Implementation Fuzzy Weighted Product Preparation Post Disaster Reconstruction and Rehabilitation Action based Dynamics Decision Support System

Agung Teguh Wibowo Almais[1], Fatchurrohman[1], Khadijah Fahmi Hayati Holle[1], Kurnia Siwi Kinasih[1], Dyah Ayu Wiranti[1] and Septian Yustina Yasin[1]

[1]*Informatics Engineering State Islamic University Maulana Malik Ibrahim Malang, Indonesia*

Keywords: Decision Support System Dynamic; Fuzzy-Weighted Product; pattern data; test data; Surveyor

Abstract: The preparation of post-disaster reconstruction rehabilitation action is conducted to determine the level of damage and loss of post-natural disasters that must be handled by the government. In order to prevent the level of post-disaster damage and loss in accordance with the conditions in the field then conducted research implementing Decision Support System Dynamic (DSSD) using the method of Fuzzy-Weighted Product (FWP). The Decision Support System Dynamic (DSSD) is the development of the latest Decision Support System (DSS) model, while Fuzzy is an algorithm for determining the level of importance of each criterion used in the Weighted Product method. Whereas Weighted Product is used as a system pattern data formation. The result is a test of the confusion matrix value of the pattern data calculated using the FuzzyWeighted Product (F-WP) method compared to the different test data. The results of the test resulted in three different types of data i.e. the same test data as the pattern data, the test data not the same as the pattern data, and the test data that could not be flown for testing. Each of these types of test data has a percentage of 73% of the same test data like the pattern data, 22% of test data is not equal to the pattern data, and 5% is data that can not be used as test data. From the results of the test can be concluded that the method Fuzzy-Weighted Product (F-WP) can be applied to the Decision Support System Dynamic (DSSD) to assist surveyors in the preparation of the rehabilitation of post-disaster reconstruction action.

1 INTRODUCTION

Determination of the level of damage and loss of the post-disaster sector is the action for the preparation of rehabilitation and post-disaster reconstruction. This activity is one of the things that must be done by one of the teams in the Regional Disaster Management Agency (BPBD), which is the planning and Control Team (P3B) to determine the level of loss and damage to the sector Affected by natural disasters, knowing the level of loss and damage will be easy in drafting the rehabilitation action and postdisaster reconstruction to determine the amount of assistance that should be channeled to victims affected by the disaster nature (Almais et al., 2016).

In his research (Oetari, 2014) explained that to determine the level of damage and damage to the sector due to natural disasters is to use a reference called the Economic Commission for Latin America and the Caribbean (ECLAC). The journal has also been explained that ECLAC has been used by the Indonesian government to calculate losses and damage to earthquakes in Yogyakarta's special region in 2006 and tsunami in special regions of ACEH. At ECLAC there are references to how to determine the level of loss and breakdown of postdisaster sectors. The current Problem is how the ECLAC is applied easily at the time of the surveyors at P3B conducted an assessment of the level of loss and damage to the post-disaster sector. Problems can be solved by implementing Information Technology (IT). One of the areas in IT can help the problem is the Decision Support System (DSS). According to (Suryadi and Ramdhani, 2000) in his book mentioned that to do research on the Decision Support System Many requirements that must be met, including the problems discussed must have a high scientific level and semi Structured.

With the development of the DSS era developed into a dynamic system with the term Decision Support System Dynamic (DSSD). Decision Support System (DSSD) has a difference with the Decision Support System (DSS), which is the Decision Support

Almais, A., Fatchurrohman, ., Holle, K., Kinasih, K., Wiranti, D. and Yasin, S.
Implementation Fuzzy Weighted Product Preparation Post Disaster Reconstruction and Rehabilitation Action based Dynamics Decision Support System.
DOI: 10.5220/0009909002720277
In *Proceedings of the International Conferences on Information System and Technology (CONRIST 2019)*, pages 272-277
ISBN: 978-989-758-453-4

System (DSS) that does not change the system that is already running when adding criteria and alternatives. With the concept of Decision Support System dynamic (DSSD), the Decision Support System Dynamic (DSSD) is suitable if applied to help the Government (P3B) in conducting the assessment of loss rate and damage to the postdisaster sector due to standard The criteria used to do so will someday increase or less depending on government policy. At this time the standard criteria to conduct an assessment of the level of loss and damage post-natural disasters using standard criteria from the Public Works office on criteria to determine the home or building earthquake resistant natural disasters. These criteria are 1). State of Building 2). State of the building structure 3). The physical state of the building is damaged by 4). Building function 5). Other supporting conditions (Almais et al., 2016).

