System Decision of Natural Disaster Logistics (Case Study of Mount Agung Eruption)

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***Abstract*— Gunung Agung is one of the most potent eruption volcanoes in Indonesia. Reflecting back to 1963 when Mount Agung erupted, the impact was so devastating. Even the impact for months. The lack of food supplies is becoming a central job for the government. The distribution of logistics plays an important role in this regard whether it is food, clothing or other necessities, but the current logistics distribution system is still manual so it is not very efficient and very likely there is a misstatement.**

The impact of difficulties in managing logistical assistance can be seen, eg uneven distribution of relief goods in terms of number of inter-regions (posts), types of relief items sent are not in accordance with the type desired by individual posts, and especially for fast food, then damaged and outdated because it was sent to the post at the wrong time and improper handling. Needed a solution to minimize the problems that arise in the process of disbursing logistics disaster management is by using the Logistics Management Information System.

In this research, the method used using two methods, namely waterfall method for system development, and for decision support system using Topsis method

Expected to be able to manage logistical support in a timely, timely, and precise location

***Index Terms*—Logistic, *Topsis*, *Waterfall*, Disaster, Eruption**

I. INTRODUCTION

Mount Agung is the highest mountain on the island of Bali with an altitude of 3,031 meters above sea level. Gunung Agung is located in Rendang district, Karangasem regency, Bali, Indonesia. Besakih Temple, which is one of the most important temples in Bali, is located on the slopes of this mountain. Mount Agung is a stratovolcano type volcano. This mountain has a very large and very deep crater that sometimes emits smoke and moisture. From Pura Besakih this mountain is visible with a perfectly pointed cone, but actually the peak of this mountain extends and ends in a circular crater and wide.

In September 2017, an increase in rumble and seismic activity around the volcano heightened the normal status of alert and about 122,500 people were evacuated from their homes around the volcano. The National Disaster Management Agency declared a 12-kilometer exclusion zone around the volcano on 24 September. Until the date of 29 November 2017 Mount Agung has twice erupted magmatik.

The increased activity of Mount Agung is accompanied by the increasing number of refugees, this is because the red zone set by the government is increasingly widespread. The central thing that always happens in every evacuation is the distribution of logistics. Logistics in the form of food, clothing or other necessities of life play a very important role in the survival of the community in the refugee camp. Any assistance, either from the government, organizations, communities or individuals directly addressed to refugees is massive in the early days of the disaster, but the readiness of the storage warehouse or inventory of logistic storage and the lack of human resources capable of managing such logistics causes the buildup in some areas post and even worse some refugee camps that are geographically difficult to achieve lack of logistics.

The number of refugee posts is very influential in decision making to determine which posts are a priority in the distribution of logistics. Determination of logistics distribution to refugee post, there are several factors that become the assessment. This assessment is based on the location of the post, the number of refugees, the geography of the region, the age of the refugees and others. For the sake of effectiveness and efficiency of logistic distribution then proper decision making is needed.

Based on the above description, it is necessary to have a decision support system that can assist the decision-making process in determining the priority of the logistics distribution area, so that the decision given is expected to meet the limits that have been determined. The method used is Topsis. This method is chosen because this method is suitable to solve the problem of multiple criteria decision making. This is because the concept is simple and easy to understand, the computing is efficient and has the ability to measure the relative performance of decision alternatives that are expected to be able to select priority posts with predetermined criteria as well as provide logistic recommendations on each refugee post.

(p-issn: 2579-5988, e-issn: 2579-597X)

II. REVIEW OF REFRENCES

Disaster is a serious disruption to the functioning of a society, thus causing widespread harm to human life from a material, economic or environmental perspective and beyond the ability of the community concerned to cope with the use of its own resources. (ISDR, 2004).

ISDR 2004 explains that basically disaster is divided into several phases, namely:

1. Response phase (response phase),
2. Reconstruction and rehabilitation phase,
3. Stages of preventive and mitigation, and
4. Stage of preparedness.

