RANCANGAN DARI SUATU RANTAI LOGISTIK BANTUAN KEMANUSIAAN : ALUR PEMODELAN DAN SIMULASI

TESIS

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FAKULTAS TEKNIK
PROGRAM PASCA SARJANA TEKNIK SIPIL
DEPOK
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Diajukan sebagai salah satu syarat untuk memperoleh gelar Magister Teknik

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FAKULTAS TEKNIK
PROGRAM STUDI TEKNIK SIPIL
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KATA PENGANTAR

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ABSTRACT

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Judil Tesis : Design of a chaine of humanitarian logistic : Modeling and Simulation Flow

Quick response to the urgent need of relief after disasters is critical issues for emergency logistics distribution. The urgent relief distribution is a vital operation to the alleviation of disaster impact in the affected areas. This study will concentrate on how to distribute relief material effectively and fairly which means that satisfied the demands and minimizing the cost of transportation. Efforts are made to ensure that required relief materials are distributed to all demands areas. By grouping the affected area that are close to the relief distribution center, the optimization approach to the operation emergency logistics and co-distribution responding to the urgent relief demand in the crucial rescue period can facilitate the distribution of humanitarian relief. According to three-layer emergency logistics co-distribution conceptual framework, the flow of relief could be implemented efficiently to the affected areas. We hope this study cannot only make the proposed emergency logistic system but also can be applied through future development in case of Natural Disasters.

Keyword:

Natural Disaster, Emergency Logistics Distribution, Relief Distribution, Multi-Objective Optimization.

ABSTRAK

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Judil Tesis : Rancangan dari suatu rantai logistik bantuan kemanusiaan : Alur Pemodelan dan Simulasi

Respon cepat untuk memenuhi kebutuhan yang mendesak setelah terjadinya bencana adalah masalah yang sangat penting dalam pendistribusian logistik pada saat keadaan darurat. Pendistribusian bantuan yang mendesak adalah operasi vital sebagai upaya pengurangan dampak bencana didaerah terjadinya bencana. Studi ini akan berkonsentrasi pada pendistribusian bahan bantuan secara efektif dan merata dengan maksud untuk memenuhi permintaan bantuan serta meminimalkan biaya transportasi. Upaya yang dilakukan adalah untuk memastikan bahwa bahan bantuan yang diperlukan didistribusikan ke seluruh daerah yang membutuhkan. Dengan cara mengelompokan daerah yang terkena bencana dekat dengan pusat distribusi bantuan, pendekatan optimisasi dalam operasional untuk pendistribusian logistik dalam keadaan darurat dan konseptual kerangka distribusi terkait dengan permintaan bantuan pada periode permintaan pertolongan dapat memudahkan aliran pendistribusian bantuan kemanusiaan pada daerah yang terkena bencana. Berdasarkan tiga lapis kerangka konsep distribusi logistik dalam keadaan darurat, aliran bantuan dapat dilaksanakan dengan efisien dan merata ke daerah-daerah permintaan. Semoga dalam studi ini tidak hanya dapat membuat sistem logistik dalam keadaan darurat yang diusulkan, tetapi dapat juga diterapkan melalui pengembangan di masa yang akan datang dalam hal terjadinya bencana alam.

Kata kunci:

Bencana Alam, Darurat logistik distribusi, Pendistribusian bantuan, Multi-Objektif Optimisasi.

DAFTAR ISI

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CHAPTER I

INTRODUCTION

1.1 Background

Although minor earthquake occur nearly every day, the effects of a strong earthquake are devastating. In the history, earthquake occurred in China that killed 830.000 people in 1556. Recent fatal earthquake occur again and took place in Taiwan (termed as the 921 Chichi earthquakes) in 1999 and killed 2455 in total, more than 8000 injuries, with 3895 homes destroyed (Executive Yuan of Taiwan, 1999). After that similar earthquakes happened again such as in India in January 2001, Southeastern Iran in December 2003. Indonesia in December 2004, Pakistan in October 2005, Haiti in 2010, Tokyo Japan in 2011 and Negros Oriental Philippines in 2012. In this study the writer take an review the events earthquakes that have occurred in Taiwan in 1999. Terms as 921 Chichi earthquakes in Taiwan, rescue efforts had been carried out immediately following the earthquake; the government of China conducts a meeting to discuss how to tackle the aftermath. In the same day the military was mobilized, with a large numbers of conscripted soldiers heading to stricken regions to assist in distributing emergencies supplies, clearing roads, and rescuing people trapped in the rubble. Helicopters were used to evacuate injured people from mountainous regions to hospitals and to supply food to communities inaccessible by road (Sen-lun, 1999). Many charities, corporation and private sectors are contributed to the relief effort and the later reconstruction. Private donations directly to the government run disaster fund, while organizations including the Presbyterian Church of Taiwan, Rotary International, Cathay Life Insurance, Dharma Drum Mountain, I-Kuan Tao, the Tzu Chi Foundation and various temple, church and community groups all contributed to aiding survivors and funding reconstruction (Ding & Yuh-Chyurn, 2006).

This paper is refers to the article with the title " An emergency logistics distribution approach for quick response to urgent relief demand in disasters ". The author of the references article is Mr. Jiuh-Biing Sheu, he works for Institute of Traffic and Transportation National Chiao Tung University, 4F, 114 Chung

Hsiao W Rd Taipei, Taiwan. In his article he presents a hybrid fuzzy clustering-optimization approach to the emergency logistics co-distribution responding to the urgent relief demands in the crucial rescue period. The proposed methodology involves two recursive mechanism: (1) disaster area grouping, and (2) relief co-distribution.

1.2 Problems of relief distribution systems

Generally, emergency logistics is different from general business logistics, emergency logistics is unique in four aspects that may increase the relative complexity and difficulty in solving the induced relief logistics problems, particularly in terms of emergency logistics distribution. In this case, running the emergency logistic distribution desperately need very accurate information related to the circumstances. First, demand-related information, for example, the severity of the disaster that caused the disaster area and the effects on victims is limited to the beginning period of search and rescue, and cannot predicted intuitively by using historical data. Second, relative to general management of business logistic, logistics resource requirements of the appropriate emergency and may not be fully controlled for decision makers on the supply side, adding more challenging problems for rapid emergency response in logistic distribution system. Third, the infrastructure damaged by disaster may lead unexpected risk to distribute the aid, and coupled by the issues lead to the restructuring of emergency logistics network, and must be completed within a limited time frame. Four, regarding the global relief supply for large-scale natural disasters such as tsunami tremendous victims from Southeast Asia, which generated International support and logistical problems of resources management, can make the entire logistics emergency system more complicated, causing more serious problems of supply-demand imbalance in the process of emergency logistics distribution. Generally, there is characteristics of relief distribution systems, general physical distribution system consist of material items, cost of materials, number of vehicles, modes of transportation, number of depots, demand of materials, transportation networks, vehicle capacity, travel time of the route, and various operational modes. The objective of physical distribution are to find a combination of those variables that minimizes total traveling time, minimizing vehicle fleet, maximizes capacity service and minimizes cost that consist of fixed and variable cost. In relief distribution system there is similar way with general physical distribution systems that also consist of three separate parts: demand, supply and transportation. The collection points in non-devastated area play the role of supply, while demand point is the affected areas by disasters where relief is provided to victims who play role as customers. In additions, large scale commodities distribution depots near the demand point or affected areas play the role of distribution centers. The only difference between general distribution system and relief distribution system that the distribution depots are temporary storage points instead of permanent distribution warehouse. Moreover, operators for relief distribution are often from government agents and non-profit organizations that emphasize efficiency and fairness.

