Acceptance Letter

2019 International Conference on Electrical, Electronics, Mechatronics, Informatics, And Vocational Education (ICE-ELINVO) 2019

Yogyakarta, Indonesia | September 14, 2019
http://ice-elinvo.uny.ac.id/

Paper ID: 322.ICE-ELINVO

Paper Title:

Implementation of Web-Based Weighted Product Use Decision Support System to Determine the Post-Disaster Damage and Loss.

Dear Ms. Aniqoh Bachriwindi,

With heartiest congratulations, I am pleased to inform you that based on the recommendations of the reviewers and the Technical Program Committees, your paper identified above has been accepted for Oral Presentation and Publication by 2019 **International Conference on Electrical, Electronics, Mechatronics, Informatics, and Vocational Education (ICE-ELINVO) 2019**.

Your paper will be published in Journal of Physics Conference Series (JPCS) published by IOP Publishing Series (Scopus indexed).

Herewith, the conference committee sincerely invites you to come to present your paper at ICE-ELINVO 2019 on September 14, 2019 at Eastparc Hotel, Yogyakarta, Indonesia.

Deadline Revised Paper	: 30 August 2019
Deadline Payment	: 5 September 2019

For more information on the conference, please check the ICE-ELINVO website at: http://ice-elinvo.uny.ac.id/.

Yours sincerely,

INTERNATIONAL CONFERENCE ELECTRICAL ELECTRONICS INFORMATICS AND VOCATIONAL EDUCATION ICE - ELINVO

Organizing Chair
ICE-ELINVO 2019

Implementation of Web-Based Weighted Product Use Decision Support System to Determine the Post-Disaster Damage and Loss

Aniqoh Bachriwindi [1], Erwin Kristian Putra [2], Umi Madinatul Munawaroh [3], Agung Teguh Wibowo Almais [4]
[1,2,3] Student, Department Informatics Technology, UIN Maulana Malik Ibrahim Malang
[4]Lecture, Department Informatics Technology, UIN Maulana Malik Ibrahim Malang
Email [1]: aniqohbachriwindi@gmail.com
Email [2]: erwindchristian@gmail.com
Email [3]: umi.madinatul@gmail.com
Email [4]: agung.twa@gmail.com

Abstract. Determination of damage and losses after natural disasters is carried out to determine the type of damage and the amount of loss after natural disasters that must be borne by the government. In order for the type of damage and the magnitude of the loss after natural disasters according to the data in the field, a study is carried out that implements the Decision Support System (DSS) with the Weighted Product (WP) method. The results obtained are tests of pattern data which are calculated using Weighted Product (WP) compared to 3 different test data, namely using damage and loss data after the natural disaster in East Java in 2010, 2011. The results of the 3 test data used the first amount of 373 data, which produces precision 56.50%, recall 50.50%, accuracy 53.30%, and f-measure 39.10%. For the second data using the data 77, which produces precision 52.80%, recall 36.30%, accuracy 43.02%, and f-measure 36.30%. And for the third data using data from data 24, which produces 50% precision, 50% recall, 50% accuracy, and 50% f-measure. From the 3 types of test data used can be concluded that the Weighted Product (WP) method has a high level of precision, f-measure, recall, and accuracy if the amount of data used is increasing.

Keyword: DSS, WP, precision, recall, accuracy, f-measure.

1. Introduction

Natural disasters are phenomenon caused by events or a series of events caused by nature, including earthquakes, tsunamis, volcanic eruptions, floods, droughts, hurricanes, and landslides [1]. There are 3 natural disaster managements in Indonesia, namely mitigation (prevention before natural disasters), during natural disasters, and post natural disasters. In Law 27 of 24 regarding to Disaster Management and Presidential Regulation number 8 of 2008 regarding to the National Disaster Management Agency, post-disaster handling includes emergency response, reconstruction rehabilitation, and sustainable development. This research is focused on post-disaster on the rehabilitation and reconstruction of the settlement sector.

The success of the "*Perencanaan dan Pengendalian Penanganan Bencana* (P3B)*"* Team in the post-disaster recovery program is largely determined by the planning of good recovery from accurate data and information. The number of problems in the field is caused by data inaccuracies. This is happened because when the initial data collection criteria used by the surveyors in the field are perceived to be different so that the categorization of existing data is different. Thus, a problem arises and the disaster data that goes to the Provincial BPBD is different from the situation in the field since the data criteria for the preparation of post-disaster rehabilitation and reconstruction actions used by each surveyor are perceived to be different.