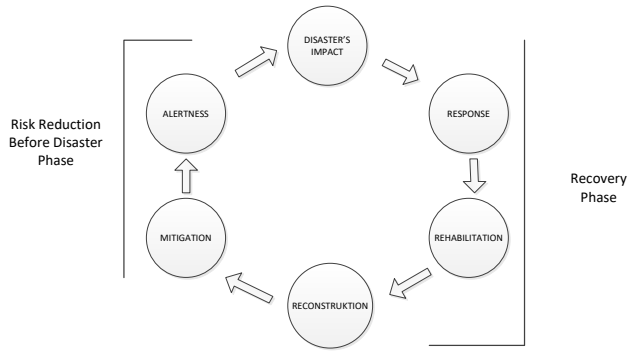

Figure 1. Disaster responses stage

2.1 System Analysis

According to Kusrini and Andri Koniyo (2007: 59), analysis can be defined as "the decomposition of a complete information system into its component parts in order to identify and evaluate the problems, opportunities and constraints that occur and the expected needs so that it can be proposed improvements ".

According to Bernd Bruegge Allen and H.Dutoit (2009; 16) during the development of bengembang aims to produce a system model that is correct, complete, consistent, and unambiguous. Developers change the use cases generated during the elicitation requirements into an object model that actually describes the system. During this activity, the developer finds ambiguity and inconsistency in the case of using the model that they complete with the client. The result of analysis is system model explained by attribute and operation, from definition of analysis above, it can be concluded that analysis is an activity identify and evaluate problem to solve problem. The steps in the analysis of decision support systems to be built is

1. Identify the problem and the cause of the problem
2. Understand the existing work system
3. Analyzing the system
4. Membuant report analysis results

2.2 System Design

According to Rosa AS and M.Shalahuddin (2011: 21) revealed: "Design in software development is an attempt to construct a system that provides satisfaction (maybe informal) to the specification of functional requirements, meet targets, meet the needs implicitly or explicitly in terms of performansi as well as the use of resources, satisfaction restrictions on the design process in terms of cost, time, and device. design, design is the translation stage of the need or data has been analyzed into a form easily understood by the user ".

Meanwhile, according to John Burch and Gary Grudnitski in Jogiyanto HM (2005: 196) reveals: "Design can be defined as, drawing, planning and making a sketch or arrangement of several separate elements into a unified whole and function", from the above definition it can be concluded system design is an activity to define how the structure of the system created and formulate how to form the structure. Design activities are activities that aim to create something.

2.3 Logistics Assistance Guidelines

According to Perka BNPB No. 4/2009 is a guide for all PB officers, especially those related to the management of logistical support. While the purpose of Perka BNPB No. 4/2009 is to process:

1. Planning of logistics assistance in PB as required.
2. Procurement of logistics assistance in PB shall refer to the applicable regulations in accordance with the number, type and quality of assistance.
3. Distribution of logistics assistance in the PB effective, efficient, targeted and accountable.

Logistic assistance is carried out by embracing organizational patterns that involve several institutions / institutions in institutional systems in various areas that are implemented in an integrated manner covering national, provincial, and district / city. Each institutional level in administering logistic assistance PB uses a logistical aid mechanism, which at each level has special characteristics in accordance with the level of authority. Deployment of logistics assistance at the national level (Central Government) is implemented in the following patterns:

1. In the case of disasters in Districts / Provinces and Provinces, BNPB mobilizes logistics resources from regional Technical Implementing Units (UPT), agencies / institutions, business and community as required to disaster site.
2. If the requirement is not available / insufficient, BNPB may mobilize assistance to BPBD of other Province, or other sources both from inside and outside the country.
3. If there is limited logistical support provided by the Head of Provincial BPBD, BNPB can assist through the assistance of ready-to-use funds specifically used during emergency response and other allocated funding sources.

The deployment of logistics assistance in the Province is carried out with the following patterns:

1. In the case of disasters in the Province, the affected Provincial BPBD mobilizes logistical resources from the Institution / Institution, Business World and Community as needed to the disaster site.