Related to general problem of emergency logistic system, this study case problems background is reportedly, the earthquake and its after shocks caused 2455 death in total, more than 8000 injuries, with 38,935 homes destroyed (Executive Yuan, 1999). The affected areas are located in Taichung and Nantou Counties, central Taiwan. There are 24 most severely affected areas (in terms of dead casualties) area of Taichung. To centralize the actions of rescue and relief distribution to the affected areas, three tentative refugee center (terms as relief distribution center 1,2 and 3) to collect and supply relief. Mean while the support of rescue and relief supply come from 6 unaffected counties. Nevertheless, due to lack of coordination between the refugee center (distribution center) and relief supply sources as well as the overestimation of relief demand from affected areas, there will make relief supply-demand imbalances problems. Base on the problem background, simplified formed as 6 x 3 x 24 relief supply network.

CHAPTER II
LITERATURE REVIEW

Despite the critical importance of emergency logistics distribution, relative to business logistics and supply chain management, only limited amount of related research has been carried out. The significance of issues on relief supply to areas suffering from disaster and the resulting logistic problems had been presented previously (Kembel & Stephenson, 1984; Ardekani & Hobeika, 1988; Long & Wood, 1995), followed by the mergence of diverse linear programing based model proposed for emergency planing (Knott, 1988) (Brown & Vassiliou, 1993) (Fiedrich, Gehbauer, & Rickers, 2000) (Barbarosoglu, Ozdamar, & Ahmet, 2002) (Ozdarmar, Ekinci, & Kucukyazici, 2004). Therein, a number of researches tended to formulate the resulting relief transportation issues as multi-commodity, multi modal flow problems with time windows (Rathi, Church, & Solanki, 1992) (Haghani & Oh, 1996). Fuzzy set method is a kind of offshot in the fuzzy mathematics, which has become an active research area in risk analysis and management for flood disaster (Feng & Luo, 2009) (Jiang, Deng, Chen, Wu, & Li, 2009) due its successful application on complex engineering optimization model. As compared with classical, fuzzy sets method possess better result and mathematical treatablity in different fields. (Chen, 1998) (Chen, 2002) has extended fuzzy set theory to many engineering fields and improved Bezdek fuzzy clustering iterative model. (Brown & Vassiliou, 1993) developed a sophisticated real-time decision support system using optimization approach simulation techniques as well as decission maker's judgment for both relief resources allocation and assignment following a disaster. Considering a multi commodity supply problems under emergency conditions three linear programming formulation are proposed in (Rathi, Church, & Solanki, 1992) where the routes and the supply amount carried on each route are assumed to be known in each of given origin-destination (O-D) pairs. (Haghani & Oh, 1996) proposed time-spaced network formulated the large scale disaster relief transportation problem as a multi-commodity and multi-modal network flow model with a single objective function. In their conceptual model, the time-varying status of commodities and vehicles moving in a transportation network is represented by three types of links, including routing, transfer, and supply/demand carry-over links, to facilitate the analysis of the resulting complicated network flow problem. In (Fiedrich, Gehbauer, & Rickers, 2000) a dynamic combinatorial optimization model is proposed to find the optimal resource rescue schedule with the goal of minimizing the total number of fatalities during the search and rescue (SAR) period, which refers to the first few days after the disaster. Although the model proposed by Fiedrich et al. Aims merely to deal with rescue resource allocation problems, their approach is unique in the estimation of fatality probabilities in various rescue scenarios during the SAR period. This may motivate further research expansion to forecast the time-varying relief demand patterns using the relationships between the survivals and the induced relief demands. In addition, three types of affected areas (termed as the operational areas in their study) coupled with three rescue-related facilities are defined in order to clarify the linkages among the affected areas, rescue facilities, and the corresponding work tasks in the resulting resource allocation process.

More recently, considering the complexity and difficulty in solving the emergency logistics distribution problem with a single model, there is a research trend of decomposing the original problem into given mutually correlated sub-problems, then solve them systematically in the same decision scheme. For instance, a bi-level hierarchical decomposition approach is proposed in (Barbarosoglu, Ozdamar, & Ahmet, 2002) for helicopter mission planning during a disaster relief operation. Therein, the top-level programming model is formulated to deal with the resulting tactical decision problems, covering the issues of helicopter fleet management, crew assignment, and the determination of the tour number undertaken by each helicopter, followed by the base-level programming model aiming to address the corresponding operational decisions, including routing, loading/unloading, rescue, and re-fueling scheduling problems. Another case studied by (Ozdarmar, Ekinci, & Kucukyazici, 2004) is unique in incorporating the vehicle routing problem into the relief distribution process, in which vehicles are treated as commodities to facilitate decomposing the comprehensive emergency logistics distribution problem into two multi-commodity network sub-problems, and then solved using Lagrangean relaxation.

Although the emergency logistics distribution problem considered here is related to vehicle routing problems (VRP) which have been extensively investigated in previous literature, the nature of the problem of a comprehensive emergency logistics distribution system can be more complicated, and needs to further include the pre-route operational tasks, such as relief demand forecasting and collection as well as efficient relief resource allocation to affected areas. In addition, the typical vehicle routing maneuvers, involving the requirement of vehicle dispatching and returning to the same depot, do not necessarily hold in the emergency logistics context. However, it is maintained in (Ozdarmar, Ekinci, & Kucukyazici, 2004) that in some emergency logistics operational cases, any given node receiving relief commodities can be the new depot or the former depot may no longer supply relief, and thus vehicles may stay at their last stop, until the next distribution mission is identified. Surveys and discussions on the existing VRP approaches and their extensions can be readily found in the previous literature (Solomon & Desrosiers, 1988) (Dror, Laporte, & Trudeau, 1989) (Laporte, 1992) (Bertsimas, Chervi, & Peterson, 1995) (Fisher, 1995) (Bramel & Simchi-Levi, 1999), and many more that support this study.