From the identification of the above problems, a system is needed to assist the surveyor team in the process of preparing post-natural disaster rehabilitation and reconstruction actions. The use of a system equipped with a decision support system is expected to accelerate the surveyor team in processing the post-natural disaster rehabilitation and reconstruction actions, and can improve accuracy in obtaining the right results. [2]

One of the Decision Support System (DSS) models used to determine the level of damage and loss of post-natural infrastructure requires research and development of a decision support system that uses the Weighted Product (WP) method. This system is expected to be a decision support tool for related parties, specifically for surveyors from the P3B team in planning post-disaster rehabilitation and protection actions as a basis for decisions to assist surveyors in determining the types of damage and losses after natural disasters into the category of “Severe Damage” ,” Moderately Broken” , and ” Lightly Broken”.

2. State of the Art

2.1. Decision Support System (DSS)

To create a dynamic and real-time irrigation management system, an irrigation management system is created using a web-based Decision Support System (DSS). According to [3] Web-based, Decision Support System (DSS) can be a solution to manage irrigation channels in large areas. The results obtained from managing the slice channel system using a web-based Decision Support System are the acquisition of data and data detection functions, real-time irrigation estimates, dynamic water allocation decisions, and irrigation information management.

From the journal [4] it was explained that a Decision Support System (DSS) could be used for scheduling emergency ambulances. There are two criterias used for the emergency ambulance scheduling system (DSS), namely the average response time and the percentage of ambulance requests that are responded to within 15 minutes. It is explained in this journal that two criterias are ignored in traditional ambulance delivery since the traditional scheduling, those two criterias are very dynamic depends on time and other parameters.

2.2. Metode Weighted Product (WP)

[5] WP is a finite set of alternative decisions which is explained in terms of several criteria decision. Weighted Product Method or commonly called WP is one of the Decision Support System (DSS). This method is used to make a decision by considering criteria and weight. The Weighted Product (WP) method is also called dimensionless analysis since its solution uses a mathematical structure that removes the measurement unit of objects in a data. In its completion, the Weighted Product (WP) method uses multiplication to connect the attribute rating. Each attribute rating is raised first with the weight of the attribute in question (such as the normalization process). Formula:

$$\boldsymbol{S_I = \prod_{j=1}^{n} X_{i_j}^{w_j}} \qquad (1)$$

Preferences for alternative S are given as follows:

S : Alternative preference is analogous to vector S
X : Criteria value
W : Criteria weight / sub-criteria
I : Alternative with i = 1, 2,..., n;
J : Criteria
N : Number of criteria

2.3. Natural Disaster

Disaster management activities are usually focused only on one activity such as evacuation, logistics, or coordination and only limited to one specific activity such as natural disaster response or disaster alertness. According to [6] the research is to find a solution, in order that disaster management activities

do not only focus on one specific activity, a Decision Support System is needed to handle all disaster management activities. This Decision Support System (DSS) requires an adequate representation of knowledge because the results presented differ according to stakeholder needs in the decision-making process.
In the journal [7] it is explained that the Decision Support System (DSS) can be used to evacuate fire victims. The journal describes the development of the Supplies Decision fire evacuation system which is integrated with social media, census surveys, Geographic Information System (GIS) data, voluntary advice, and remote sensing data. The integration is based on a variety of scientific and multi-disciplinary experts in the fields of expertise including civil engineering, computer science, geographic information systems, transportation, social media, and communication. To develop an integrated Decision Support System (DSS) fire evacuation, four core modules are needed: dynamic population estimation, stage-based strong evacuation planning, social perception analysis, and web-based geomatics analytic platforms.

3. Research Methods

3.1. System Architecture

Figure I shows the relationship between the components of the Decision Support System (DSS) and the problems that occur in the system. In the component parts of the Decision Support System (DSS) it is divided into four environments, namely database management, knowledge base, engine, and interface. The database contains data used for pattern data and test data in the system. The knowledge base contains all knowledge from libraries or from related parties. The engine is described as two parts; the first one is the Weighted Product (WP), which is included to a Decision Support System (DSS) method. This engine interacts with interface components that contain input and output data.

