Coordination of Humanitarian Logistic Model Plan for Natural Disaster in East Java

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Coordination of Humanitarian Logistic Model Plan for Natural Disaster in East Java, Indonesia

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***Abstract*—Natural disasters in Indonesia often resulted in huge casualties and material lost. Therefore, the coordination of humanitarian logistic is important to be upgraded. The result of this research is a model plan of humanitarian logistic coordination in East Java with case study in Pasuruan regency. The simulation of dynamic system model is run using Vensim software. The objective function is to minimize the response time for emergency response. The proposed model involves Indonesia Red Cross (IRC) as a core team in humanitarian logistic in East Java. The order of priority that could be considered is the assessment team only conducted by IRC, addition of IRC's doctors, addition of IRC's boats for evacuation, additions of IRC's personnel for soup kitchen, and addition of IRC's boats for aid distribution. The simulation results show that the proposed model can reduce the response time up to 20 hours.**

***Keywords*—** *logistic; humanitarian;dynamic simulation; natural disaster*

1. Introduction

The number and magnitude of disasters have grown recently therefore humanitarian logistic is essential in the response to any disasters. Humanitarian logistic is the process of planning, implementing, and controlling the effectiveness and efficiency of the flow of resources and information from the help centre to the disaster site. Ref. [1] reviewed some discussions and applications of humanitarian logistics. There are some important topics in humanitarian logistic such as delivery and casualties transports, infrastructure restoration, information systems, and coordination networks. Every stakeholder in humanitarian logistic must work together to achieve comprehensive and sustainable results. Ref. [2] stated that inaccurate coordination leads to inefficiencies, including the duplication of unrequired effort. However accurate and efficient coordination is not an easy effort. Ref. [3] reviewed the challenge of humanitarian logistic coordination. Even though coordination is not easy, there are opportunities to expand coordination to maximize their benefits. Ref. [4] stated that the important stakeholders are governments, military, donors, aid agencies, NGOs, logistic companies, and other companies

From 1815 until August 2015, the Indonesian National Board for Disaster Management (BNPB) noted that Indonesia has experienced 19.877 disasters. The largest disaster that occurred in Indonesia is flood, which has 31% of the total disaster that ever happened. Those disasters caused to negative impacts that need special attention to minimize the impacts.

There are only few papers discuss humanitarian logistics practice in Indonesia. Ref.[5] developed a coordination model in Indonesia disaster management. They found that the disaster management structure in Indonesia deals with the main problems on organizational, communication and logistical level. However their model is only a general model. In this research we develop a detail coordination model in humanitarian logistic in Indonesia. There is no humanitarian logistic model in detail from some previous research. The existing model use BNPB as the main coordinator, with local government, Social Office, Public Health Office, and Indonesia Red Cross (IRC) as other stakeholders. The existing coordination model still makes duplication of efforts across sectors. Existing and proposed model coordination are analysed using quantitative factors in the simulation model. The simulation model is run using Vensim software. Indonesia humanitarian logistic model

2. Humanitarian Logistic Model in Indonesia

Indonesian National Board for Disaster Management (BNPB) is government institution that became the main coordinator in Indonesia humanitarian logistic. Other stakeholders that contributed in Indonesia humanitarian logistic areIndonesian Red Cross (IRC), the Indonesian National Army (TNI), police, Public Health Office

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(PHO), Social Office (SO), the National Search and Rescue Agency (BASARNAS), and non-governmental organisations (NGOs). Each humanitarian logistic stakeholder has a level of authority, which is national, provincial, and district or city. BPNB has a regional institution called Regional Board for Disaster Management (BPBD). The case study for this research will take East Java region, in Pasuruan regency.

BNPB will become the center of coordination and director in every phase of disaster. Military and police have a role in victims' search and rescue and security control at the site of the disaster. Public Health Office is in charge of planning and preparing medical personnel, including logistic and medicine requirement. Social Office role is social protection and assistance, including fulfilment of food, clothing, shelter and other emergency needs. BASARNAS is assigned to search and rescue the victims. IRC and NGOs act as a donor, both the logistic needs and human resources.