Accordingly, this study concentrate on how to distribute relief material effectively and fairly in the specific grouped areas of disaster that had been determined during the crucial rescue period right after occurrence of natural disaster. The following are the important steps taken during the rescue within the first three days after the disaster, which became a critical time in search and rescue victims trapped in collapsed buildings. Refers to the scope of research that has been defined above, the proposed emergency logistic is unique with three particular features as shown below:

(1) Relief demand related to time-varying in each disaster areas predicted by using a proposed term relief demand forecast model. The relief demand may highly correlate with the number of survivals trapped in the affected areas without receiving any rescue aid. Information concerning to the number of trapped survival in the collapsed building in the affected areas is quite

limited, and may change at any time depending on disaster condition. Consider two things that are uncertain, an estimate of the specific mechanism is proposed to predict the time-varying relief demands in the affected areas.

(2) Before the vehicle is sent, clustering or grouping procedure implemented on the affected areas classified according to estimation for the severity level of damage and also the area that closes to relief distribution center. Here, the affected areas are categorized based on the most severe level of damage to determine the scheduling priority of delivery of aid to disaster areas.

(3) Due to specific demand based on the needs, feature of logistics operation comprises of two stages. First, demand chain optimization-based dynamic model are formulated to integrate the decision of relief from multi sources (suppliers) to distribution center or may states with from the first to the second layer. Second, from relief distribution to demand point that can be stated with from second layer to third layer in the specified emergency logistic co-distribution framework.

CHAPTER III
LOGISTIC DISTRIBUTION PROBLEM IN CASE OF EARTHQUAKE DISASTER IN TAIWAN

3.1 Relief Logistic Network

In case of disaster occurred, the victims need to be provided with food, medicine, water, tents, hygiene products and other relief goods. However, due to disaster, the infrastructure in the affected region can be destroying to a large extent. Therefore, transportation system including intermediate depots has to be establishing in order to be able to transport the relief goods from suppliers to disaster victims. In this case (chichi earthquake) suppliers are come from another local region out from the disaster area which is the resources of the relief. Thereafter, we have to transport those materials to Relief Distribution Center. The recipients at Relief Distribution Center could be a Governments or Relief Agency. Thus, the transportation has to establish to deliver materials to demand point or affected areas.

The relief logistics network considered in this study is described in Fig. 1 which includes three main chain members: (1) relief suppliers, (2) relief distribution center, and (3) demand point (disaster group area) forming a specific three-layer relief supply chain. Here, relief suppliers refer to the sources of relief supply from private or public sector or relief organization agency. Depots or relief distribution center set as the relief supply hub that relative to inbound and out bound relief logistics in response the demands from affected areas during crucial rescue period. Generally, in considering a particular logistic requirements and the size of required facilities, such as distribution center is occupied by the public sector, for example, the depots or relief distribution center controlled by local government or the corresponding regional rescue organizations.

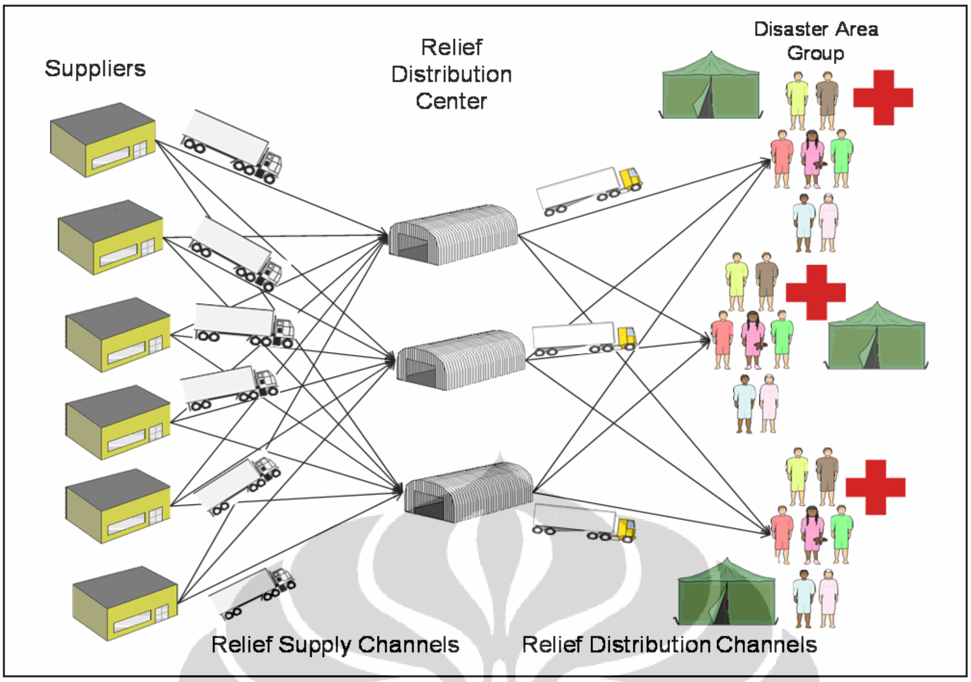

Fig 1.3 Schema of Relief Supply Network

The next step is to transfer the relief material right after arriving in the distribution center to affected area casualty and damaged caused by disaster. Data may need used for relief demand forecasting and area grouping, it may facilitate to deliver a numbers of needed relief materials related to the demand of disaster area. The (Executive Yuan, 1999) reported that official statistic of casualty and number of damaged data in the 921 earthquake summarizes as below. Aggregat statistic in terms of disaster effects as well as the corresponding population data associated with the affected areas of the study site. In this tables, area 1 to 24 means the affected areas that hit by the earthquake. This areas terms as demand point in need of help. Population is the number of people whose living at that area. Helpless people means that a part of population would need more extra attention related to their health, for example they need supply of meal box/pack (food, medicine, vitamins,etc) that cover their health. Hereinafter, the casualty means that building damage condition caused by disaster, it is stated by the degree of damage which is VS: very significant, S: significant, and M: medium. The effect of that casualty, population needs support of a camp for a temporary shelter because their homes are damage by the earthquake until the reconstruction.

Affected area	Population	Number of helpless people	Casualty	Building damage condition
area 1	1572	230	100	VS
area 2	5377	1106	42	S
area 3	1764	327	33	VS
area 4	9330	2369	251	S
area 5	11149	3110	125	S
area 6	26581	8864	172	VS
area 7	3874	961	136	VS
area 8	2398	552	44	S
area 9	1084	283	69	S
area 10	870	199	28	S
area 11	1672	347	14	M
area 12	1304	265	47	M
area 13	2899	330	71	VS
area 14	961	314	19	S
area 15	4385	1081	106	S
area 16	2890	477	38	M
area 17	1746	293	62	M
area 18	9881	2019	17	S
area 19	27759	8910	237	S
area 20	5633	1992	89	VS
area 21	3701	656	25	S
area 22	11933	3712	83	S
area 23	2908	983	27	M
area 24	1856	507	48	S

Table 1.3 Statistic of disaster effects and population of the affected areas

3.1 Strategic Level

(Executive Yuan , 1999) reported that the earthquake and its aftershock caused 2455 death in total; more than 8000 injuries with 38.935 homes destroy. The affected areas, Taichung and Nantou County are located in central Taiwan. Here, this study aimed at 24 areas most severely affected (in terms of death people or victims) by disaster in the city of Taichung. To centralize the action of rescue and distribute humanitarian relief to the affected areas, three temporary refugees center (can be mentioned as relief distribution centers 1, 2, and 3) to collect and supply relief which was establish in three towns (Dongshih, Shinkang and Wufong) in Taichung Country.