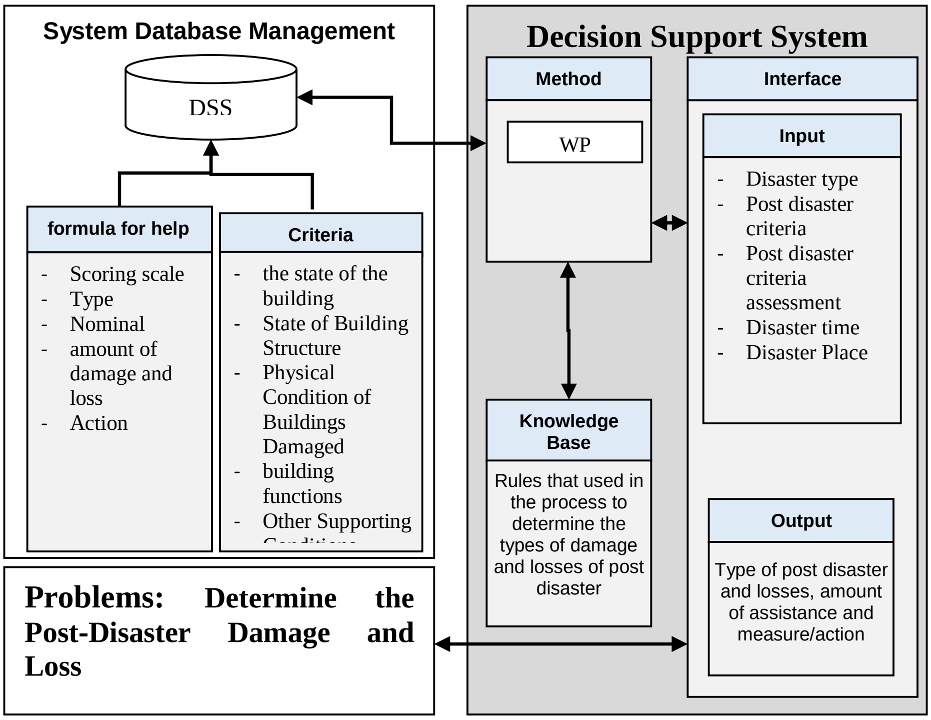


Figure I Architecture System

3.2. Weighted Product as Pattern Forming Data

According to Yoon ***[8]*** the weighted product method uses multiplication techniques to connect the attribute rating, where the rating of each attribute must be raised first with the weight of the attribute in inquiry. The first step to create pattern data is by determining the criteria. After getting the criteria, the next step is to determine the compatibility rating . Then normalize the weight. After getting the normalized value from the weight, determine the value of vector S and the value of vector V. The last is the vector V value ranking.

$$\sum_{j}^{n} = 1 \; W_{j=1} \qquad (2)$$

$$S_i = \prod_{j}^{n} = 1 \; x_{ij} w_j \quad i=1,2,\ldots,m \qquad (3)$$

$$V_i = \frac{\prod_{j}^{n}=1 \; X_{ij} w_j}{\prod_{j}^{n}=1 \; (x_j) w_j}; i = 1,2,\ldots,m \qquad (4)$$

3.3. Data flow on the System

In general, the forming components of the Decision Support System (DSS) include alternatives, criteria, weights and values. Each component has its own purpose. Alternatives are used for output or results from the Decision Support System (DSS) as in table III. Whereas criteria is requirements or assessment components to achieve an alternative as in table II, while weights are the importance of each criterion as in table III , and value is an assessment of each criterion.

Table I Alternative

No.	**Alternative**
1.	Light Damage
2.	Moderate Damage
3.	Heavy Damage

Table II Criteria Data

No	**Criteria**
1	Building’s state
2	Building structure's state
3	Physical Condition of Damaged Building
4	Building’s Functions
5	Other Building Conditions

(Source: BPBD Jawa Timur, tahun 2010, 2011, 2013 and Data Direktorat Jenderal Cipta Karya, DPU, 2006, Pedoman Teknis Rumah dan Bangunan Gedung Tahan Gempa Data)

Table III Damage and Value Level Scale

No.	**Criteria**	**Scale of Interest**	**Scale Rating**
1.	Building’s state	Light	Standing
		Moderate	Sloping
		Heavy	Collapsed
2.	Building structure's state	Light	A small part of the building was lightly damaged
		Moderate	A small part of the building is damaged
		Heavy	Most buildings are damaged
3.	Physical Condition of Damaged Building	Light	< 30%
		Moderate	30-50 %
		Heavy	> 50%
4.	Building’s Functions	Light	No danger