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2. If the requirement is not available / insufficient, the relevant provincial government may request logistical assistance to other nearby Provinces.
3. If the Province requested for assistance does not have the availability of logistical / insufficient resources, the affected provincial government may request assistance to the Central Government (BNPB)
4. The costs incurred by the mobilization of logistic assistance are borne by the relevant provincial government.
5. Implementation of deployment of logistics resources from origin to disaster location is carried out under coordination / control of the Head of Provincial BPBD concerned.

The deployment of logistic assistance at the district / city level is carried out with the following patterns:

1. In the case of disaster in the Regency / City, the affected District / Municipal BPBD mobilizes logistics resources from the institutions / institutions, the Business World and the Community as needed to the disaster site.
2. If the requirement is not available / insufficient, then the relevant regency / municipality may request logistic assistance to the nearest regency / municipality in one province or other province.
3. If the District / City government requested equipment assistance does not have available / insufficient resources, then the affected district / municipal government may request logistical assistance to the relevant provincial government.
4. The costs incurred by the mobilization of this equipment aid shall be borne by the respective district / city government.
5. Implementation of the mobilization of logistical aid from origin to disaster location is carried out under the coordination / control of the Head of the relevant Regency / City BPBD.

2.4 Decision Support System

According to Gorry and Scott Morton in the Turban book (2005: 19) Decision Support System is an interactive computer-based system, which helps decision makers to use data and models to solve unstructured problems.

Moore and Chang in Turban (2005: 137) define DSS as an expandable system capable of supporting ad hoc data analysis and decision modeling, oriented toward future planning, and used at irregular and unplanned intervals. A system dedicated to assisting decision-makers in less structured / semi-structured decisions of Ephraim Turban (2005; 136).

According to Man and Watson in the book Udo Richard Franz Averweg (2012: 16) Decision Support System is an interactive system, which helps decision makers through the use of data and decision models to solve problems.

Based on the understanding of various experts, it can be concluded that Decision Support System is a computer-based system that can help decision-making to solve certain problems by utilizing certain data and models.

(p-issn: 2579-5988, e-issn: 2579-597X)

2.5 Decision Support System Components

According to Ephraim Turban (2005: 143) the components of the Decision Support System are as follows:

1. Data Management, includes databases containing relevant data and organized by a system called Database Management System (DBMS).
2. Model Management, is a software package that incorporates finavdnsial models, statistics, management sciences, or other quantitative models that provide systems analysis and related management software capabilities.
3. User Interface, media interaction between system with user, so user can communicate and give command on SPK through this subsystem.
4. Knowledge Based Subsystem, subsystem that can support other subsystems or act as a stand-alone component.

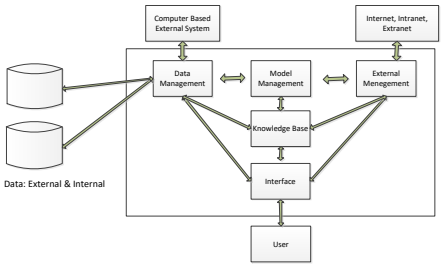

Figure 2. Decision Support System Concept

2.6 Refugee Data

The data of Mount Agung refugee camps reach 253 posts, and spread throughout the district in Bali, both posko government and volunteering community who donate their houses as refugee camps. Here are the details of the eradication of Mount Agung eruption post.

Table 1. List number of posko in each region

Name of District	Amount of Posts
Karangasem	158
Klungkung	38
Bangli	30
Buleleng	9
Gianyar	8
Tabanan	6
Denpasar	4

Data of refugees who occupy refugee posts scattered throughout the district in Bali reached 39114 people consisting of 10646 families with the following details.

Table 2. Detail data of refugees

Age Range	Total
Baby (0-11 Month)	487
Toddler (1-5 Year)	2747
Child (6-11 Year)	4051
Adult (12-25 Year)	6246
Mature (26-45 Year)	17785
Elderly (46-64 Year)	5782
Old (Above 65)	2016

2.6 Topsis Method

Technique for Order Performance of Similarity to Ideal Solution (TOPSIS) is one of multicriteria decision support systems. TOPSIS has the principle that the chosen alternative must have the closest distance from the ideal ideal solution and has the furthest distance from the ideal ideal solution from a geometric point of view by using the Euclidean distance (the distance between two points) to determine the relative proximity of an alternative.