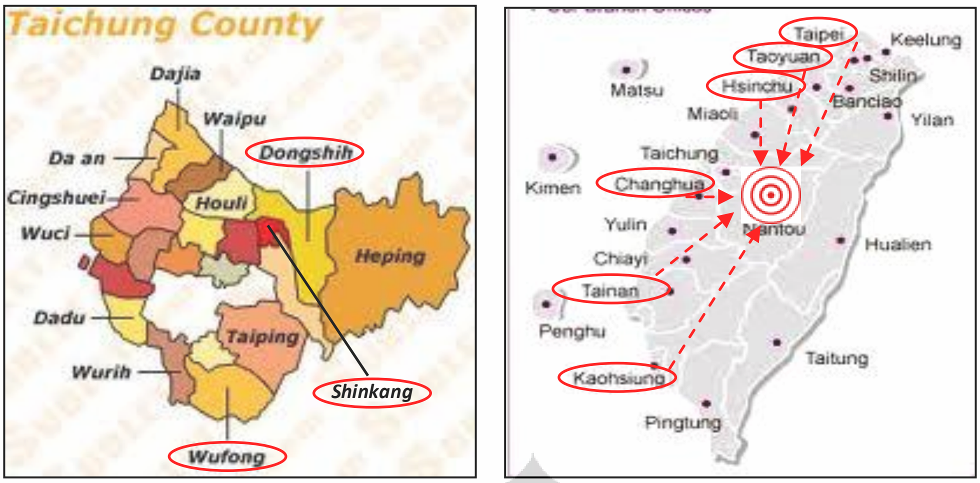

Fig 2.3 Maps of Relief Distribution Center and Suppliers

Meanwhile, the support of trapped victims in the collapsed building rescue and relief supply from 6 unaffected counties including Taipei, Taoyuan, Hsinchiu, Changhua, Tainan, and Kaohsiung (termed as supply sources 1 to 6), was requested immediately by the corresponding refuge centers. Based on the background of the problems mentioned above, a simplified 6 x 3 x 24 relief supply network is formed as shown in figure 2., where the geographical relationship among these relief demand and supply units are specified.

However, due to the lack of coordination between the refuge center and source of relief demand from affected areas, pose a serious problem for relief supply became imbalance. In addition, the allocation of relief distribution resources such as vehicles and volunteers, and the corresponding vehicle dispatching strategies implemented as these relief distribution centers become disordered, resulting in significant delay in transporting relief to certain affected areas.

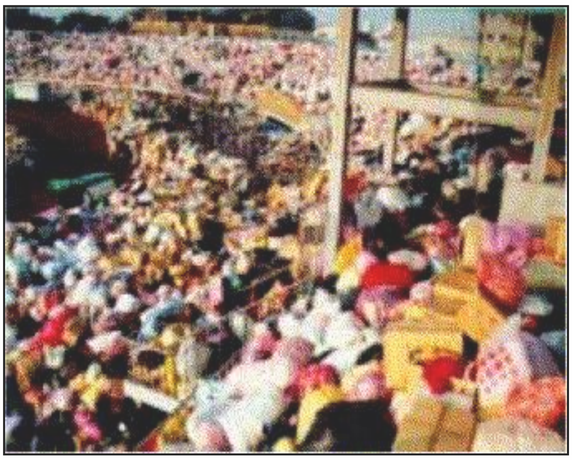

Fig 3.3 Illustration of Imbalance relief over supply at Distribution Center

Therefore, this phase aims to transport the optimal relief supply amounts efficiently in multiply relief supply channels (from multiple relief suppliers to multiple relief distribution centers). Differing from the previous relief distribution phase which serve to distribute various or mixed type of relief in each given relief distribution channel (pair of relief distribution center and affected area), and the phase of relief supply aims to transport homogenous supplied relief in each relief supply channel with the goal of minimizing the transportation cost.

3.2.1 Location of Warehouse (Relief Distribution Center)

As aforementioned, the relief distribution center had defined in three tentative area (Dongshi, Shingkang and Wufan) right inside the Nantou County that affected by disaster. Each relief distribution center which predetermined has storage capacity with respect to a given type of relief. The placement of three warehouses had defined because they are close to the disaster area in order to short access to serve delivery of humanitarian aid to disaster areas. In order to minimize the cost of transportation, distance from warehouse to disaster area has an important role to be defined related to the flow of materials to serve the demand area as fast as they could do. The distance from distribution center located in Dongshi is 5, 81 km from distribution center located in Shinkang. But, the longest distribution center is located in Wufong, they took 45,31 km from Dongshi and 43,13 km from Shinkang. The problem is all distribution center has to serve 24 disaster area that has been grouped before that is closed to each distribution center. Disaster area group 1 which is consisting of area 1 – 7 are close to Dongshi distribution center. Disaster group area 2 which is consist of area 8 – 15 are close to distribution center located in Shinkang and Disaster group area 3 which is consist of area 16 -24 are close to distribution center located in Wufong.

3.2.2 Definition the number and storage capacity of Relief Distribution.

The capacity storage of relief distribution center is different among the three of relief distribution center. Each of them has a different capacity to accommodate the type of relief from different suppliers. Table below show the capacity of each different distribution center related to storage of different relief materials.

CAP_m^l (m^3 ; l = 1,2,3,4; m=1,2,3)											
CAP_1^1	CAP_1^2	CAP_1^3	CAP_1^4	CAP_2^1	CAP_2^2	CAP_2^3	CAP_2^4	CAP_3^1	CAP_3^2	CAP_3^3	CAP_3^4
1000	5000	5000	5000	1000	3000	3000	3000	1000	5000	5000	5000

l=1:water; l=2:meal box; l=3:sleeping bag; l= 4:camp

Table 2.3 Capacity storage of distribution center related to the relief materials

UNV_l (cm^3; l = 1,2,3,4)			
UNV_1	UNV_2	UNV_3	UNV_4
20 x 20 x 10	*30 x 20 x 5*	*50 x 40 x 30*	*120 x 120 x 30*
0,004cm^3	0,003cm^3	0,06cm^3	0,423cm^3

Table 3.3 Unit volume of relief materials

Notation:

C = Set of affected area i, indexed by 1,....c

N = Set of relief supplier, indexed by 1,...n

M = Set of relief distribution, indexed by 1,...m

L = Set of type of relief, indexed by 1,...l

i = represent of affected area ($i \in C$)