2.2 Disaster emergency response coordination model

Coordination of emergency response can be done with a variety of convenient ways. Each government stakeholders incorporated in a chat groupso it facilitates the information's spread quickly across East Java. When disaster strikes, BPBD as the main coordinator will perform a joint meeting with all stakeholders in the humanitarian logistic.

BPBD will set up a command post for emergency response by dividing tasks into eight sectors. These sectors will be established according to the conditions and requirements of each disaster. Each sector has a leading sector that acts as coordinator. The eight sectors are data and information, administration, search and rescue, soup kitchen, logistics-equipment-aid management, vital infrastructure recovery, health service, and safety-security. The coordination model is figured out in Figure 1. This research study is limited to logistic sectors, which are soup kitchen, logistics-equipment-aid management, and health services.

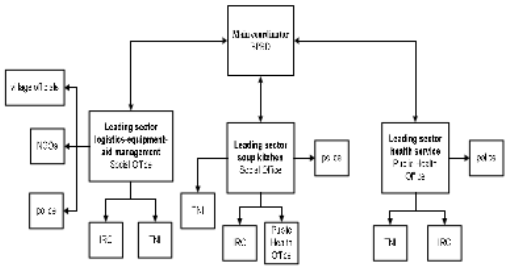

Figure 1. Sectors coordination model

2.3 BPBD's management disaster emergency response

Disaster emergency response began with the report of the disaster from the public or local authorities. This report was accepted by local BPBD through rapid communication tools, such as short message, chatting application, or phone. This report is processed by local BPBD for commissioning Quick Response Team (TRC) to conduct field assessments. Results of the assessment will be made into a report and became reference of what requirements need to be prepared by BPBD and other sectors.

The next process is preparing logistic needs with checking the availability of aids in the warehouse. If the items aren't available, local BPBD will ask to provincial BPBD. If the items aren't available, provincial BPBD will apply to the BNPB. Provincial BPBD and BNPB will send the logistics to the disaster areas. At the same time, local BPBD will also be coordinated with the existing leading sectors, particularly Public Health Office and Social Office which handles the logistic sector.

Local BPBD will establish a command post as a center area for logistic and coordination. The main task of this post is making the disaster emergency response run efficiently and well-coordinated. Local BPBD will be the main coordinator through the command post. Command post will organise the distribution of aid to disaster victims.

2.4 IRC's management disaster emergency response

Disaster emergency response by IRC begins with the disaster reports from the society, especially the IRC volunteers in each region. This report will be followed up with IRC assessment team assigned to evaluate the condition of the field. The assessment report is used as a reference for preparing a number of goods, personnel, and what else needed.

Local IRC will prepare the logistics and personnel required. If the supply is not enough, the local IRC will ask the provincial IRC to help providing logistics and personnel. If the supply is still not enough, the provincial IRC will ask the national IRC to help provide logistics and personnel.

IRC will be coordinated with BPBD and other leading sectors to share information and the aid's distribution area that can be handled by IRC. This coordination is needed so that the victims do not get double aids from different institutions. IRC will also assist in evacuating the victims together BPBD and BASARNAS, provides a soup kitchen with the Social Office, and provides health posts along with Public Health Office.

2.5 Public Health Office's management disaster emergency response

The disaster emergency response begins with public report to the local Public Health Office. Local Public Health Office sends the initial assessment team to look at the condition of the field to know the medicines,

equipment, and the number of personnel required. The team will report the results of assessment as the basis for setting up logistic. Local Public Health Office will check whether the medicines are available. If the supply is not enough, Local Public Health Office will ask the Provincial Public Health Office to help providing the logistic. If the supply is still not enough, the Provincial Public Health Office will ask the Ministry of Health to help providing logistic.

