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GIS-BASED DECISION SUPPORT SYSTEM FOR CASH WAQF DISTRIBUTION

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ABSTRACT

Gunung Kidul Regency of Indonesia has a problem with a massive number of former Migrant Women Workers (MWW) who live in poverty. Meanwhile, Indonesian people who are Muslim in majority have a huge potential to do cash waqf (a form of donation worship in Islam). The fund collected can be utilized for community empowerment, specifically former MWW to reach their financial independence. It needs a model to do cash waqf distribution so the fund can be right on target and by the needs of the community. A decision support system approach utilizing knowledge representation in an expert system is proposed in this research. The model built is implemented in the application with GIS-shaped visualization. The model and applications have been tested and were accepted by potential users, but further development is still required to be implemented.

Keywords: *DSS, GIS, Knowledge Representation, Cash Waqf*

1. INTRODUCTION

Gunung Kidul Regency is located in the province of Special Region of Yogyakarta which has a wide coastal area. The condition of barren land and the low level of education make Gunung Kidul declared as one region with a high poverty rate. Gunung Kidul is known as the highest number of migrant worker among regencies in Yogyakarta. Many women work as domestic servants as well as abroad. Women working overseas especially as maid or laborer are often referred as Migrant Woman Worker (abbreviated as MWW or TKW Tenaga Kerja Wanita in Bahasa Indonesia).

Some of the migrant workers earn significant income to build their family's economic life, but many also fail. Regardless of the success of these migrant workers, they have the same risks, namely torture and ill-treatment. Based on existing data in Dinsoskertrans Gunung Kidul, there are at least 373 cases that hit MWW from Gunung Kidul, and there is an increasing trend every year [1].

The high number of incidences of these migrant workers has prompted the Provincial Government of Yogyakarta Special Region (DIY) to take firm action by issuing a restrictive law and even prohibiting the sending of migrant workers abroad. The existence of the direction of the Governor of DIY which prohibits the sending of informal workers abroad since 2014 ago has been effectively proven. This was emphasized by the head of Dinsosnakertrans (Social Service of Manpower and Transmigration) that, since 2 years ago, Gunung Kidul has no longer given the permit to work abroad.

The problem rised as the most of returning migrant workers (former MWW) can only utilize their income for consumptive purposes. Their lack of education and skills makes them unable to manage their money for their future life.. As a result, when they return to Gunung Kidul they soon go back down into poverty life and intend to return as MWW. To overcome this problem, the local government has tried to find a solution so that the former MWWs can still improve their standard of living without having to become MWW again. Skills improvement and productive capitalization are the basic needs for the former MWWs.

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On the other hand, the population of Indonesia is predominantly Muslims. In Islamic teachings one of the ways of helping other people or society is by utilizing waqf. Wakaf is a legal act of a party (wakif) to give some of his properties to be used forever or for a certain period in accordance by the purposes of worship and/or general welfare according to sharia [2]. Waqf is widely used for religious endowments, such as the construction of mosques, mushala, graveyard and so forth [3]. On the other hand, for the purpose of empowerment - such as educational waqf, economic empowerment and welfare- has not been considered important by the community. The *wakif* usually simply give the land or school buildings to be managed by the waqf manager (*nazhir*). As a result, many Islamic educational foundations based on waqf can not survive because they can not afford the operational cost and do not have adequate productive resources.

Besides in the form of land, waqf can be carried on in the form of money or simply named as cash waqf. The *Nadzir*, that is zakat institutions previously existed in Indonesia, receive the waqf funds and manage the money for programs that are beneficial for the community. Cash waqf is usually developed into a productive project such as animal husbandry, industry or agriculture [4].

The law of cash waqf (cash waqf) is *sunnah* (recommended). When a Muslim (wakif) donates with a cash waqf transaction, he receives a reward from God that continues to flow even though he has died. In other words, cash waqf is very attractive and therefore has a very bright prospect to improve the welfare of Muslims [4] and can also be a potential alternative to solve the former MWW problem discused previously.

As a form of responsibility to hold the trust of waqf management, *nazhir* must be able to manage the waqf professionally and transparently. The legal basis that can be used in the management of wakaf in the form of money is Law No. 41 of 2004 on Wakaf and Government Regulation Number 42 of 2006 on Implementation of Law No. 41 of 2004 on Waqf [2]. Money is more flexible and does not recognize the boundaries of the distribution area. Money can be easily collected with bank transfer facilities and can be quickly used for community welfare. However, this highly liquid fact of cash waqf also implies the complexity of its distribution.