$X^{l}_{nli,m}$ (t) = represent of decision variable of time varying quantities relief type

d_{li} = represent of demand of relief type of customer i

n = represent relief supplier ($n \in N$)

m = represent the relief distribution ($m \in M$)

l = represent the type of relief ($l \in L$)

n_{l} = represent relief supplier related to type of relief

CAP (m^3) = represent the storage capacity m

CAP_m^l = represent the storage capacity ($m \in M$), ($l \in L$)

UNV (cm^3)= represent unit volume l

UNL_v = represent unit loading vehicle related to l

CT = Cost transportation

$CT_{nl}{}^{l}{}_{,m}$ = Cost transportation related to l from n to m

$CT_m{}^{l}{}_{,i}$ = Cost transportation related to l from m to i

$CS_m{}^{l}{}_{,i}$ = Cost Setup related to l from m to i

Based on capacity storage of each relief distribution center, this study propose on how to optimize relief distribution with given data which is more than capacity storage of each relief distribution center to disaster areas effectively and equitably, thus, all demand points related to relief aid distribution may properly fulfilled.

n_l l	1	2	3	4	5	6
1 (water; gallon)	50000	30000	30000	20000	30000	20000
2 (meal box; pack)	6000	4000	3000	3000	5000	5000
3 (sleeping bag; set)	3000	2000	2000	1000	3000	3000
4 (camp; set)	500	300	300	300	400	400

Table 4.3 Number of relief supplies from suppliers

Optimizing the number of relief supply has to determine in connection with the limitation of capacity of the relief distribution center. But, since the capacity of the relief distribution center as known above in m^3 and volume of relief in cm^3, we equate the volume of relief materials in to the same denomination with relief capacity storage. Accordingly, we have the equation as shown below;

Suppliers	Water	Meal box	Sleeping bag	Camp	TOTAL
SP 1	200 m^3	18 m^3	180 m^3	216 m^3	614 m^3
SP 2	120 m^3	12 m^3	120 m^3	130 m^3	382 m^3
SP 3	120 m^3	9 m^3	120 m^3	130 m^3	379 m^3
SP 4	80 m^3	9 m^3	60 m^3	130 m^3	279 m^3
SP 5	120 m^3	12 m^3	120 m^3	173 m^3	425 m^3
SP 6	80 m^3	15 m^3	180 m^3	173 m^3	448 m^3

Table 5.3 Relief Materials in units (UNV in m3)

Beside the capacity storage of Relief Distribution Center we have also the capacity of vehicle that transports all relief materials to Relief Distribution Center. The capacity of vehicle loading as shown is UNL_v (Unit Loading Vehicle cm^3) 350 x 187 x 180 or equal with $12m^3$. Than we can deduce that vehicle capacity may contain of a mixed relief materials type such as below;

$$\text{Max} \sum_{\forall l}^{l} \sum nl,m \leq \text{UNL}_v$$

Equation	Water	Meal box	Sleeping bag	Camp
$3m^3$	750	1000	50	7
$6m^3$	1500	2000	100	14
$9m^3$	2250	3000	150	21
$12m^3$	3000	4000	200	28

Table 6.3 The Equation of relief type in vehicle loading capacity

3.2 Operational Level

Prior to the relief humanitarian operation is executed the first thing to defined is the ability of the transportation and availability the personnel to drive the vehicle to the set of destination place. The driver is a significant thing should be hired when the catastrophe happens. Driving in a long distance and going back and forth is impossible done by certain people that have not trained before to face the situation and limited personnel. Therefore, employing the right people can facilitate the work. Scheduling time determined to distribute the relief humanitarian related to the transportation and drivers. Distance also could be more considerate to find efficiently the fleet of vehicles. Path defined to get the shortest route, thus, after first sending the humanitarian relief to distribution center, the vehicles return to the point of departure and resent the another order. Apart from all this, the need of fuel for vehicle should keep in mind of no less important. Typically, when disaster happened the consumption of fuel for domestic use or industrial will increase. Therefore, planning system for relief humanitarian operational has to establish before the action in order to have a good task.

This operational phase aims to transports numbers of relief materials from suppliers to distribution center, there after transports the relief materials from relief distribution center to disaster/affected areas. The objective of this phase is how to minimize the transportation cost related to the number of relief type materials and number of relief distribution, meanwhile simultaneously minimize the time of transfer materials. Due to the cost of transportation, each relief type has a different cost of transport to a different destination (relief distribution center). Corresponding to to relief type there are also cost set-up of each given relief type that respectively added in the transportation cost. This cost setup divided in two base on the suppliers location. Cost setup 1 related to suppliers n = 1,2 and 3 and Cost setup 2 related to supplier n = 4,5 and 6. Considering to the cost setup and cost transportation the of this study is to minimize the cost transport related to given relief materials from the suppliers to distribution center and from distribution center to disaster areas. The cost setup and cost transport show below correlate to the type of relief and supplier.

CS^{l}_{n} (US$: l=1,2,3,4 n=1,2,3.....6)							
n=1,2,3				n=4,5,6			
CS^{1}_{nl}	CS^{2}_{nl}	CS^{3}_{nl}	CS^{4}_{nl}	CS^{1}_{nl}	CS^{2}_{nl}	CS^{3}_{nl}	CS^{4}_{nl}
1,5	1	5	25	1	0,7	4	20

Table 7.3 Cost Setup of relief materials

$$\min \sum_{\forall l} \sum_{m=1}^{M} \eta_m (t) \times \left\{ \sum_{n=1}^{Nl} \left(\mathbf{CS}^{l}_{nl} + \mathbf{CT}^{l}_{nl,m} \right) \times X_{nl} (t) \right\}, \forall t$$

$$\sum_{g=1} \sum_{\forall ig \in g}^{G} X^{l}_{mi,g} (t) \leq \sum_{nl} X^{l}_{nl,m} \leq CAP_{lm} , \quad \forall (l, m , t)$$

$$X^{l}_{nl .m} (t) \geq 0, \forall (l, m, nl, t)$$

Here below is the cost of transportation related to each type of relief materials for each destination (relief distribution center), as shown;

Water			
RS	Distribution Center		
	1	2	3
1	0.3	0.2	0.3
2	0.2	0.1	0.2
3	0.1	0.1	0.1
4	0.1	0.1	0.1
5	0.2	0.2	0.2
6	0.2	0.2	0.1

Meal box			
RS	Distribution Center		
	1	2	3
1	0.5	0.5	0.6
2	0.3	0.3	0.4
3	0.3	0.2	0.2
4	0.2	0.1	0.1
5	0.2	0.2	0.2
6	0.3	0.2	0.2

Sleeping bag			
RS	Distribution Center		
	1	2	3
1	5	5	6
2	4	3	4
3	3	2	3
4	3	2	2
5	3	3	3
6	4	3	4