The next process is the Local Public Health Office send a Quick Response Team (TRC) for treatment to the victims. The team will set up health posts and treat patients at the health posts. Patients with serious illnesses are referred to the nearest health center or hospital. At the same time, Local Public Health Office also send the Rapid Health Assessment (RHA) team to conduct a complete assessment as the accountability and performance evaluation.

2.6 Social Office's management disaster emergency response

The disaster emergency response begins with the disaster reports from the society to local Social Office. Then local Social Officewill send assessment team to evaluate the condition of the field. Reports from assessment team will be used to prepare logistic requirements, especially those related to food, clothing, and shelter. If the local Social Officedoesn't have enough inventories, local Social Officewill ask the Provincial Social Office to help providing logistic. If the supply remains insufficient Provincial Social Office Provincial Social Office will ask the Ministry of Social Affairs to help providing logistic.

Local Social Officewill establish a soup kitchen area and temporary shelter for disaster victims. The soup kitchen will cook meals served three times a day and distribute it to the victims who were affected by the disaster. The temporary shelter will be used for temporary place to live.

3. Simulation model

The simulation model uses Vensim program with the objective function is to minimize the response time during disaster emergency response. The faster the response time of each humanitarian logisticstakeholder, the victim will be quickly rescued and reduce the risk of fatalities.

The data used in the model simulation obtained through the interview process with the Head of Logistic East Java BPBD, East Java IRC, East Java Public Health Office, and East Java Social Office. The case study used to supplement the data in the model is the flood that occurred in Pasuruan District. Data retrieval is done through the interview with the Head of LogisticPasuruanBPBDand PasuruanPublic Health Office.

3.2 Existing model

Variables that influence the objective function (response time) are evacuation time, aid distribution time, food distribution time, construction of temporary shelter time, and treatment of disease time.Each variable is influenced by other variables to know what data is necessary to make this model. The response time is obtained from the maximum time between these five variables (evacuation time, aid distribution time, food distribution time, construction of temporary shelter time, and treatment of disease time). To get the most minimum response time, then these five variables should be completed quickly and accurately. The Existing model's mind map can be seen in Appendix 1.

Total of flood disasters in Pasuruan during 2011 to 2015 is 103 times. The number of districts that have experienced flood in Pasuruan is 18 districts. In every district, there are several villages that are often affected by flood.

Table 1. Number of villages and occurrence probability

Districts	Total Village	Total Disaster	Random number
Bangil	4	26	1 – 26
Beji	3	12	27 – 38
Rejoso	4	12	39 – 50
Kraton	3	10	51 – 60
Grati	2	10	61 – 70
Winongan	4	6	71 – 76
Rembang	1	4	77 – 80
Pohjentrek	1	4	81 – 84
Purwodadi	2	3	85 – 87
Nguling	2	3	88 – 90
Gondang Wetan	5	2	91 – 92
Purwosari	3	2	93 – 94
Pandaan	2	2	95 – 96
Lumbang	1	2	97 – 98
Gempol	1	2	99 – 100
Sukorejo	1	1	101
Pasrepan	1	1	102
Kejayan	2	1	103
Total	**42**	**103**	**103**

Total familiesaffected and disaster occurrence will be generated randomly according to historical data as shown in Table 1. Total families affected will influence the amount of aids, boats, personnel, food, disease management, and evacuation time needed. The more densely populated in a village, the emergency response will take more time.

$$\text{Total families affected in a district} = \sum_{i=1}^{n} \frac{\sum_{j=1}^{t} a_{ij}}{t} \quad (1)$$

a_{ij} : total families affected in *i* villagewhen *j* disaster occur

t : total flood disaster events in *i*village within five years (2011-2015)

n : total village in one district

3.2.1 Aid distribution time

Aid distribution time is the total time needed by humanitarian logistic players to find, prepare, and deliver logistic aids to disaster victims. The logistic aids are hygiene kits (soap, shampoo, toothpaste, toothbrush, diapers, etc.), family kits (shirt, etc.), and staple food (rice, oil, soy sauce, noodles, etc.).