Based on the situation, the researchers proposed a distribution model of cash waqf. This model was implemented in the application of decision support system of determining the form and amount of distribution of cash waqf to be distributed to former MWWs. The distribution simulation results are visualized in GIS form. With this visualization, decision makers would find it easier to understand the situation. The results of this study are expected to be a consideration in the development of integrated system of cash waqf management in Gunung Kidul Regency. Utilization of cash waqf funds by considering data area, character and culture of former MWWs will be modeled in DSS so that the distribution of cash waqf becomes optimal. The result is expected to support the achievement of economic independence of former MWWs. The concept carried out in this study is illustrated in Figure 1.

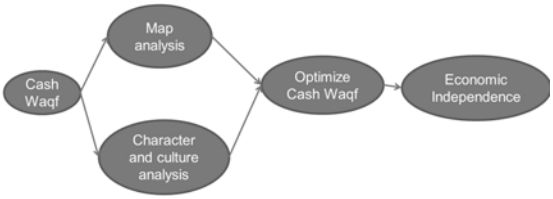

Fig 1. Research Model

The motivation of this research is to help solve the problems of MWW where they have not been able to be economically independent by utilizing the potential of cash waqf fund. This research increases the likelihood of success of cash waqf programs by creating a distribution model of cash waqf. The model is in the form of rules for deciding the form and amount of cash waqf that will be given to match the profile of the waqf recipient. With the rules that clear and open, it is expected to attract more people to do cash waqf.

2. LITERATURE REVIEW

Modeling in decision support system has been carried out by Emilia, et al [5]. The research conducted to model a sustainable procurement to provide guidance for buyers in making the most informed decision. Unlike traditional methods, that use attributes of people to define social structure, they use attributes of organisations or institutions as an essential units of analysis to compared. In this research, we use combination between personal attributes of MWW and attributes of talents.

In other research, Kyunyong [6] also modeled IT pre-entrepreneur's decision making process between psychological perception of self and behavioral intentions toward founding. The study is expected to help the development of entrepreneurial decision making information system for IT start-up. While they created model to find intention of the subjects, we build model that related to the action

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to be taken after finding the intention of the subjects.

Ye Jin Kiim [7] proposes an expert system that recommends the most suitable fundamental beauty cosmetics for the users. They utilized rule-based expert system combined with the logic-based language PROLOG. While also build a rule-based expert system, we implement it using procedural programming language PHP.

Taridala et al [8] also built an Expert Systems with GIS to implement urban model of fire station allocation assessment. The difference of our research are the case to overcome and the implementation tool of GIS. They used ArcView as the tool while this research utilizes Google Map API.

Huang et al [9] illustrated the system architecture, the functional framework and the design of decision support sub-system to control flood and reduce disaster. The DSS adopted advance knowledge management theory to construct an experience base of flood control. They used a variety of thematic maps, including historic flood information maps, economic loss diagrams, flood division maps, evacuation maps and the model predicting thematic maps as knowledge base. They used GIS in their research in different approach. Unlike our work that uses GIS as a visualization of the output, they just used GIS as one of DSS input.

Yu [10] designed DSS using data mining and webGIS to monitor emergency logistics system. Similar with this research, Yu also used webGIS to visualize DSS output. However, that research used data mining as model in decision process, while in this research we opt using the rule based system to drive the decision process.

Hasan, et al [11] developed a web based expert system that can assist and advise engineers for dealing with geometric design problems. The expert system is developed to fill the gap between the sustainable urban design experts and people who seek to employ Geometric Design of bicycle paths including decision makers, engineers, and students. Divayana [12] made evaluative research using CSE-UCLA model that consisted of system assessment, program planning, program implementation, program improvement and program certification. The subjects were the head of library, the development team, the lecturers, and the students. The data were collected through questionnaire, observation, interview, and documentation and were analyzed using descriptive quantitative technique to analyze each of the components of the CSE-UCLA model and descriptive qualitative technique to analyze the constraints metin the program implementation. In other research, Kusrini [13] modeled a system used to get a decision to diagnose a disease from a group of doctor team in managing a geriatric patient. In that research, knowledge representation in production rule form was built automatically by utilizing CUC-C4.5 algorithm. Those researches above used rule based method to represent knowledge in decision making process. Instead of using such data text to present the decision making recommendation alternatives like them, this research visualized the recommendation in the form of GIS.