Camp			
RS	Distribution Center		
	1	2	3
1	8	6	7
2	6	5	6
3	5	5	4
4	4	4	3
5	5	5	4
6	7	6	6

Table 8.3 Cost Transport from Relief Suppliers to Relief Distribution Center

DC	Affected Areas																							
US$ = *l*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
2	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7

DC	Affected Areas																							
US$ = *l*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
2	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
3	1.0	1.0	1.0	1.0	1.0	1.0	1.0	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5

DC	Affected Areas																							
US$ = *l*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	3	3	3	3	3	3	3	4	4	4	4	4	4	4	4	6	6	6	6	6	6	6	6	6
2	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	6	6	6	6	6	6	6	6	6
3	6	6	6	6	6	6	6	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3

DC	Affected Areas																							
US$ = *l*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	10	10	10	10	10	10	10	12	12	12	12	12	12	12	12	13	13	13	13	13	13	13	13	13
2	12	12	12	12	12	12	12	10	10	10	10	10	10	10	10	13	13	13	13	13	13	13	13	13
3	13	13	13	13	13	13	13	12	12	12	12	12	12	12	12	10	10	10	10	10	10	10	10	10

Table 9.3 Cost Transportation from Relief Distribution Center to Disaster Areas

CHAPTER IV
MODELING AND SIMULATION

4.1 ARENA^{TM} Simulation Software

In this study to find the objective result the writer use ARENA^{TM} Rockwell Software Basic Edition (Student Version) as a solver of the problems show in this paper. Some data may need during the simulation to run the programming system of the simulation. This software can makes simple way to build the model and simulation of the work. Arena Rockwell Software is most effective when analyzing business, service, or simple (non material-handling intensive) manufacturing processes or flows. Therefore, this study needs to use the software to perform the task.

Typical scenarios in this software are including:

- Documenting, visualizing, and demonstrating the dynamics of a process with animation.
- Predicting system performance based on key metrics such as costs, throughput, cycle times, and utilization.
- Identifying process bottlenecks such as queue build ups and over-utilization of resources.
- Planning staff, equipment, or material requirements.

Using ARENA^{TM} Rockwell Software Basic Edition (Student Version) has limited module in the run set up and data that can be in-put in this software, therefore, to outsmart the task, the writer work separately in running the program to achieve the objective of the study.

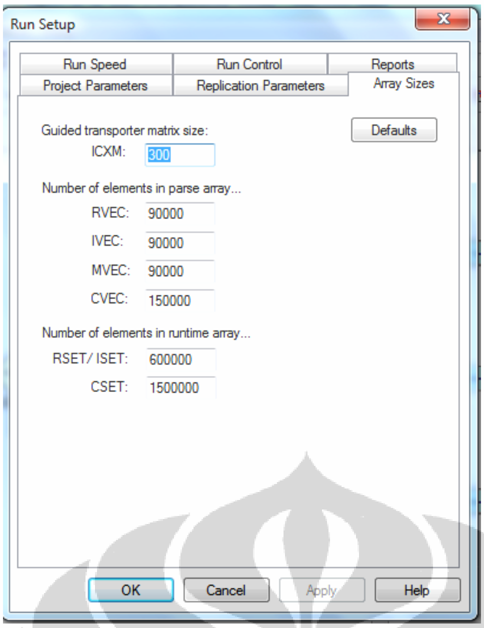

Fig 1.4 Limited Running Setup in Arena Basic Edition (Student Version)

In order to enter the data by using Microsoft Excel as data source that link to the software module can facilitate the work of the module to read data. Thus, all the input data can be readily simplified to get the result after the software do the calculation of the data. This study using the three basic templates to running the program such a Basic Process Template, Advance Process Template and Advance Transfer Template. These templates contain the modeling shapes, called modules that use to define the process. These templates are related to each other to run the program that became the aims of the objective which are how to find the total cost of the transportation from the suppliers to distribution center and the transportation cost from distribution center to disaster area.

4.2 Building the Model

4.2.1 First phase (Flow materials from supplier to distribution center)

Before building the model with Arena Software, the first thing that we use is to define the module template. There is two module used to building the model and simulation. The module terms as Flow Module and Data Module. Module Flow defined in order to create the model in window flowchart model screen and data module is to input values related to the model defined. As aforementioned above, that in this study using three module templates to run the program. Starting from Basic Process Template which begins of every single task is used and begin with:

a. CREATE MODULE. Create module is the beginning of the process flow in the simulation related to the flowchart and individual entity. In this study the entity expressed as a suppliers because the number of relief materials start from this entity.

b. READ/WRITE MODULE which is in the Advance Process Template is used to read data from an input file or the keyboard and assign the data values to a list of a variables or attributes or other expression. The function of this module is to retrieving data from others file (Microsoft Excel Spread Sheet) that link to the module in the software. Since we need as much as data to be used in running the process or to get the outcome or result, this module will take the data from the other file and read it through the read/write module. In addition, to read/write the data, the variable should be set than the module can read the data from the file.

c. SEPERATE MODULE. This module function is to separate the variable read in the file. Splitting the existing variables in the files such as Water, Meal box, Sleeping bag and Camp, we can define those variables out and enter to the next module. Besides that, this module can show the number of read data out in accordance with data that is read.

d. ASSIGNMENT MODULE is the module that assigns data out from separate module or assigning values to variables, entity attributes, entity types, entity pictures or system variables. In this study assigning the variables such as Water, Meal box, Sleeping bag and Camp, than assign them a new value to a new variable, attribute and entity picture. By assigning them to a new variable we can find out or ensuring the output data is same with read data from the files.

e. DECIDE MODULE. This module allows for decision-making process in the system. In this study decision must be made in order to delivery relief materials to a given distribution center. There are three distribution centers which will accommodate relief materials from supplier. This module decides the number of variables such as Water, Meal box, Sleeping bag and Camp that fulfill the distribution center according to with a predetermined amount.

f. ASSIGN MODULE. This module function is to give the new value of number of entities out according to their type or entity picture that has been assigned before. The values are the cost of transport of each entity enters the assign module. The expression variable will show the values (cost of transportation) of each entities after out from the assign module. By assigning the new values for the entities which is means the cost of transport of Water, Meal box, Sleeping bag and Camp from supplier will be different amounts with each other when entering the distribution center. There are 12 assign module set for each relief type for three distribution center.

g. STATION MODULE. Station modules define a station (or a set of station) corresponding to a physical or logical location where processing occurs. In this study, a station is set of supplier station, which means starting point of the station that parked the vehicles to transport materials from suppliers to distribution center.

h. REQUEST MODULE. The request module assigns a transporter unit to an entity and moves the unit to the entity station (distribution center station). A specific transporter unit may be specified or the selection of the transporter may be occur base on destination.

i. TRANSPORT MODULE. The transport module transfers the entity to a destination stations. In this study, a destination stations are set as distribution center station. In this module also set the name of transporter that transports the entities to the destination stations.

j. STATION MODULE. This module set as distribution center station, where the end of the vehicles trip transports the relief materials.

k. MOVE MODULE. The move module in advance transfer templates is a transporter from one location to another. By moving the entities that has been carried out by the transporter means delivering them from starting point (supplier station) to ending destination (distribution center station).

l. FREE MODULE. This module function is to release the entities and free the vehicles after sending the entities. In this study, by free the vehicles means that they can return to the beginning station (supplier station) than reload again (the relief materials) and re-delivery to the distribution center.