The process starts from society report about events of flood to local government (head of the village or sub-district head). This report is forwarded to local BPBD through rapid communication (short message, phone, chatting application, or handy talky). Local BPBD will send emergency response team(TRC) to assess the condition of the field and what things are required for disaster emergency response. Total time from society report until TRC report is six hours (based on BPBD's standard operational procedure).

The results of the assessment will be the reference to prepare what kind and the amount of aids needed by disaster victims. The process continued with the delivery of aids from local BPBD to post and delivery from provincial BPBD to local BPBD. The aids that aren't available in the warehouse or urgent need can be purchased at the nearest place using BPBD's fund.

At the same time, the society can also report the disaster to local IRC. IRC has many volunteers in various areas so they can also provide information to IRC. This information is followed up by sending a field assessment team. The time required to complete the assessment is six hours according to the IRC working principles, namely "six hours to the disaster area". The results of this assessment will be used to determine the amount of aid should be prepared. IRC will prepare for total families affected, but will send only the amount needed by BPBD. IRC has a large logistic and personnel, but in practice they only deploy total required by BPBD. The process continued with the delivery from local IRC to the post and delivery from provincial IRC to local IRC. The aid distribution timeis obtained by finding the maximum value between distribution time in the post and distribution time to houses.

$$Delivery\ time = \sum_{i=0}^{n-1} t_{i,(i+1)} \quad (2)$$

$t_{i,(i+1)}$: traveling time from *i* village to (*i+1*)village

i =0 : BPBD / IRC / Public Health Office/ Social Office, otherwise number of village

$$Distance\ from\ post\ to\ house\ in\ a\ district = \frac{\sum_{i=1}^{n} \sqrt{(total\ area\ of\ i\ village)}}{n} \quad (3)$$

3.2.2 Construction of temporary shelter time

Construction of temporary shelter time is the total time of assessment, preparing, sending temporary shelters logistic, and setting up a temporary shelter. Temporary shelters are usually located in the village hall because it is easy to reach by the victims. The construction of temporary shelter is the main task of Social Office as a leading sector. Logistic needed for the temporary shelter are tents, blankets, beds, and so on.

The process starts from the society report on the disaster event to local Social Office. This report is different with the report accepted by local BPBD and IRC. Social Affairs send an emergency response team (TRC) to conduct field assessments. The TRC is also different with BPBD's and IRC's team. Results of the assessment are used to determine what kind and amount of aids needed. Logistic aids for temporary shelter delivered from local Social Office to post and from provincial Social Office to local Social Office.

BPBD will also send a temporary shelter logistic as needed. At the same time, the result of IRC's assessment will be used to prepare the amount of aids needed and then sent to the post as requested by BPBD and Social Office. Construction of temporary shelter time is obtained by finding the maximum value between BPBD's, Social Office's, and IRC's aids delivery time.

3.2.3 Evacuation time

Evacuation time isthe total time required to prepare until evacuate victims from the house to the temporary shelter. The process starts from the society report on the disaster event to local BPBD. Results of the assessment are used to determine the number of affected families and location of affected villages.

Evacuation time is affected by total BPBD'sboats, BPBD'sboats capacity, total families affected, assessment time, and the delivery time from home to post. The more families affected by the disaster, the more time required to evacuate families from the house to the post. This will result in longer evacuation time.

3.2.4 Food distribution time

Food distribution time is the total time needed to prepare and distribute food to disaster victims. Preparation and distribution of foodsare coordinated by a soup kitchen under the primary task of Social Office as a leading sector.The process starts from the society report of the disaster to local Social Office. Then the Social Office's emergency response team will make field assessment report. This report is used as a reference to determine the total servings of food needs to be prepared every day.