3. RESEARCH METHODOLOGY

The steps carried out in this research are shown in Figure 2.

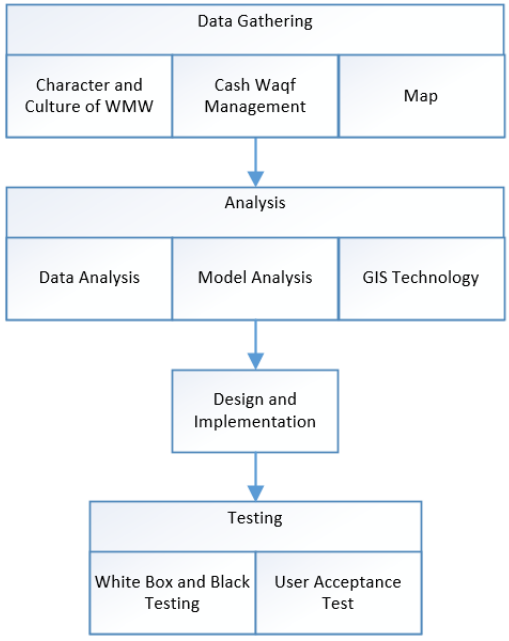

Fig 2. Research Steps

At the beginning, a data gathering step to determine the characteristics and culture of former MWW is carried out. The data were collected through questionnaire method. The researchers, along with Dinas Tenaga Kerja dan Transmigrasi (Government Office of Manpower and Transmigration) of Gunung Kidul Regency, held a business dialogue by inviting MWW and collecting their perception. To enrich the data, researchers also conducted interviews with the officers from Kantor Wilayah Kementerian Agama (Regional

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Office of Ministry of religion) of Gunung Kidul Regency to get information the pattern of current cash waqf management and the map data.

The existing data was then analyzed to specify system requirement, distribution decision-making model and the selection of GIS technology. The analysis results were then used to do the design and implementation process. To be more technical, the implemented application is a web based system that uses PHP as programming language and utilizing the codeigniter framework.

Applications that have been built are tested further using whitebox and blackbox methods performed by the research team. In addition, the researchers also conducted *Focus Group Discussion* (FGD) with stakeholders consisting of officials and staff of Kementerian Agama of Gunung Kidul and the people in charge from sharia management institutions.

4. RESULT AND DISCUSSION

The development of GIS system to support the optimalization of cash waqf potential is conducted with prototyping approach. With this approach, the researchers made a prototype to make the visualization of features to be built easier. Then, the prototype was presented to the main stake holders of this system in order to obtain feedbacks.

4.1 Initial System Requirements Gathering

System requirement identification was done by analyzing the obtained data, which are:

1. Poor people number
2. Poverty distribution number
3. Former MWW number
4. Sampling based former MWW distribution
5. The interests and talents of former MWWs
6. Interview result with the former MWWs in businesss dialogue activity
7. Interview result with the staffs of Kementerian Agama of Gunung Kidul Regency
8. Interview result with the officer and staffs of the Dinas Tenaga Kerja dan Transmigrasi (Government Office of Manpower and Transmigration) of Gunung Kidul Regency

Based on the data above, the researchers make conclusion that the system to be built is expected to have the abilities to:

1. Visualize the poverty distribution of Gunung Kidul Regency
2. Visualize the distribution of former MWWs in Gunung Kidul Regency
3. Manage the master data of regencies, talents and the distribution forms
4. Manage the former MWWs respondent data
5. Manage the distribution rules
6. Simulate the cash waqf distribution for the former MWWs
7. Visualize the simulation result of cash waqf distribution on a GIS

The system can be directly managed by the administrator from Kementerian Agama and accessed by community.

4.2 Features Evaluation

The features evaluation is carried out by making a FGD with the officers and staffs of Kementerian Agama Kabupaten Gunung Kidul. This activity was held at the office of Kementerian Agama of Gunung Kidul Regency.