These criteria can be used to build a Decision Support System Dynamic (DSSD) because one of the requirements for building a Decision Support System (DSS) is to have an alternative, criteria, and level of importance. These criteria have a level of interest each depending on the type of cautiousness. In previous research (Suhada et al., 2018) explained that the Fuzzy-Weighted Product method is used as the Decision Support System (DSS) Determination of the customer in obtaining credit in a BPR. The Fuzzy in the journal is used as a level of importance (weight) of each criterion converted to a crisp number. Because the criteria used have different levels of importance depending on the type of criticism, the level of importance can be converted to a crisp number using the Fuzzy method (Kusumadewi et al., 2006). Based on the research, it applied the fuzzy-weighted product method to determine the level of loss and damage to the old post-disaster sector that will be used as a rehabilitation and reconstruction action of post-disaster.

The fuzzy result is used as a scale for the Weighted Product (WP) method in order that each criterion has its own scaling scale depending on the criteria. Then the result of the WP method will be saved to make the system data pattern to become a reference surveyor in determining the damage and loss of the post-disaster sector. To test the accuracy level of the Decision Support System Dynamic (DSSD) system, you can use the method of Confusion matrix in which there is recall, precision, f-measure, and accuracy.

2 STATE OF THE ART

In the journal (Suhada et al., 2018) The fuzzy use of the weighted product method is found at the level of importance (weight) of each criterion using crisp numbers resulting from the conversion of fuzzy numbers. The result of the fuzzy number conversion is crisp numbers using reasoning theory where numbers close to number 1, the higher the dependency rate.

According to (Kusumadewi et al., 2006) method, the weighted Product is the classic formula of the Multi-Criteria Decision Making method. To develop these methods need to be developed with the addition of a fuzzy method so that the Multi-Criteria Decision Making (Weighted Product) method can distinguish the use of the assessment scale of each criterion that corresponds to each criterion.

Weighted Product is one of the solution models on the problem FMADM (Fuzzy Multi-Attribute Decision Making), this method evaluates several alternatives to a set of criteria whereby each criterion interdependent one with Others (Suhada et al., 2018).

Weighted Product method requires normalization process because this method multiplies the judgment result of each criterion, the multiplication result is not meaningful if not compared (divided) with the default value. The importance of the criteria serves as a positive rank in the multiplication process, while the cost weight serves as a negative rank (Suhada et al., 2018).

1. Advantages and disadvantages Weighted Product like an analytical method, Weighted product also has an advantage in the analysis system that can provide value of cost and benefit to the value of each. But having weaknesses is only used in the process of values that have a range value.
2. Stages Weighted Product The stages in the calculation of the weighted product method include a) multiplying the entire attribute for all alternatives with weights as a positive rank for the cost attribute. b) The multiplication result is sum to generate value on each alternative. c) Divide the value of V for each alternate with value on each alternate. d) found the best alternative sequence that will be the decision of the calculation of vector V then carried out the alignment sorted from vector value V of the largest value to the smallest and the largest vector value V (Vi) is the alternative Ai Elected to the best. Preference for Ai alternatives using equations (1):

$$S_i = \prod_{j=1}^{n} X_{i_j}^{w_j} \tag{1}$$

While the Σ WJ = 1 and WJ is a positive value rank for the attribute of profit and negative value to the cost attribute. The relative presentation of each alternative uses the following equation (2) (Nofriansyah, 2014):

$$V_i = \frac{\prod_{j=1}^{n} x_{i_j}^{w_j}}{\prod_{j=1}^{n} (x_j^i)^{w_j}} \qquad (2)$$

3 RESEARCH METHODS

In this research, there are two types of data, namely pattern data and test data. Pattern data is used to form a data pattern using the Fuzzy-Weighted Product (F-WP) method, while test data is used to test built-in pattern data. The pattern data is the result of the breakdown of Fuzzy-Weighted Product (F-WP), using the damage and loss data of the East Java provincial disaster in 2010-2013. The result of the pattern data is a result of the damage and loss of each sector (damaged, mild, moderate and severely damaged).