The process continued with the logistic delivery to the soup kitchen. Deliveries are made from local Social Office to post and from provincial Social Office to local Social Office. Time to prepare the soup kitchen is three hours.Once the food is available, it will be sent from the post to houses and into the temporary shelter.Food

distribution time is obtained by finding the maximum value between food delivery time to houses and the temporary shelter.

3.2.5 Treatment of disease time

Treatment of disease time is the total time required to set up logistic aids to treat patients at the health centre. Disease management becomes the main task of the Public Health Office as a leading sector.The process begins with a society report to the local Public Health Office. People who report this are different from the people who report to BPBD, IRC, and Social Office. The report was followed up by initial assessment team to assess the condition of the field. Follow-up of the report is the delegation of health emergency response team (TRC) and rapid health assessment (RHA) team.

TRC team is a team of doctors and nurses on duty at the health post. RHA team assesses field conditions in detail. The result of the RHA team is the requirements of amount and what kind of medicine needs to be delivered from the local Public Health Office to the post and from provincial Public Health Office to local Public Health Office. Treatment of disease time is obtained by finding the maximum value betweenthe disease management timeat the health centerand at the hospital.

3.3 Existing model result

Total run in Vensim model is 1000 times. The result shows that the response time fluctuates in the range of 27.5 to 50 hours as shown in Figure 2.

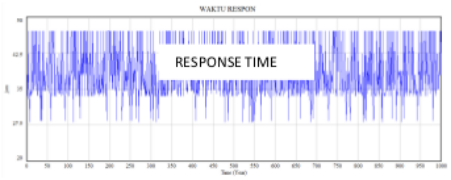

Figure 2. Response time of existing model

Figure 3 shows the simulation result for the variables that affect the response time (evacuation time, aid distribution time, food distribution time, construction of temporary shelter time, and treatment of disease time). Aid distribution time is the fastest time done by humanitarian logistic stakeholders. Evacuation and treatment of disease time are critical variables that affect the response time so they need to be improved to achieve minimum response time.

The average response time of emergency response in the simulation model is 38.4 hours. The maximum response time in the simulation model is 47 hours, or two days.

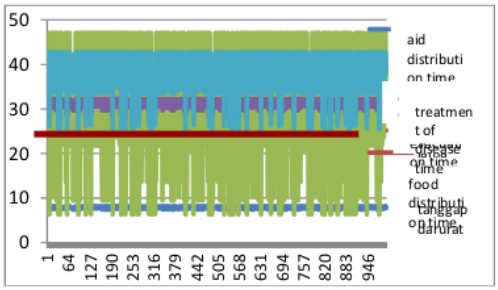

Figure 3. Variables affecting response time of existing model

3.4 Proposed model

In the existing disaster emergency response system, each stakeholder has different emergency response team to do its own initial assessment. This system results in a double process that is not necessary. It also causes some agencies work faster than the other because of the delay in getting the information and assessment. IRC is chosen because it has many volunteers in each area so the information will be known more quickly. Assessment done by IRC also quick and precise so that the data needed can be identified quickly. There are several changes need to be used in standard operational procedure (SOP) of emergency response. The change is making a platform or joint website that can be accessed by all humanitarian logisticstakeholders to exchange information and assessment results.

Another proposed improvement in this model is the addition of IRC as a leading sector in the core team. This is necessary because the IRC has huge human resources and aids logistic, but so far still working out of coordination system and merely as complement. The response time will be minimized if IRC, both personnel and aids logistic, could be deployed directly as a major player.

Data change in the proposed model are the total of distribution's boats, total of evacuation's boat, and total of food distribution's boatwill be added with IRC's boat. Other changes are the total of soup kitchen personnel and doctors in health postwill be added with IRC's personnel. The Proposed model's mind map can be seen in Appendix 2.

3.5 Proposed model result

Total run in Vensim model is 1000 times. The result shows that the response time fluctuates in the range of 7.5 to 30 hours. The average and maximum response time for each improvement can be seen on Table 2.