The FGD shows some results as follows:

1. The users and system features details:
   a. Superadmin of Kementerian Agama of Gunung Kidul Regency:
      - Region setting
      - Year setting
      - Talent setting
      - Management of Respondent Data
      - Master Distribution Form
      - User seting (including the manager)
   b. Disnakertrans:
      - Setting of former MWWs number in a year
      - The former MWWs data
   c. Managers of cash waqf i.e. banks like BPD Syariah, BMT, Mandiri Syariah, Badan Wakaf Indonesia (BWI), and so on:
      - The management of distribution rules
      - Setting of former MWWs number in a year
      - Simulation of cash waqf distribution
      - Visualization of simulation result of cash waqf distribution
      - Management of waqf source data
      - Management of cash waqf receiver data with a synchronization to former MMW data
      - Management of waqf receiving data
      - Management of distribution data
      - Visualization of the realization of cash waqf distribution

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d. Decision makers, such as SKPD (Government Office) of Women Empowerment:
   - Visualization of the realization of cash waqf distribution
e. Community:
   - Visualization of poverty distribution in Gunung Kidul Regency
   - Visualization of former MWWs distribution in Gunung Kidul
   - Visualization of distribution realization

2. The data of MWWs are required to be added: name, religion, current monthly income, status (widow/married)

4.3 GIS Technology Selection

There are many methods that can be used in implementing GIS, such as Falahah's research which designed a system than can be run in web based application using several GIS softwares, namely ArcGIS, Quantum GIS, PostGIS, Geoserver, OpenLayers and using PostgreSQL database [14]. In other research, Tradigo used open source GIS named Geomedica was developed by Bioinformatics Laboratory of University Magna Graecia. Geomedica used Google Map Service and Google Map API to present, manipulate and visualize geographical data [15].

In analyzing the suitable method to implement GIS supporting in visualization and to support decision making, researchers conducted ability assessment for each method. The researchers also identify any supporting aspects needed to implement those methods. After that, the researchers evaluate the available infrastructures and data owned by Kementerian Agama of Gunung Kidul Regency as the main stake holder of this system. From all three variables, the researchers determined which method has the best possibility. The researcher decided to use Google Map Service and Google Map API [3].

4.4 Data Analysis

Data used in this system are grouped into 3, i.e master, former MWW profiles and rules. The master data consists of :

1. Talent, needed in recording talent data of former MWWs. This data is also required to develop channeling rules and coaching rules
2. Distribution form, required to arrange the distribution rules
3. District, used to manage former MWWs data and will be used as the basis for visualization with GIS
4. Year, the data used as the basis for calculating the number of MWWs to be visualized in GIS with annual filter

MWW profile data is needed mainly to know the talent possessed by former MWWs. It was used to simulate the distribution of cash waqf. The rules data consist of distribution rules. Distribution rules were used to simulate the distribution of cash waqf. When doing simulation feature with the system, the user must also enter the amount of funds to be distributed as well.

4.5 Model Analysis

At this stage, the construction of decision making scenarios is carried out. The expected outcomes are the distribution of cash waqf funds based on the amounts input by users, the distribution rules and the MWWs talent's. Informations generated from this data are:

1. The form and amount of the distribution of waqf in a region.
2. The amount of waqf distribution for each region

The steps made to complete this stage are:

1. Determining the estimated number of former MWWs in the population based on respondent data using Equation 1.

$$p_i = \frac{s_i}{s} x\ p \qquad [1]$$

Where:
p_i is the estimated number of population in region number i
s_i is the number of sample in region number i
s is the total sample size
p is the total number of population of former MWW

For example, the data obtained in 2016 is shown: the total population (p) is 400, the total sample size (s) is 139 and the number of samples in Patuk District (s_i) is 27. Thus the estimated number of MWWs in Patuk District can be calculated as:

$$p_i = \frac{27}{139} x\ 400 = 78$$

2. Determining the form of knowledge to know the suitable form of distribution based on the existing talent. The rules are made in the form

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of production rules. In general, the production rule is written as follows:

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If Premise Then Conclusion
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Premise is obtained from talent data. Since conclusion will use distribution data, the production rule then becoming:

```
If Talent
Then distribution_form_1 weight_1
and distribution_form_2 weight_2
…
and distribution_form_n weight_n
```

Each rule consists of one premise and several conclusion connected with "And" operator.

3. Calculating distribution unit that will be received by each MWW by using Equation 2.

$$d = \frac{c}{p} \quad [2]$$

Where:
d is distribution unit
c is total funds
p is the former MWW total population

4. Counting the waqf distribution value per talent per form. For each talent in all rules, find the distribution value by multiplying proporsion of distribution in that talent with the unit that will be received for each MWW, using Equation 3.

$$dr_{ij} = \frac{w_{ij}}{\sum_{j=1}^{n} w_{ij}} x\ d \quad [3]$$

Where:
i is the rule order
j is the conclusion number in the rule
dr_{ij} is the count of waqf distribution according rule i and conclusion j
n is number of conclusion
w_{ij} is the weight at rule i and conclusion j

The weight for each calculation for rules and talents will be inserted to a temporary table with columns of talent, distribution form, and waqf distribution value.