No.	Criteria	Scale of Interest	Scale Rating
		Moderate	relatively dangerous
		Heavy	Danger
5.	Other Building Conditions	Light	A small part of the building is damaged
		Moderate	Most buildings are damaged
		Heavy	Totally damaged

This study uses the Weighted Product (WP) method that is used as an engine in the system. The test will use two types of data, namely pattern data and test data. Pattern data is data that is processed using the Weighted Product (WP) method. If the pattern data has been formed, the user is easier to use this system. While the data test is data that is input by the user (user) to get the results in the pattern data. Users only enter the type of disaster, criteria and criteria values to get the expected results. So users don't use weights to look for expected results, weights are obtained from pattern data based on data entered by the user. As in Figure II which illustrates the flow of the system.

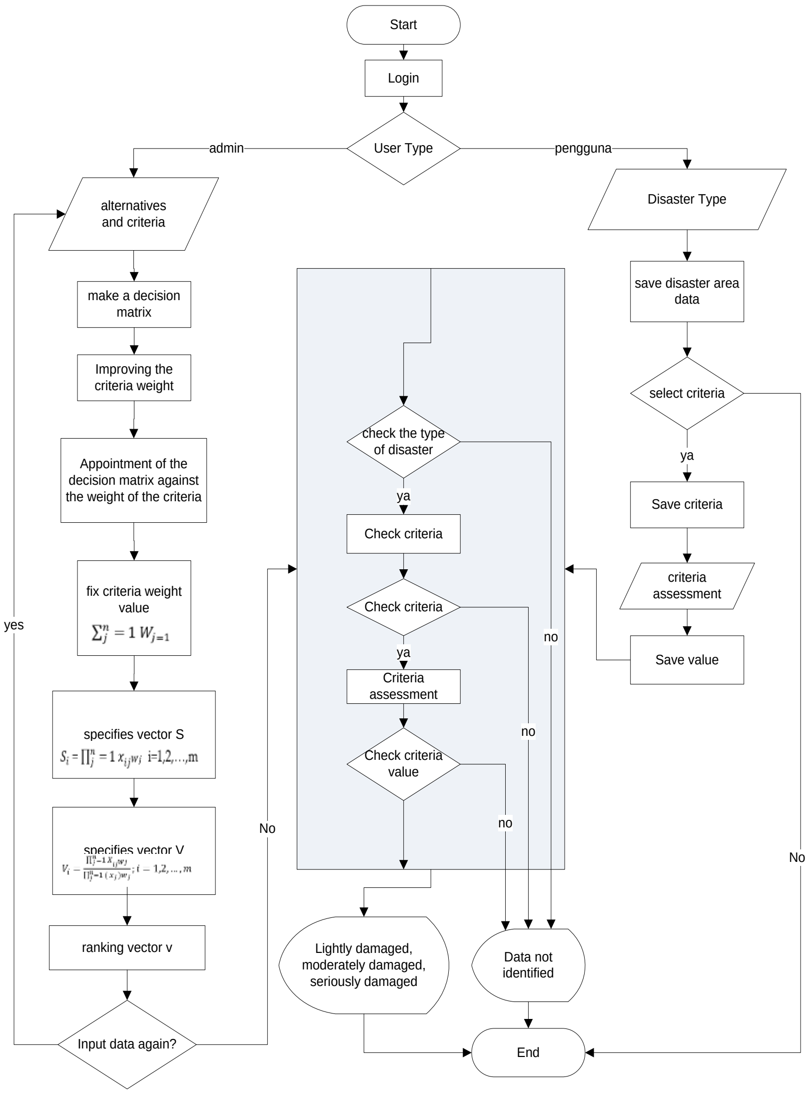


Figure II. System Flow

3.4. System Design

To make a system, first we have to analyze the needs and existing systems. From the results of the analysis, it will be normalized into a 1NF database design by removing duplicate columns from the same table and creating separate tables for each group of related data and identifying each row with a unique column (primary key).

After the normalization results of 1NF is gained, further it will be normalized to 2NF by deleting some subset of data in the table and placing them in separate tables, creating relationships between new tables and old tables by creating foreign keys, and no attributes in tables that functionally depend on the candidate key table. After that, the third step is 3NF normalization which is fulfilling what is in normalization 2NF and deleting columns that are not dependent on the primary key. The results of 3NF can be seen in Figure III which illustrates the relationship between tables in the Entity Relational Database (ERD).