3.6 Existing and proposed model result comparison

Table 3 shows that the first priority needs to be considered is the assessment process only done by IRC's assessment

team. Second priority is the addition of health post's doctors by IRC's personnel. Third priority is the addition of evacuation's boats by IRC's assets.
Fourth priority is the addition of soup kitchen's personnel. Although this improvement doesn't reduce the average response time directly, this improvement will reduce 1.4 hours of food distribution time variable. Fifth priority is the addition of aid distribution's boats.
Although this improvement doesn't reduce the average response time directly, this improvement will reduce 0.18 hours of aids distribution time variable. The addition of food distribution's boats can be ignored because it doesn't affect either response time or local variable (food distribution time variable). Total reduction of average response time for all improvement is up to 20.5 hours.

Table 2. Simulation result for proposed model

Number	Improvement	ResponseTime (hr)	
		Average	Maximum
1	Assessment by IRC	29.4	47.1
2	Addition of evacuation's boats	37.3	42.8
3	Addition of aid distribution's boats	38.4	47.1
4	Addition of food distribution's boats	38.4	47.1
5	Addition of soup kitchen's personnel	38.4	47.1
6	Addition of health post's doctors	35.1	47.1
7	All improvement	17.9	26.5

Table 3. Reduction of average response time for proposed model

Number	Improvement	Reduction of Average ResponTime (hr)
1	Assessment by IRC	9.04
2	Addition of evacuation's boats	1.1
3	Addition of aid distribution's boats	0
4	Addition of food distribution's boats	0
5	Addition of soup kitchen's personnel	0
6	Addition of health post's doctors	3.3
7	all improvement	20.5

4. Conclusion

Humanitarian logistic stakeholders in East Java are BPBD, IRC, Social Office, and Public Health Office. Each stakeholder has their special tasks that have been set by government regulation. Unlike the other stakeholder, IRC is a non-governmental organization that is not tied to the government bureaucracy. It is also why IRC has limitations in coordination when performing emergency response. IRC and other stakeholders do the same work but it is not included in the same team.
Coordination and emergency response process during flood disaster in East Java simulated with Vensim software. The objective function is to minimize the response time. There are five variables that affect the objective function, which areevacuation time, aid distribution time, food distribution time, construction of temporary shelter time, and treatment of disease time. The average response time result from the existing model is 38.4 hours. The maximum response time generated by the existing model is 47 hours.
The proposed model changes several processes of disaster emergency response. The changes are IRC's direct involvement in the main coordination.The average response time result from the existing model is 17.9 hours. The maximum response time generated by the existing model is 26.5 hours. The proposed model can reduce the response time up to 20.5 hours. The order of priority of the improvement are the assessment process only conducted by IRC's team, addition of health post's doctors, addition of evacuation's boats, the addition of soup kitchen's personnel, and the last is addition of aid distribution's boats.

