \dfrac{x - ba}{k}, & bb \leq x \leq ba \\ 0 & x \geq ba \end{cases}$$

Where:
ba = upper limit / largest value of data.
bb = lower bound / smallest value of the data.
k = upper limit - lower limit.
x = calculated data.

Table 1. Variabel function.

Variable	$\mu(low)$	$\mu(high)$
Governance	$\begin{cases} 1 & x \le 28 \\ \frac{89-x}{61}, & 28 \le x \le 89 \\ 0 & x \ge 89 \end{cases}$	$\begin{cases} 0 & x \le 28 \\ \frac{x-28}{61}, & 28 \le x \le 89 \\ 1 & x \ge 89 \end{cases}$
Risk Management	$\begin{cases} 1 & x \le 19 \\ \frac{47-x}{28}, & 19 \le x \le 47 \\ 0 & x \ge 47 \end{cases}$	$\begin{cases} 0 & x \le 19 \\ \frac{x-19}{28}, & 19 \le x \le 47 \\ 1 & x \ge 47 \end{cases}$
Framework	$\begin{cases} 1 & x \le 31 \\ \frac{106-x}{75}, & 31 \le x \le 106 \\ 0 & x \ge 106 \end{cases}$	$\begin{cases} 0 \\ \frac{x-31}{75}, \\ 1 \end{cases}$ $x \le 31$ $31 \le x \le 106$ $x \ge 106$
Asset Management	$\begin{cases} 1 & x \le 0 \\ \frac{112-x}{112}, & 0 \le x \le 112 \\ 0 & x \ge 112 \end{cases}$	$\begin{cases} 0 & x \le 0 \\ \frac{x-0}{112}, & 0 \le x \le 112 \\ 1 & x \ge 112 \end{cases}$
Technology	$\begin{cases} 1 & x \le 0 \\ \frac{92-x}{92}, & 0 \le x \le 92 \\ 0 & x \ge 92 \end{cases}$	$\begin{cases} 0 & x \le 0 \\ \frac{x-0}{92}, & 0 \le x \le 92 \\ 1 & x \ge 92 \end{cases}$
Evaluation Result (output)	$\begin{cases} 1 \\ \frac{429-x}{318}, \\ 0 \end{cases}$ $x \le 111$ $111 \le x \le 429$ $x \ge 429$	$\begin{cases} 0 & x \le 111 \\ \frac{x-206}{318}, & 111 \le x \le 429 \\ 1 & x \ge 429 \end{cases}$

The results of the acquisition value will be determined based on the value of the variable membership degree as the table below.

Table 2. Variabel degrees.

Variable	$\mu(low)$	$\mu(high)$
Governance	0,38	0,62
Risk Management	0	1
Framework	0,13	0,87
Asset Management	0,43	0,57
Technology	0,46	0,54
Evaluation Result (output)	0,33	0,67

After that the training data value will be determined to produce a pattern. Following the fuzzy rules table that has been formed based on the degree of membership of the training data:

Table 3. Rules *fuzzy*.

No	Variable					
	Governance	**Risk Management**	**Framework**	**Asset Management**	**Technology**	**Evaluation Result**
1	High	High	High	High	High	High
2	Low	High	Low	Low	Low	Low
3	Low	Low	Low	High	Low	Low
4	Low	Low	Low	Low	High	Low
5	High	Low	High	High	High	High
6	Low	Low	Low	High	High	Low

4.2. Implication
Implication is the process of getting output from rules that have been made before. The implication function used is min. The following are examples of calculation implications:

$$\boldsymbol{Implication} = \boldsymbol{min}(\boldsymbol{\mu_{tk}} \cap \boldsymbol{\mu_{pr}} \cap \boldsymbol{\mu_{kk}} \cap \boldsymbol{\mu_{pa}} \cap \boldsymbol{\mu_t}[\boldsymbol{x}]) \quad (3)$$

4.3. Aggregation
Aggregation is a combination of several rules that are made into a single fuzzy set. The aggregation method used is max or for all fuzzy rule outputs. If the implications of using the min and max functions in aggregation, the Mamdani method is often called the MIN-MAX method (min-max inferencing). Based on the degree of membership of the output data displayed, the greatest value of the membership degree will be taken as a benchmark for the next method, namely, defuzzification. The following is an example of an aggregation calculation:

$$0.54 = \frac{x - 111}{318}$$
$$0.54\,x\,318 = 111 + x$$
$$x = 111 + 171.72$$
$$x = 282.72$$

4.4. Defuzzification of the MoM method (Mean of Maxima)
Defuzzyfication of the process of mapping the magnitude of a fuzzy set into crisp values. The reason for doing defuzzyfication is that the system was initially regulated by real quantities, not fuzzy quantities. The defuzzyfication method used in this study is the MoM (Mean of Maxima) method. Based on the formula above, the Mean of Maxima method retrieves data with the highest degree of membership from the aggregation results then adjusted to the rules in the output. If there is only one data with the highest degree of membership, then that data is the result. But, if there is more than one data, then all the data will be divided and then divided by the amount of data. Following is an example of using the formula in the previous aggregation results:

$$x^* = \frac{upper\ limit\ (output) + aggregation}{lots\ of\ data}$$

$$x^* = \frac{429 + 282{,}72}{2}$$
$$x^* = 355.86$$

5. Testing
The test results use the MAPE (Mean Absolute Percentage Error) calculation method. MAPE is the average of the overall percentage of error between actual data and predictive data. To calculate the MAPE value, there is a formula or equation:

$$MAPE = \frac{1}{n}\sum_{i=1}^{n}\frac{|y - y^{*}|}{n}x100\%$$

In this study there are 14 input simulation data for the value of n, the value of y is the actual result data, and y * is the predictive data. Following is the calculation of the MAPE value for each result:

Table 4. Calculation.

No	*Y*= (True Value)	*y** = (Prediction Value)	$\frac{\|y - y^{*}\|}{n}x100\%$
1	323	355,86	16,43
2	111	150,75	19,875
3	179	182,55	1,775
4	200	174,6	12,7
5	429	367	31
6	245	169,83	37,585
7	227	181	23
8	191	185,73	2.635
9	228	171,42	28,29
10	223	188,91	17,045
11	308	327,24	9,62
12	360	271,59	44,205
13	190	182,55	3,725
14	305	349,5	20,45
	$\frac{1}{13}\sum_{i=1}^{13}\frac{\|y - y^{*}\|}{n}x100\%$		268,335

MAPE calculation process for all data:

$$MAPE = \frac{1}{13}\sum_{i=1}^{13}\frac{|y - y^{*}|}{n}x100\%$$
$$= \frac{268{,}335}{14}x100\%$$
$$= 19.17\%$$

The results of the calculation of MAPE (Mean Absolute Percentage Error) in this study are, 19.17%.

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