The result of the pattern data will be tested using damage and loss data after the East Java provincial disaster in 2018. For test data only use the criteria and assessment of each criterion to get the result of the type of damage and loss of each sector (damaged light, moderate damage, and severely damaged). The result of the test data will be searched in the pattern data already created. For more details on how to find or match test data with existing pattern data in the system, see the following figure 1:

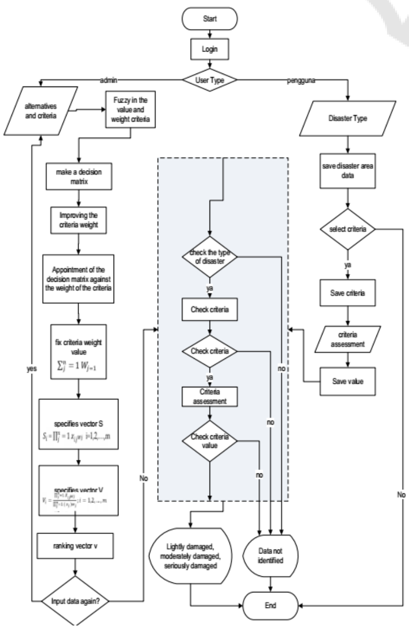

Figure 1: System flows

4 RESULTS AND DISCUSSION

4.1 RESULT

4.1.1 Modeling Systems

The Model weighted product uses multiplication to meet the rating of the criteria, where the rating of each criterion should be attached to the corresponding weights. This process is similar to the normalization process, in this case, the weighted product method is used to determine the level of loss and damage of sectors affected by natural disasters. The result of a weighted product method will be stored in a data store for use as pattern data.

The first phase of the admin to input cases using existing criteria is the building state, the state of the building structure, the physical state of the building is damaged, building functions, and other supporting conditions. The second stage gives a level of importance to each of these criteria.

The third stage gives each of these criteria based on the alternatives that are lightly damaged, medium damaged, and heavily damaged. The fourth stage of the Decision Support System Dynamic (DSSD) will automatically process the case and will result in a number of alternatives. The fifth stage tests the resultant from step four above with data that has the same characteristics. The sixth stage gets the result that is wanted by the user (*surveyor*).

4.1.2 The System Needs Analysis

The need for information on the Decision Support System Dynamic (DSSD) in preparation for rehabilitation and reconstruction action is: the state of the building (C1), the state of the building structure (C2), the physical state of the building is damaged (C3), the function of the building (C3), and Other supporting conditions (C4).

From each of these criteria, determined the weight. This weight is then used for the calculation of the Weighted Product (WP) model. The weight used is a Fuzzy number that can be converted to a crisp number. The determination of the number is crisp using reasoning theory where numbers close to 1, the higher the dependency rate. Conversely, if the number approaches 0, the dependency rate is getting lower.

There are five criteria used to determine the level of damage and damage to the post-natural disaster sector according to the journal (Almais et al., 2016) namely:

No	Criteria Name
1	Building conditions
2	State of the building structure
3	The physical condition of buildings damaged
4	Building functions
5	Other supporting conditions

Figure 2: Data criteria.

Each criterion in table 1 above has its own scale. By using the fuzzy then the scale of each criterion can be determined by converting the existing fuzzy number to crisp numbers on each criterion in Figure 2 above.

a Building state assessment Scale
For the criteria of the state of the building has three types of valuation scale is still standing, tilt and collapse Total. Each scale of the assessment limit has its own value. To scale the rating still stand has a value of 0-0.33, for the tilt Rating scale has a value of 0.33 – 0.66 and for a Total Robot rating scale has a value of 0.66 – 1. More details can be seen in Figure 3 below.

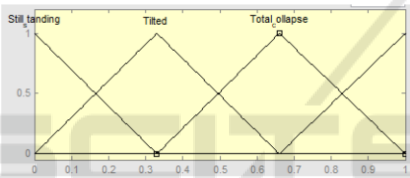

Figure 3: Scale of the building State assessment

b Building structure State Assessment scale
For the criteria of the state of the building, structure has three types of valuation scale IE small partly damaged light, partly damaged and most damaged. Each scale of the assessment limit has its own value. To scale a small portion of the light damaged assessment has a value of 0-0.33, for the scale of the scoring the damaged part has a value of 0.33 – 0.66 and for the scale of the assessment most damage has a value of 0.66 – 1. More details can be seen in Figure 4 below.