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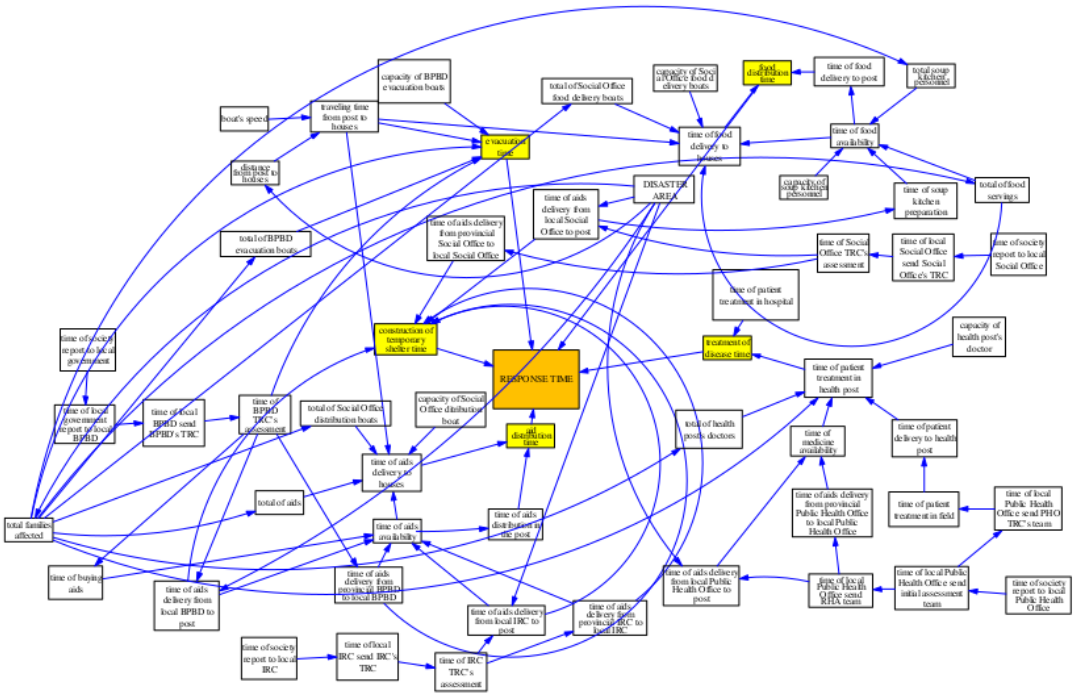
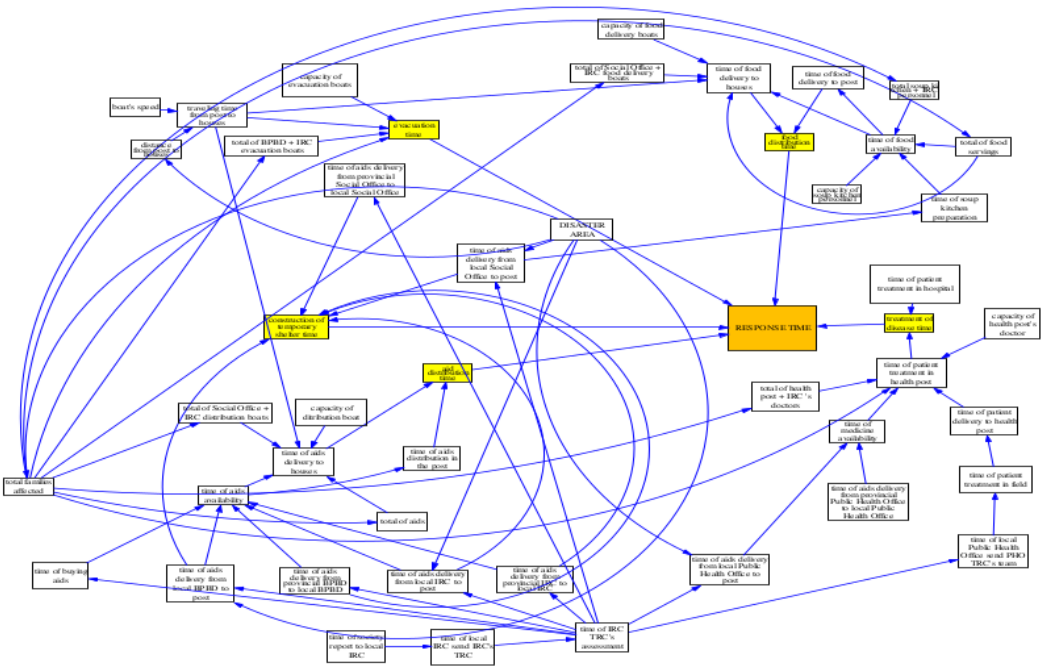
Appendix 1. Existing model's mind map



Appendix 2. Proposed model's mind map



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