1. TOPSIS method has the following advantages: Topsis method is one of the simple method and the concept of rational is easy to understand.
2. Topsis method is able to measure relative performance in forming simple mathematical form.

Stages of Topsis method:

1. Make a normalized decision matrix.
2. Create a weighted normalized decision matrix.
3. Determine the matrix of positive ideal solutions and the ideal negative solution matrix.
4. Determine the distance between the value of each alternative with the positive and negative ideal solution matrix.
5. Determine the preference value for each alternative.

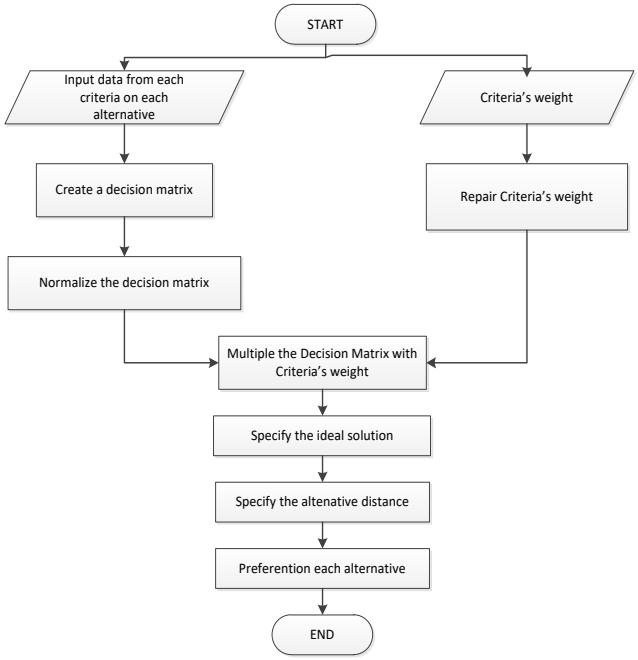

Figure 3. Flowchart of Topsis Method

Topsis requires performance rating of each alternative Ai on each of the normalized Ci criteria, namely:
The steps of the algorithm of the Topsis method are:

a. Determine the normalization of the decision matrix. The normalized value of rij is calculated by the formula:

$$Rij = \frac{Xij}{\sum_{i=1}^{m} X_{ij}^{2}} \quad (1)$$

Explanation:
i = 1,2,...,m
j = 1,2,...,n

b. Determine the normalized weight of the decision matrix. The normalized weights of yij are as follows:

$$Yij = WijRij; \quad (2)$$

Explanation:
i = 1,2,...,m
j = 1,2,...,n

$$A^{+} = (y_1^{+}, y_2^{+}, \dots, y_n^{+}) \quad (3)$$
$$A^{-} = (y_1^{-}, y_2^{-}, \dots, y_n^{-})$$

With the value j = 1, 2, ..., n

1. The distance between alternative Ai with positive ideal solution is formulated as:

$$D_i^{+} = \sqrt{\sum_{j=1}^{n}(yij - y_i^{-})^2} \quad (4)$$

With i = 1, 2, ..., m

1. The preference value for each alternative (Vi) is given as:

$$V_i = \frac{D_i^{-}}{D_i^{-} + D_i^{+}} \quad (5)$$

With i = 1, 2, ..., m
A larger Vi score indicates that Ai alternatives are preferred.

1.7 Case Study

Manual calculations using TOPSIS method with several criteria related to the problems encountered.

For example there are 4 criteria that are used as guidance in the selection of places of distribution of logistics

K1 = Number of Refugees
K2 = Distance to Command Post
K3 = Foodstuff Stock
K4 = Number of sick people

1. Analysis of the importance of criteria

Table 3. Value of number of refugees

Amount	Level	Value
> 1000	Very Important	100
750 - 1000	Important	90
500 – 749	Average	80
250 – 499	Low	70
100 - 249	Very low	60
< 100	Lowest	50