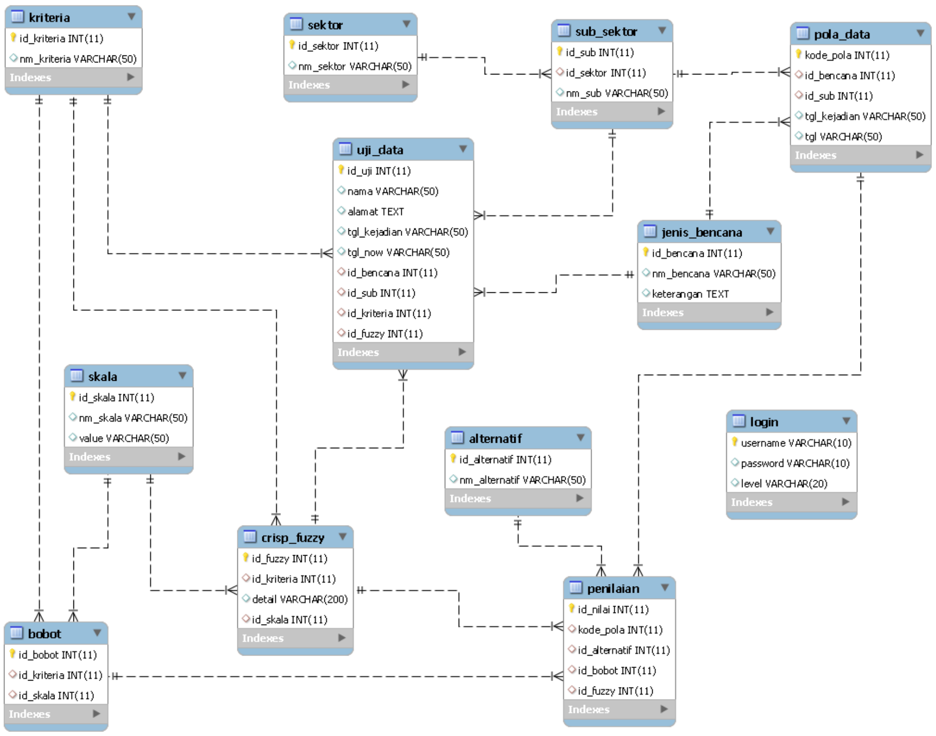
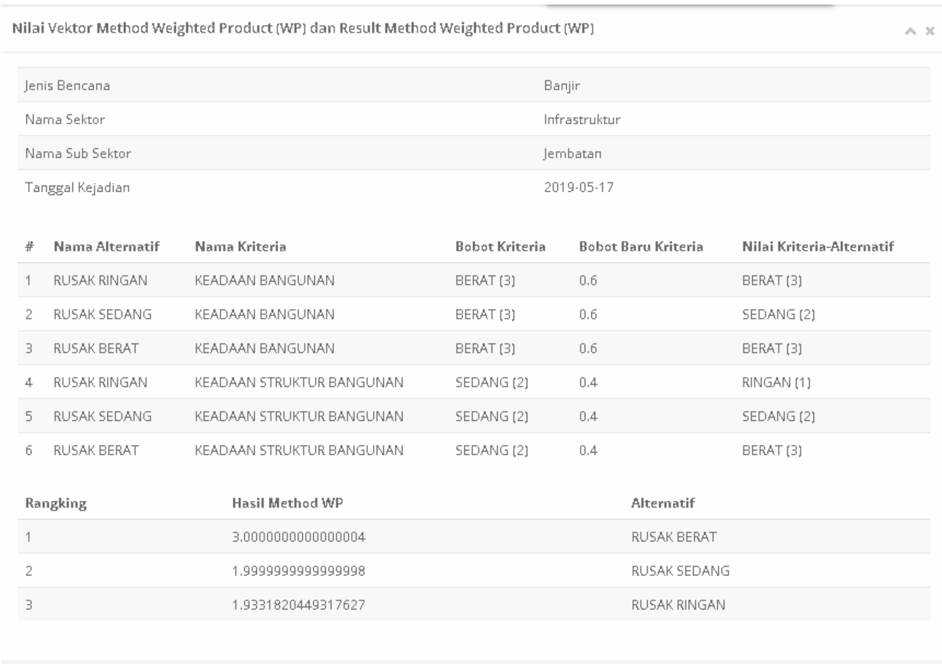


Figure III Entity Relational Database (ERD)

The results of implementing the above Entity Relational Database (ERD) can be seen in Figure IV which describes the process of the Weighted Product (WP) method that has been implemented in a web-based Decision Support System (DSS). In Figure IV, there are steps to calculate the Weighted Product (WP) equations.