5. Determining the distribution forms and number for each specific region. For each form, the distribution number is calculated by using Equation 4.

$$drp_j = \sum_{i=1}^{n} (pr_i\ x\ dr_{ij}) \quad [4]$$

Where:
drp_j is the distribution amount in form number j based on region population
pr_i is the population number owning talent i
dr_{ij} is the distribution unit amount for talent number i and form number j that is calculated with equation 3
n is the talent number in the region

6. Calculating the distribution number in a region by using Equation 5.

$$dr = \sum_{j=1}^{n} drp_j \quad [5]$$

Where:
dr is the number of distribution in all form for specific region
drp_j is the number of distribution in the form number j based on region population that calculated with equation 4
n is the number of distribution form in the region

Illustrationof sample rules is shown in Table 1 and data sample of former MWW in Table 2.

Table 1. Distribution Rules (example)

No	Rules
1	If Talent Farming Then Seed weight 2 And Fertilizer weight 3 And Money weight 5.
2	If Talent Animal Husbandry Then Goat weight 5 And Money weight 6
3	If Talent Enterpreneurship Then Training weight 4 And Money weight 6

Table 2. Former MWW Data

Region	Talent	Count*
A	Farming	5
A	Animal Husbandry	3
B	Farming	6
B	Enterpreneurship	6
Note: The count is calculated by proporsion based on equation 1.		

By using data from Table 1 and Table 2 and the total cash waqf fund that will be distributed to former MWW of Rp. 200.000.000,-, the cash waqf distribution can be calculated as follow:

1. The distribution unit value is calculated by using Equation 2.

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$$d = \frac{Rp.200.000.000,-}{20} = Rp.10.000.000,- \quad [5.3]$$

2. The value of waqf distribution per talent per form calculated by using Equation 3.

For the talent Farming (rule no. 1) and form Seed (form no 1), user will get the distribution worth:

$$dr_{11} = \frac{2}{10} x Rp.10.000.000,- = Rp.2.000.000,-$$

For the talent Farming (rule no. 1) and form Fertilizer (form no 1), user will get distribution worth:

$$dr_{12} = \frac{3}{10} x Rp.10.000.000,- = Rp.3.000.000,-$$

For the talent Farming (rule no. 1) and form Money (form no 3), user will get distribution:

$$dr_{13} = \frac{5}{10} x Rp.10.000.000,- = Rp.5.000.000,-$$

For the talent Animal Husbandry (rule no. 2) and form Goat (form no 1), will get distribution worth:

$$dr_{21} = \frac{5}{10} x Rp.10.000.000,- = Rp.5.000.000,-$$

For the talent Animal Husbandry (rule no. 2) and form Money (form no 2), will get distribution of:

$$dr_{22} = \frac{5}{10} x Rp.10.000.000,- = Rp.5.000.000,-$$

For the talent Enterpreneurship (rule no. 3) and form Training (form no 1), will get distribution worth:

$$dr_{31} = \frac{4}{10} x Rp.10.000.000,- = Rp.4.000.000,-$$

For the talent Enterpreneurship (rule no. 3) and form Money (form no 2), will get distribution of:

$$dr_{32} = \frac{6}{10} x Rp.10.000.000,- = Rp.6.000.000,-$$

Those data inserted to the Temporary Distribution table as shown in Table 3.

Table 3. Temporary Distribution

Talent	Distribution Form	Amount
Farming	Seed	Rp. 2.000.000,-
Farming	Fertilizer	Rp. 3.000.000,-
Farming	Money	Rp. 5.000.000,-
Animal Husbandry	Goat	Rp. 5.000.000,-
Animal Husbandry	Money	Rp. 5.000.000,-
Enterpreneurship	Training	Rp. 4.000.000,-
Enterpreneurship	Money	Rp. 6.000.000,-

3. The calculation of the form and number for Region A. According Table 2, Region A has 5 people with farming talent and 3 people with animal husbandry. The distribution based on talent and distribution form calculated by using Equation 4.