Table 4. Value of distance to command post

Distance (km)	Level	Value
> 100	Very Important	100
75 - 100	Important	90

50 – 74	Average	80
25 – 49	Low	70
10 – 24	Very low	60
< 10	Lowest	50

Table 5. Value of foodstuff stock

Food Stock (kg)	Level	Value
< 100	Very Important	100
100 - 500	Important	90
499 - 750	Average	80
751 - 1000	Low	70
1001 - 2000	Very low	60
> 2000	Lowest	50

Table 6. Value of number of sick people

Amount of sick people	Level	Value
> 100	Very Important	100
75-99	Important	90
50-74	Average	80
25-49	Low	70
10-24	Very low	60
< 10	Lowest	50

2. Case Table

The decision maker gives the preference weight for each of the following criteria:

K1 = 4; K2=2 ; K3= 3 ; K4=5

The candidates (alternatives) to be elected as a priority where the distribution of logistics, namely:

Table 7. Value of each criteria

Name	Amount	Distance	Stock	Amount of sick people
Sebudi	850	110	800	60
Tejakula	400	60	250	95
Manggis	780	55	755	70
Tulamben	810	40	150	22
Kubu	880	58	280	34

2. Normalization of Matrix, R:

a. The value of R11 can be from = 90 / 193.13 to R51 adjusted to the value below
b. The value of R12 can be from = 100 / 184.66 to R52 adjusted to the value below
c. The value of R13 can be from = 70 / 184.66 to R51 adjusted to the value below
d. The value of R14 in can be from = 80 / 171.46 to R52 adjusted to the value below

$|X1|=\sqrt{90^2+70^2+90^2+90^2+90^2}$ $|X2|=\sqrt{100^2+80^2+80^2+70^2+80^2}$

|X1|= 193.13 |X2|= 184.66

R^{11}= 0.47 R^{12}= 0.54
R^{21}= 0.36 R^{22}= 0.43
R^{31}= 0.47 R^{32}= 0.43
R^{41}= 0.47 R^{42}= 0.38
R^{51}= 0.47 R^{52}= 0.43

$|X3|=\sqrt{70^2+90^2+70^2+90^2+90^2}$ $|X4|=\sqrt{80^2+90^2+80^2+60^2+70^2}$

|X3|= 184.66 |X4|= 171.46

R^{13}= 0.38 R^{14}= 0.47
R^{23}= 0.49 R^{24}= 0.52
R^{33}= 0.38 R^{34}= 0.47
R^{43}= 0.49 R^{44}= 0.35
R^{53}= 0.49 R^{54}= 0.41

The value of R is taken based on the above values calculated above

$$R=\begin{matrix}0.47 & 0.54 & 0.38 & 0.47\\ 0.36 & 0.43 & 0.49 & 0.52\\ 0.47 & 0.43 & 0.38 & 0.47\\ 0.47 & 0.38 & 0.49 & 0.35\\ 0.47 & 0.43 & 0.49 & 0.41\end{matrix}$$

Normally normalized matrix, Y:

$$R=\begin{matrix}0.47 & 0.54 & 0.38 & 0.47\\ 0.36 & 0.43 & 0.49 & 0.52\\ 0.47 & 0.43 & 0.38 & 0.47\\ 0.47 & 0.38 & 0.49 & 0.35\\ 0.47 & 0.43 & 0.49 & 0.41\end{matrix} \quad X \quad (4,2,3,5)$$

$$Y=\begin{matrix}1.88 & 1.08 & 1.14 & 2.35\\ 1.44 & 0.86 & 1.47 & 2.6\\ 1.88 & 0.86 & 1.14 & 2.35\\ 1.88 & 0.76 & 1.47 & 1.75\\ 1.88 & 0.86 & 1.47 & 2.05\end{matrix}$$

Determining Ideal Ideal Solutions and Negative Ideal Solutions
a. Positive Ideal Solution (A +):

$Y_1^+ = Min(1.88; 1.44; 1.88; 1.88; 1.88) = 1.44$
$Y_2^+ = Max(1.08; 0.86; 0.86; 0.76; 0.86) = 1.08$
$Y_3^+ = Max(1.14; 1.47; 1.14; 1.47; 1478) = 1.47$
$Y_4^+ = Max(2.35; 2.6; 2.35; 1.75; 2.05) = 2.60$