Nilai Vektor Method Weighted Product (WP) dan Result Method Weighted Product (WP)

Jenis Bencana	Banjir
Nama Sektor	Infrastruktur
Nama Sub Sektor	Jembatan
Tanggal Kejadian	2019-05-17

#	Nama Alternatif	Nama Kriteria	Bobot Kriteria	Bobot Baru Kriteria	Nilai Kriteria-Alternatif
1	RUSAK RINGAN	KEADAAN BANGUNAN	BERAT (3)	0.6	BERAT (3)
2	RUSAK SEDANG	KEADAAN BANGUNAN	BERAT (3)	0.6	SEDANG (2)
3	RUSAK BERAT	KEADAAN BANGUNAN	BERAT (3)	0.6	BERAT (3)
4	RUSAK RINGAN	KEADAAN STRUKTUR BANGUNAN	SEDANG (2)	0.4	RINGAN (1)
5	RUSAK SEDANG	KEADAAN STRUKTUR BANGUNAN	SEDANG (2)	0.4	SEDANG (2)
6	RUSAK BERAT	KEADAAN STRUKTUR BANGUNAN	SEDANG (2)	0.4	BERAT (3)

Rangking	Hasil Method WP	Alternatif
1	3.0000000000000004	RUSAK BERAT
2	1.9999999999999998	RUSAK SEDANG
3	1.9331820449317627	RUSAK RINGAN

Figure IV Implementation Result of Weighted Product Method

4. Results and Discussion

After the stages of designing entity relational diagrams and implementation in programming to create pattern data and test data, the next step is to test the system using confusion matrix calculations.

4.1 Testing Method Weighted Product (WP)

Data pattern formation in the Decision Support System (DSS) uses the Weighted Product (WP) method. The pattern data will be tested using test data to test the role of the pattern data. Pattern data testing will be carried out three times with the same type of test data used but different contents of the data. Table 4 is a description of the composition of the data used for pattern data and test data. The test data used is damage and loss data after the disaster in East Java province in 2010. While the pattern data uses post-disaster data in East Java province years 2010, 2011 and 2013.

Table IV Data Composition

Method	**Data**	**Testing Data**		
	Amount of data	**Case I**	**Case II**	**Case III**
		373 data	**77 data**	**24 data**
WP	36	146	28	12

Each experiment will produce a confusion matrix rule and calculation. From several experiments, there is the same rule, so that if the test data used is always the same then the value of precision, recall, f-measure, accuracy and response time are also the same. This can be seen in the results of the 1st, 2nd, and 3rd experiments. The similarity of the value of precision, recall, f-measure, accuracy and response time of some experiments is caused by the pattern data used to produce the same pattern of rules and the same test data used. In summary, the test results can be seen in Table V.

Table V Result Testing method *Weighted Product* (WP)

Testing Method	**Experiment**			**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%

4.2. Discussion

Based on the table V, it can be seen that the more pattern data used, the greater the value of precision, recall, f-measure, and accuracy. The greater the value of precision, recall, f-measure, and accuracy produced, the method used is getting better. Therefore by using the test in table 5 above, it shows the performance of the Weighted Product (WP) method to be used to determine the damage and loss of settlements after natural disasters. To explain the test results from the Weighted Product (WP) method can be seen in Figure 5 illustrates the percentage of the results of the comparison between the value of precision, recall, f-measure, and accuracy.