Refer to Table 3, the number of Farming talent is 5, then the distribution form will be:

Seed = 5 x Rp. 2.000.000,-
= Rp. 10.000.000,-
Fertilizer = 5 x Rp. 3.000.000,-
= Rp. 15.000.000,-
Money = 5 x Rp. 5.000.000,-
= Rp. 25.000.000,-

Animal Husbandry talent number is 3, the distribution form is:

Goat = 3 x Rp. 5.000.000,-
= Rp. 15.000.000,-
Money = 3 x Rp. 5.000.000,-
= Rp. 15.000.000,-

Thus, it can be obtained the cash waqf distribution in region A in the form and number is as follow:

Seed = Rp. 10.000.000,-
Fertilizer = Rp. 15.000.000,-
Money = Rp. 25.000.000,- +
Rp. 15.000.000,-
= Rp. 40.000.000,-
Goat = Rp. 15.000.000,-

From those data, the total number of distribution to the Region A can be calculated by summing all the form worths above:

dr = Rp. 10.000.000,- +
Rp. 15.000.000,- +
Rp. 25.000.000,- +
Rp. 15.000.000,- +
Rp. 15.000.000,-
= Rp. 80.000.000,-

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4.6 Implementation

The software application product is built using PHP and Code Igniter framework. The result of simulation is shown by not only a table, but also in a digital map (GIS Software) to make it easier to read. The rule page is shown in Figure 1 while the simulation is in Figure 2.