A = (1.44, 1.08, 1.47, 2.60)

b. Negative Ideal Solution (A^-):

$Y_1^- = Max(1.88; 1.44; 1.88; 1.88; 1.88) = 1.88$
$Y_2^- = Min(1.08; 0.86; 0.86; 0.76; 0.86) = 0.76$
$Y_3^- = Min(1.14; 1.47; 1.14; 1.47; 1478) = 1.14$
$Y_4^- = Min(2.35; 2.6; 2.35; 1.75; 2.05) = 1.75$

A = (1.88, 0.76, 1.14, 1.75)

The distance between the weighted value of each alternative to a positive ideal solution
$D_1^+ = 0.365$

$D_2^+ = 0.0484$
$D_3^+ = 0.47$
$D_4^+ = 0.07$
$D_5^+ = 0.0417$

The distance between the weighted value of each alternative against the ideal negative solution,
$D_1^- = 0.4624$
$D_2^- = 1.035$
$D_3^- = 0.37$
$D_4^- = 0.1089$
$D_5^- = 0.2089$

The proximity of each alternative to an ideal solution is calculated as follows:
V1 = 0.5588
V2 = 0.955
V3 = 0.47
V4 = 0.07
V5 = 0.04

From the value of V this can be seen that V2 has the greatest value, so it can be concluded that alternative

Table 8. Range of value

Range of Value	Distribution Status
1 – 0.76	Priority of Distribution
0.75 – 0.50	Distribution
0.49 – 0	Not Priority to Distribute

Table 9. Result of calculation topsis method

Alternative	Value	Distribution Status
Sebudi	0.55	Distribution
Tejakula	0.95	Priority of Distribution
Manggis	0.47	Not Priority to Distribute
Tulamben	0.07	Not Priority to Distribute
Kubu	0.04	Not Priority to Distribute

III. METHOD

The framework used in the process of completion of this research is basically a sequence of steps that must be done so as to produce an end goal of this research, which is to produce a decision support in determining the priority of the distribution of logistics.

Based on the research framework above can be described each discussion of the stages of this study are as follows:

1. Problem Formulation
   This stage the authors formulate the scope of the problem to be discussed in this study.
2. Literature Studies
   This stage the authors do what is called the literature review is to study reference books, articles on relevant sites on monitoring. The goal is to gain an understanding of the theories and concepts on the issues under study. Which later can be used by authors in developing applications and making reports.
3. Data Collection
   This stage the authors do data collection, data collection is a stage in the process of research is important, because only by getting the right data, then the research process will last until the author get answers from the formulation of the problem that has been set.
4. System Development
   System Development can mean setting up a new system to replace the old system as a whole or improve existing systems.

3.1 Waterfall Model

Waterfall method is a method that is often used by system analyzers in general. The essence of the waterfall method is the workmanship of a system performed sequentially or in a linear fashion.

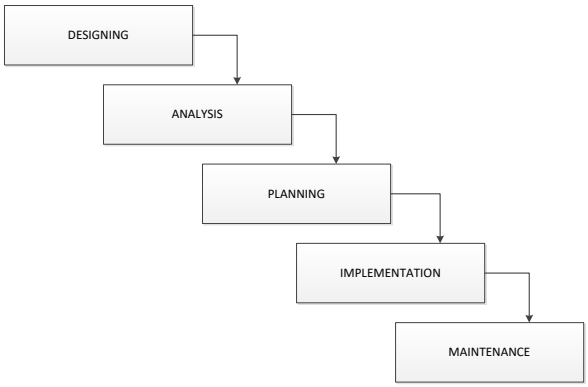

Figure 4. Waterfall method

1. Requirement Analysis
   This stage of system developers required communication aimed at understanding the software expected by the user and the limitation of the software. This information can usually be obtained through interviews, discussions or direct surveys. Information is analyzed to get the data required by the user.
2. System Design
   The requirements specifications of the previous stage will be studied in this phase and the system design is prepared. System design helps in determining hardware devices and system requirements and also helps in defining the overall system architecture
3. Implementation
   At this stage, the first system is developed in a small program called the unit, which is integrated in the next stage. Each unit is developed and tested for functionality called unit testing.
4. Integration & Testing
   All units developed in the implementation phase are integrated into the system after the tests performed by

each unit. After integration the whole system is tested to check for any failures or errors.