4.2.2 Second phase (Flow materials from distribution center to disaster areas)

After relief materials delivered from suppliers to distribution center the next step is to re-deliver them again to the disaster area which is a demand point of relief materials. Continuing the step from the first phase, the module starts from;

a. DECIDE MODULE. This module function is to split the relief materials enter to distribution center and classifying them by their type. For instance, grouping the relief materials of water.

b. ASSIGN MODULE. This module related to previous decide module, to assign the entities (relief materials) by their type and assign new values.

c. DECIDE MODULE. This module is to make a decision on amount of relief materials that will be sent to disaster area. There are 24 affected areas by the earthquake which requires a different amount of aid. Thus, this module set with the demand of each area as constraints of total of the entities out from distribution center.

d. ASSIGN MODULE. This module is set to a value of each entities (relief materials) which enter the assign module and converting them to a new value (cost transport). Which mean this module will calculate for each entities (relief materilal) enter to the assign module and accumulate into the value of total cost transport of each relief materials to given affected areas (demand point). In this block side, there are 96 assign module that set to 24 affected areas for each type of relief materials.

e. STATION MODULE. Station modules define a station (or a set of station) corresponding to a physical or logical location where processing occurs. In this study, a station is set of distribution center station, which means starting point of the station that parked the vehicles to transport materials from distribution center to disaster areas.

f. REQUEST MODULE. The request module assigns a transporter unit to an entity and moves the unit to the entity station (disaster areas station). A specific transporter unit may be specified or the selection of the transporter may be occur base on destination.

g. TRANSPORT MODULE. The transport module transfers the entity to a destination stations. In this study, a destination stations are set as disaster areas station. In this module also set the name of transporter that transports the entities to the destination stations.

h. STATION MODULE. This module set as disaster areas station, where the end of the vehicles trip transports the relief materials.

i. MOVE MODULE. The move module in advance transfer templates is a transporter from one location to another. By moving the entities that has been carried out by the transporter means delivering them from starting point (distribution center station) to ending destination (disaster areas station).

j. FREE MODULE. This module function is to release the entities and free the vehicles after sending the entities. In this study, by free the vehicles means that they can return to the beginning station (distribution center station) than reload again (the relief materials) and re-delivery to the disaster areas.

Besides flowchart module that has been outlined the function above, the data module function also determined in order to input some data or variables related to the model flowchart function. Data module is necessary to define a number of value to compute number of variable in order to have an expected result after running the operation in the program.

4.3 Numerical result

This numerical result in the study case show the number of relief materials from suppliers 1,2,3,4,5, and 6 delivered to a given distribution area 1,2, and 3.

Taipei	DC1	DC2	DC3
Water	16769	16432	16799
Meal box	2278	1465	2257
S. bag	1164	737	1099
Camp	162	131	207

Taoyuan	DC1	DC2	DC3
Water	10024	9904	10072
Meal box	1551	936	1513
S. bag	777	456	767
Camp	110	82	108

Hsinchu	DC1	DC2	DC3
Water	10024	9904	10072
Meal box	1136	699	1165
S. bag	798	484	718
Camp	122	69	109

Changhua	DC1	DC2	DC3
Water	6707	6557	6736
Meal box	1150	694	1156
S. bag	345	264	391
Camp	102	73	125

Tainan	DC1	DC2	DC3
Water	10024	9904	10072
Meal box	1551	936	1513
S. bag	777	456	767
Camp	153	106	141

Kaohsiung	DC1	DC2	DC3
Water	6707	6557	6736
Meal box	1872	1209	1919
S. bag	1142	728	1130
Camp	157	101	142

Table 1.4 Number of relief materials to distribution center

And this below is the number of relief materials from distribution center 1,3 and 3 to 24 affected areas.

Resource from supplier 1 (*l = unit)*

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	180	618	213	1052	1341	3129	426	277	112	104	202	151	344	111	516	346	213	1128	3264	635	476	1356	366	209
Meal box	27	79	39	158	188	396	66	37	20	16	36	31	52	15	69	44	16	130	354	60	52	137	39	26
S. bag	6	38	11	72	91	265	37	10	3	5	7	6	10	9	32	10	11	62	239	49	22	120	35	11
Camp	14	2	2	19	14	14	15	4	5	1	0	1	5	1	9	0	7	0	21	9	4	7	4	4

Table 2.4 Number of relief material distributed to DC1 from supplier 1

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	164	639	187	1037	1279	3087	454	270	117	98	184	137	333	111	515	446	247	1382	3745	776	554	1772	378	258
Meal box	22	44	21	94	112	126	40	27	12	9	22	16	28	7	46	23	15	109	277	51	32	133	32	167
S. bag	1	18	7	39	51	163	25	4	6	2	7	5	11	4	19	7	4	54	188	30	16	55	14	8
Camp	7	5	1	20	1	16	5	2	6	3	2	5	6	1	5	6	6	1	15	6	3	6	2	1

Table 3.4 Number of relief material distributed to DC2 from supplier 1

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	174	662	184	1084	1264	3126	409	297	119	114	183	140	346	135	517	339	186	1196	3263	649	426	1424	329	23
Meal box	20	78	37	145	183	452	64	37	20	25	25	19	53	20	57	59	24	128	419	80	60	189	40	23
S. bag	6	29	8	63	105	267	27	11	7	6	8	5	10	9	37	13	12	53	211	56	26	95	23	12
Camp	15	7	2	24	16	20	20	5	5	2	2	5	8	1	7	3	6	2	20	14	4	10	4	5

Table 4.4 Number of relief material distributed to DC3 from supplier 1

Resource from supplier 2 (*l = unit)*

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	112	363	135	641	763	1853	299	171	77	45	111	93	186	57	299	202	133	694	1975	399	263	821	196	136
Meal box	10	67	11	88	124	299	46	26	12	8	16	12	37	8	42	31	24	93	281	55	45	159	35	22
S. bag	4	29	6	48	65	167	20	11	4	5	5	5	7	8	28	3	5	35	182	34	10	64	23	9
Camp	4	2	2	12	11	12	5	0	4	2	1	1	8	0	6	2	4	2	15	4	0	7	2	4