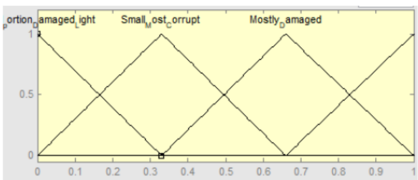

Figure 4: of the building structure State assessment scale

c The large scale of damaged building conditions
The criteria of the big damaged building conditions have three types of assessment scale is < 30%, 30-50%, and > 50%. Each scale of the assessment limit has its own value. To scale the assessment of the< 30% has a value of 0-0.33, for a rating scale of 30-50% has a value of 0.33 – 0.66 and for the rating scale > 50% has a value of 0.66 – 1. More details can be seen in Figure 5 below.

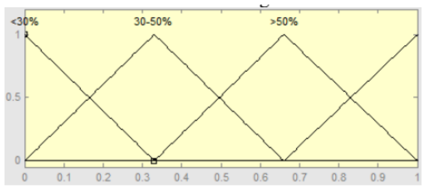

Figure 5: Scale assessment of large damaged building conditions

d Building function Valuation Scale
For the criteria, building function has three types of assessment scale is harmless, relatively dangerous and harmful. Each scale of the assessment limit has its own value. The scale of the harmless rating has a value of 0-0.33, for the relative hazard rating scale has a value of 0.33 – 0.66, and for the scale of hazardous assessments has a value of 0.66 – 1. More details can be seen in Figure 6 below.

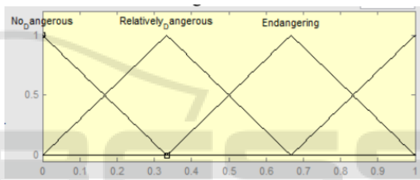

Figure 6: of the building function rating Scale

e Other supporting state assessment scales
For the criteria of the large damaged building conditions have three types of grading scales that are partially damaged, mostly damaged and damaged in Total. Each scale of the assessment limit has its own value. For the assessment scale, the damaged part has a value of 0-0.33; for the scale of the assessment, most damage has a value of 0.33 – 0.66, and for the scale of Total damage assessment has a value of 0.66 – 1. More details can be seen in Figure 7 below.

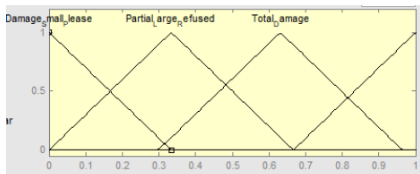

Figure 7: Other supporting conditions assessment scale

The above scale is used to perform assessments and weight for each criterion. If implemented in the form of a system like Figure 8 below:

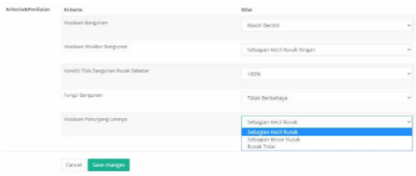

Figure 8: Fuzzy-Weighted Product (F-WP) implementation

4.2 DISCUSSION

After the stage of the design entity relational diagram and implementation in programming to create data patterns and test data, then the next step is to test the system using the calculation of the confusion matrix.

4.2.1 Testing Fuzzy-Weighted Product (F-WP)

The formation of data patterns on the *Decision Support System* (DSS) uses the Fuzzy-Weighted Product (F-WP) method. The pattern data will be tested using test data to test the role in the pattern data. Test pattern data will be done three times the experiment with the test data type used the same but different content from the data. Figure 9 is a description of the data composition used for pattern data and test data. The test data used is the data on the damage after the East Java provincial disaster in 2010. While the pattern data uses post-disaster data in East Java province 2010-2019.

Method	Pattern Data	Test Data		
	Amount of Data	Case I	Case II	Case III
		373 data	77 data	24 data
F-WP	36	146	28	12

Figure 9: Data Composition.

Each trial will result in a rule and calculation of a confusion matrix. From some experiments, there is the same rule, so that if the test data used is always the same then the precision, recall, f-measure, accuracy, and response time values are also the same. It can be seen in the results of 1st, 2nd, and 3rd experiments. The similarity of precision value, recall, f-measure, accuracy, and response time of some experiments is caused because the pattern data used produces the same pattern of rules, and the test data used is also the same. In summary, test results can be seen in Figure 10.