5. Operation & Maintenance

The final stage in the waterfall model. The ready-made software is run and maintained. Maintenance includes fixing errors not found in the previous step. Improved implementation of system units and improvement of system services as new needs.

IV. Result dan Discussion

The design process needs to be done to produce a good system design. Because with the right design will produce a system that is easier to be developed in the future. To handle the results in accordance with the above requirements, it takes several stages of system design consisting of 6 (six) stages, among others:

a. Designing Use Case Diagram
b. Designing Activity Diagram
c. Designing Class Diagrams
d. Program Structure Design
e. Interface Design
f. Database Design

The design of the above system is prepared and designed in accordance with the theory in the literature review used by Researchers.

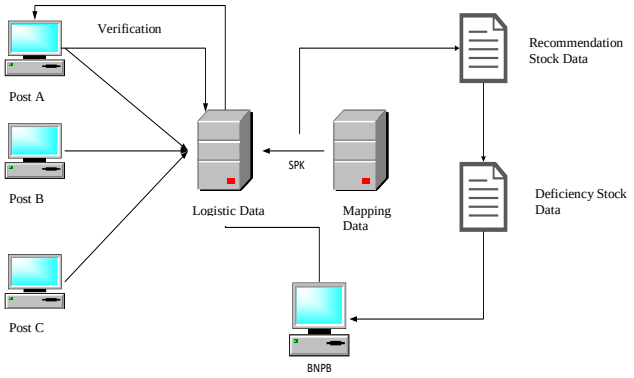

Figure 5. Decision Support System of Logistic Distribution

Input data in the form of logistics reports from each post, which where each post has an operator that will manage any information deficiencies, complaints or logistical recommendations. The logistics data center will verify and validate whether the proposed data can be further processed or not.

Output of data in the form of data recommendations and data deficiencies that will be forwarded to the authorized institution that is BNPB that will be distributed to the related posts.

4.1 Pieces Analysis

Pieces uses six variables, Performance, Information/Data, Economic, Control/Security, Efficiency, and Service.

Tabele 10. Pieces Analysis

Analysis Type	Weakness of the old System	Submitted System
Peformance	Refugee information system issued by BPNB as the official body is still manual and post processing data is inefficient and tend to be slow	The new information system can be managed via computer, so the system is more accurate and information exchange becomes faster
Information	Refugee information systems are still decisions and circulars,	Already a report via web based, so it can be accessed anywhere
Ekonomi	The cost is quite large, considering the report is still physical	The cost is quite large, considering the report is still physical
Control	The old system is very difficult to control because, equity between posko not yet exist	The old system is very difficult to control because, equity between posko not yet exist
Eficiency	It's easy to control, because every post bias is monitored and its data can be kept updated	It's easy to control, because every post bias is monitored and its data can be kept updated
Service	Service to interested parties will take a lot of time due to human resource constraints	Service to interested parties will take a lot of time due to human resource constraints

V. Conclusions dan Suggestions

Based on the results of research and testing decision support system of teacher performance appraisal on SMK Yadika Jambi which has been done by the author, it can be taken some conclusions:

1. Decision Support System (SPK) is currently not implemented effectively so there are still many reports about the wrong logistics target
2. Decision Support System (SPK) with Technique for Order Performance of Similarity to Ideal Solution (TOPSIS) method is used to solve the logistics problem in natural disaster eruption Gunung Agung

1.1 Suggestions

The author realizes there are still many shortcomings in the designed application. As for suggestions that are useful for authors for the development of applications that have been designed are:

1. In order to add other data such as adding criteria.
2. The system has been built is expected to provide additional information about the transparency of data logistics sent
3. For further developments, the system is expected to incorporate Technique for Order Performance of Similarity to Ideal Solution (TOPSIS) method with another method for more detailed research results.

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