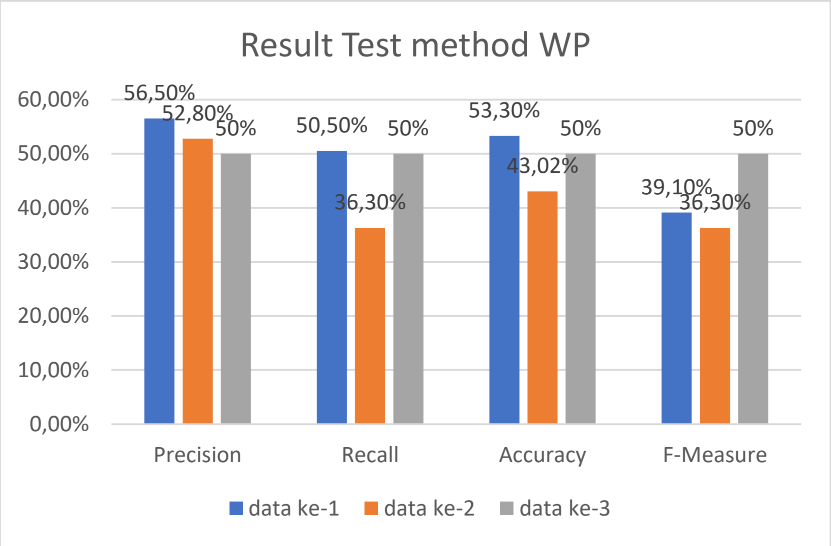


Figure V Test Result of Weighted Product Method

5. Conclusion

Based on the testing result that has been done, it can be concluded that the Weighted Product (WP) method can be implemented in the Decision Support System (DSS) to determine the damage and loss of housing after natural disasters properly since the testing pattern data carried out using three different test data can produce better data based on the value of precision, recall, f-measure, and accuracy. Thus, for further research more test data can be used in order to get better values of precision, recall, f-measure, and accuracy. It can also be developed using other types of Multi-Criteria Decision Making (MCDM) methods or Artificial Intelligent (AI) methods to get better precision, recall, f-measure, and accuracy results.

References

[1] P3B, Penilaian Kerusakan dan Kerugian, Jakarta, 2008.

[2] A. T. W. Almais, M. Sarosa and M. A. Muslim, "Implementation Of Multi Experts Multi Criteria Decision Making For Rehabilitation And Reconstruction Action After A Disaster," *Jurnal MATICS,* vol. 8, pp. 27-31, 2016.

[3] W. Wang, Y. Cui, Y. Luo, Z. Li and J. Tan, "Web-based decision support system for canal irrigation management," *Computers and Electronics in Agriculture*, pp. 1-10, 2017.

[4] L. Zhen, S. Sheng, Z. Xie and K. Wang, "Decision rules for ambulance scheduling decision support systems," *Applied Soft Computing,* pp. 1-7, 2015.

[5] Basri, "METODE WEIGHTD PRODUCT (WP) DALAM SISTEM PENDUKUNG KEPUTUSAN PENERIMAAN BEASISWA PRESTASI," 2018.

[6] D. I. Inan, G. Beydoun and B. Pradhan, "Developing a Decision Support System for Disaster Management: Case study of an Indonesia volcano eruption," *International Journal of Disaster Risk Reduction,* pp. 1-17, 2018.

[7] A. Nara, X. Yang, S. G. Machiani and M.-H. Tsou, "An Integrated Evacuation Decision Support System Framework with Social Perception Analysis andDynamic Population Estimation," *International Journal of Disaster Risk Reduction,* pp. 1-33, 2017.

[8] S. Kusumadewi, S. Hartati, A. Harjoko and R. Wardoyo, Fuzzy Multi-Attribute Decision Making (MADM), Yogyakarta: Graha Ilmu, 2006.

[9] R. Yager, "Non-numeric multi-criteria multi-person decision mak-ing," *Kluwer Academic Publishers,* p. 81 – 93, 1993.

[10] D. E. Kartika, W. A. P. Dania and R. L. R. Silalahi, "Analisis Elemen Kunci dan Alternatif Perbaikan Mutu Susu Pasteurisasi dengan Metode ISM dan Fuzzy ME-MCDM (Studi Kasus KUD DAU, Malang)," pp. 1-11, 2014.

[11] M. Noor-E-Alam, T. F. Lipi, M. A. A. Hasin and A. Ullah, "Algorithms for fuzzy multi expert multi criteria decision making (ME-MCDM)," *Knowledge-Based Systems,* pp. 367-377, 2010.

[12] R. A. Hadiguna, I. Kamil, A. Delati and R. Reed, "Implementing a web-based decision support system for disaster logistics: A case study of an evacuation location assessment for Indonesia," *International Journal of Disaster Risk Reduction,* pp. 38-47, 2014.

[13] N. Nurhasanah, "PENENTUAN PRIORITAS ALTERNATIF KEBIJAKAN SISTEM PRODUKSI BERDASARKAN PENDEKATAN NON NUMERIC MULTIEXPERTS MULTICRITERIA DECISION MAKING: STUDI KASUS PT X," *INASEA,* 2006.