Testing method	Trial			Average
	1	2	3	
Precision	56.50%	52.80%	50%	53.1%
Recall	50.50%	36.30%	50%	45.6%
Accuracy	53.30%	43.02%	50%	48.7%
F-Measure	39.10%	36.30%	50%	41.8%
Respon Time	730 sec	140 sec	60 sec	310 sec

Figure 10: Test Results Fuzzy-Weighted Product (F-WP) Method.

Based on Figure 10, it is known that the more pattern data used will be more likely to be, the greater the value of precision, recall, f-measure, and accuracy generated. With the greater value of precision, recall, f-measure, and accuracy are generated, the method used is better. Therefore, by using the testing in Figure 10 above, shows the performance of the Fuzzy-Weighted Product (F-WP) method is good and suitable for determining the damage and loss of post-disaster settlement. To explain the test results of the Fuzzy-Weighted Product (F-WP) method can be seen in Figure 11, it illustrates the percentage results between precision value, recall, F-measure, and accuracy. While in Figure 9 is a graph for the test time response from the Fuzzy-Weighted Product (F-WP) method.

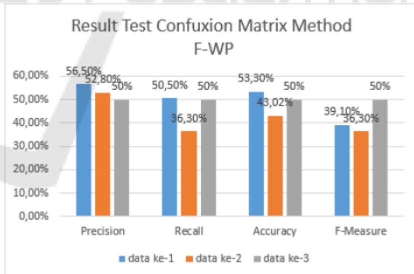

Figure 11: Test Results of The Fuzzy-Weighted Product (F-WP) Method

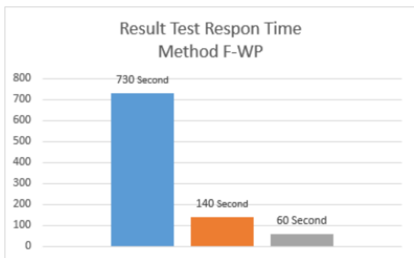

Figure 12: Response Time Test Results of the Fuzzy-Weighted Product (F-WP) Method

5 CONCLUSIONS

Based on the results of the tests that have been done, it can be concluded that the Fuzzy-Weighted Product (F-WP) method can be implemented on the Decision Support System (DSS) to determine the damage and losses of the post-disaster housing well. Since testing the pattern data done using three different test data can result in better data based on precision, recall, f-measure, and accuracy values. But for relaxation time, the method fuzzy-weighted product (F-WP) the more data, the longer because in the method of the fuzzy-weighted product (F-WP), there are measures negation of weights, aggregation of criteria and aggregation of experts. Therefore, the more pattern data used in the Fuzzy-Weighted Product (F-WP) method, The longer the response time as each incoming data will be searched for the negative weight, the critical aggregation, and the Expectation aggregation using the method FuzzyWeighted Product (F-WP). So for further research can use more test data to get better precision, recall, f-measure, and accuracy values. And it can also be developed using the other Fuzzy-Weighted Product (F-WP) methods or Machine Learning methods to get even better relaxation time results.

REFERENCES

Almais, A. T. W., Sarosa, M., and Muslim, M. A. (2016). Implementation of multi experts multi criteria decision making for rehabilitation and reconstruction action after a disaster. *MATICS*, 8(1):27–31.

Kusumadewi, S., Hartati, S., Harjoko, A., and Wardoyo, R. (2006). Fuzzy multi-attribute decision making (fuzzy madm). *Yogyakarta: Graha Ilmu*, pages 78–79.

Nofriansyah, D. (2014). Concept of data mining vs decision support system. *Yogyakarta: Deepublish*.

Oetari, F., J. S. Y. . N. A. (2014). Pengembangan sistem informasi penilaian kerusakan dan kerugian bencana menggunakan metode eclac (economic commission for latin american and carribean)(studi kasus erupsi gunung merapi 2010 di kab. boyolali).

Suhada, S., Hidayatulloh, T., and Fatimah, S. (2018). Penerapan fuzzy madm model weighted product dalam pengambilan keputusan kelayakan penerimaan kredit di bpr nusamba sukaraja. *JUITA: Jurnal Informatika*, 6(1):61–71.

Suryadi, K. and Ramdhani, M. (2000). Decision support system: A structural discourse of idealization and implementation of the concept of decision making. *Teen Rosdakarya*, 7.