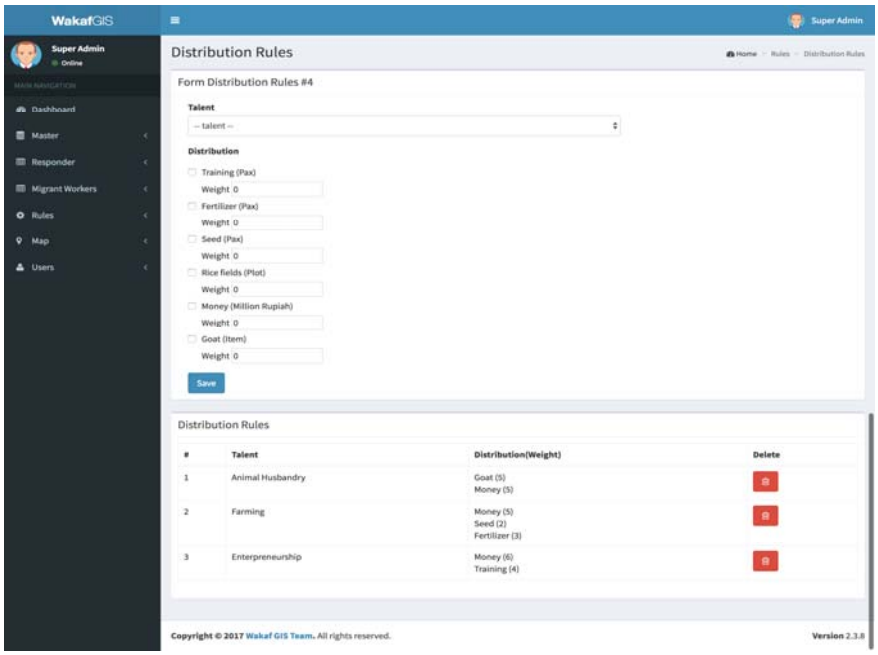

Fig. 1 List of Rules Interface

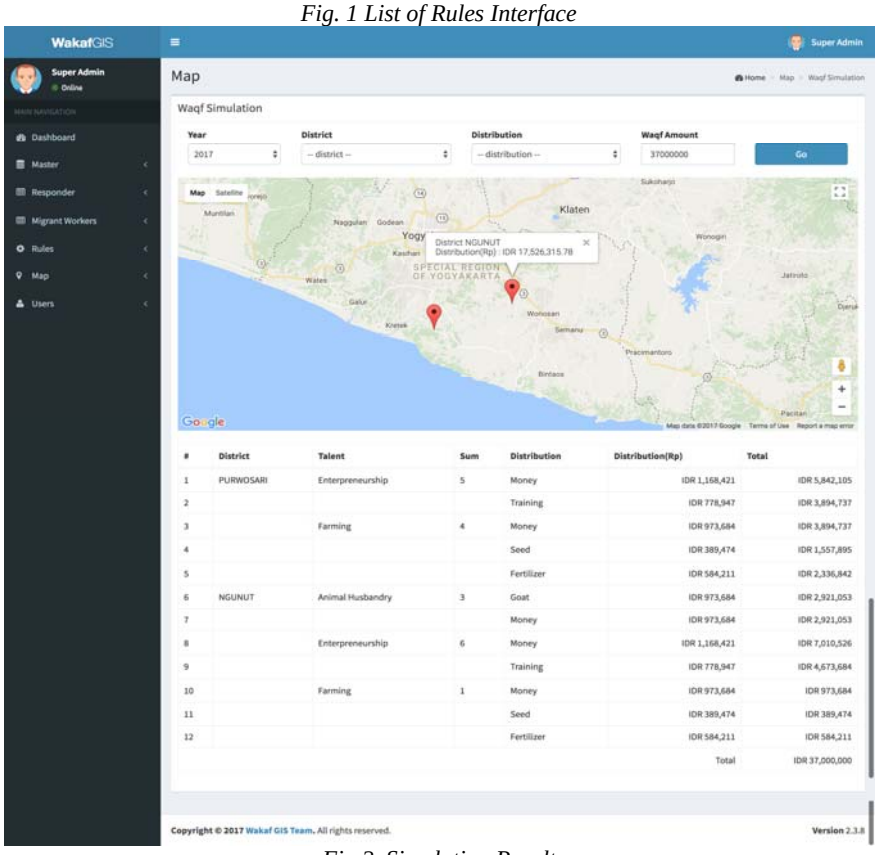

Fig 2. Simulation Result

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4.7 Testing

The simulation application for Cash Waqf Distribution has been made and the test has been run. The test was made using whitebox and blackbox testing methods done by researcher team. The test result showed that the expected functions could ran well and produce outputs that confirmed to the manual calculation. This application was then uploaded to http://wakaf-gunungkidul.com/.

The test was also taken by the user candidates. They were trained to use the application and later they were asked to try it themself and answer some questions. The questions and answer recap are shown in Table 4. The questions were given to 7 user candidates. The scoring is using Likert Scale in which 1 represents very disagree, 2 disagree, 4 agree, and 5 very agree.

Table 4. The Test Result of Cash Waqf Distribution Simulation Application

NO	STATEMENT	%			
		1	2	4	5
1	The contents of the information generated by the application are indeed I need			1	5
2	The application generates the exact report I need			5	1
3	The application generates enough information			5	1
4	I am satisfied with the level of accuracy / correctness of the application			4	2
5	The application is able to provide information that conform with the format needed			5	1
6	The application can provide information can be understood clearly			3	3
7	The application is easy to be used			2	5
8	I can obtain information I need in time			2	4
9	The application can produce uptodate information			3	3
Total		0	0	30	25

The acceptance is calculated by using Equation 6.

$$a = \frac{s}{(r \ x \ q)} \quad [6]$$

Where:
a is the acceptance score
s is total score
r is total respondents
q is total questions

By using Equation 6, the acceptance score of the application can be calculated as below:

$$a = \frac{55}{(7x9)} = 87\%$$

Beside that, the candidates were also invited to give input for application improvement. The input received are:

1. Involving BWI as the institution that gives permission to nadzir (waqf management)
2. Developing integrated system which manages the funds from wakif, the contract between wakif and nadizr.
3. Developing the system that can be used to manage the use of waqf fund because not every waqf fund can be used (only increasing value result of the waqf can be used).
4. Developing the system to manage the funds from nadzir to sharia executive institution.
5. Continuing developing the aplicatiom so it can be used directly by community.

5. DIFFERENCE OF PRIOR WORK

According on the literature review, results and discussion sections, it can be seen that this research is the follow-up of the research finding of the entrepreneurship intention factor of MWW in Gunung Kidul [1]. The results of that research are used in the knowledge representation in this study.

This study is also a follow up of GIS technology selection for visualization of independent economic modeling of the former MWW [3]. That research analysed of GIS technology selection that appropriate to visualize the data and simulation results of the distribution of cash waqf, while in this research the implementation of the selected technology is done. This research also utilizes the technology used by Falahah and Ayuningtyas [14] in implementing GIS, but done for different case. In this research the visualized data from GIS is the output of the decision support system in determining the distribution of cash waqf.

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6. CONCLUSION

The model of decision making of cash waqf distribution for Former MWWs financial independence has been made. The model was well implemented in a GIS based application. The level of acceptance of the user candidates to the application reached 87%. The application still needs improvement to be used directly by the stakeholders of cash waqf management.

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