Table 5.4 Number of relief material distributed to DC1 from supplier 2

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	105	371	126	612	770	1867	255	153	70	55	102	87	225	52	272	229	122	687	1899	359	297	847	204	138
Meal box	7	26	13	72	79	80	3300	16	14	2	11	7	21	5	42	14	15	44	183	31	271	71	12	111
S. bag	2	16	4	33	31	97	20	6	2	2	4	1	0	20	13	5	3	19	216	24	8	48	9	4
Camp	3	0	0	15	6	7	7	0	5	0	0	4	4	1	4	2	2	1	11	2	1	3	2	2

Table 6.4 Number of relief material distributed to DC2 from supplier 2

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	85	370	121	657	754	1919	269	194	84	47	119	83	219	62	303	191	105	749	1913	385	260	848	217	118
Meal box	17	71	17	103	138	277	40	19	14	11	11	9	33	6	44	35	19	95	309	57	28	118	24	18
S. bag	4	22	7	38	59	163	13	14	6	3	9	7	9	7	22	12	3	42	169	38	18	76	17	9
Camp	4	4	1	12	5	15	6	1	3	0	0	3	7	1	4	2	4	0	20	4	1	3	3	5

Table 7.4 Number of relief material distributed to DC3 from supplier 2

Resource from supplier 3 (*l = unit)*

	DC1 to Disaster Area																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	97	376	128	670	765	1887	275	166	68	48	105	84	194	50	287	221	132	698	1938	377	267	849	220	122
Meal box	12	44	17	73	83	225	25	25	9	3	16	9	18	5	31	21	11	79	235	45	17	99	24	10
S. bag	6	15	4	46	60	182	23	9	4	6	4	4	4	7	31	10	7	41	164	47	15	70	24	15
Camp	4	2	0	17	7	8	3	6	5	5	0	3	7	0	8	4	2	0	20	8	0	7	1	5

Table 8.4 Number of relief material distributed to DC1 from supplier 3

	DC2 to Disaster Area																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	99	1352	125	605	737	1858	293	166	89	49	118	89	220	71	270	215	117	683	1908	363	270	848	198	125
Meal box	3	31	8	49	53	57	22	35	10	0	6	13	15	6	27	15	7	50	125	26	29	54	12	68
S. bag	2	7	6	20	42	120	15	20	2	1	1	3	5	4	11	7	3	26	105	31	5	40	13	6
Camp	6	2	2	6	7	5	7	8	3	0	0	0	2	2	2	2	6	1	5	3	1	3	0	2

Table 9.4 Number of relief material distributed to DC2 from supplier 3

	DC3 to Disaster Area																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	105	383	132	646	758	1869	271	171	75	56	113	81	207	44	309	183	114	730	1949	382	273	876	197	148
Meal box	10	49	14	75	80	225	27	21	11	6	5	13	28	10	25	23	15	87	235	48	32	80	32	14
S. bag	6	27	5	41	56	151	19	9	6	5	5	2	8	6	20	6	10	44	157	34	19	51	22	9
Camp	7	4	2	19	7	7	4	2	2	2	2	0	4	0	7	4	4	1	17	5	2	5	1	3

Table 10.4 Number of relief material distributed to DC3 from supplier 3

Resource from supplier 4 (*l = unit)*

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	64	233	91	387	533	1322	165	115	45	37	85	63	123	41	191	135	63	465	1332	248	169	553	148	99
Meal box	19	39	18	76	94	203	38	120	9	3	10	12	19	9	30	26	22	90	227	45	32	89	18	10
S. bag	3	9	1	20	4	68	6	3	1	3	6	1	2	3	12	7	3	18	76	16	6	29	11	4
Camp	3	2	1	12	7	11	9	3	3	1	1	2	4	0	3	3	3	0	24	2	0	3	0	5

Table 11.4 Number of relief material distributed to DC1 from supplier 4

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	57	233	78	447	487	1213	197	99	43	42	75	62	127	31	188	136	91	487	1316	232	169	527	136	84
Meal box	9	25	3	34	51	64	24	9	20	7	7	8	20	4	24	20	8	55	123	27	16	53	20	79
S. bag	1	5	1	18	25	67	4	2	1	1	1	2	4	4	3	2	0	13	58	17	4	26	2	3
Camp	2	0	1	12	4	5	7	2	3	0	0	6	3	0	4	2	5	0	9	4	0	2	0	2

Table 12.4 Number of relief material distributed to DC2 from supplier 4

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	78	262	90	409	550	1260	174	95	54	30	55	48	140	55	202	149	77	474	1305	269	187	567	118	88
Meal box	12	40	14	85	81	225	33	18	8	7	8	14	21	7	23	22	18	65	253	44	32	97	17	12
S. bag	2	8	4	19	24	91	8	5	2	2	2	6	7	7	8	5	5	22	86	23	5	36	8	6
Camp	8	3	3	12	11	7	17	2	3	3	3	1	4	0	8	0	5	2	15	7	3	4	3	1

Table 13.4 Number of relief material distributed to DC3 from supplier 4

Resource from supplier 5 (*l = unit)*

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	92	374	139	636	774	1904	296	168	88	57	116	86	208	61	291	203	99	723	1944	384	230	818	211	122
Meal box	15	71	17	92	129	304	32	27	12	11	10	13	38	12	37	35	20	116	297	66	34	110	28,8/0,9	21
S. bag	2	21	9	37	62	177	19	10	5	3	11	5	5	6	18	12	5	49	175	36	19	67	13	11
Camp	8	3	1	12	4	9	11	6	1	5	3	4	6	1	8	3	4	5	8	12	3	16	4	5

Table 14.4 Number of relief material distributed to DC1 from supplier 5

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	92	360	121	619	793	1875	260	165	73	33	97	800	208	49	284	188	127	700	1931	383	288	819	207	152
Meal box	14	4	11	76	82	79	25	14	5	7	9	11	21	6	26	17	5	58	167	31	27	79	24	105
S. bag	5	19	1	30	25	103	10	9	6	1	4	4	4	3	14	7	3	23	105	23	3	37	12	5
Camp	3	4	2	16	3	6	3	5	7	1	0	0	3	0	8	2	2	1	18	8	1	7	3	3

Table 15.4 Number of relief material distributed to DC2 from supplier 5

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	108	376	119	656	735	1856	270	178	72	52	121	90	200	51	305	216	121	705	1932	365	303	916	206	119
Meal box	15	53	18	95	123	303	53	28	11	7	21	8	29	11	37	34	21	114	278	53	26	128	30	17
S. bag	5	16	3	46	59	161	26	10	7	2	9	3	5	8	22	12	7	34	174	42	13	71	22	10
Camp	10	4	1	18	9	11	12	3	7	3	0	6	6	1	8	3	2	1	17	4	1	8	0	6

Table 16.4 Number of relief material distributed to DC3 from supplier 5

Resource from supplier 6 (*l = unit)*

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	68	264	77	409	540	1251	172	102	54	36	59	54	144	46	182	135	78	461	1334	275	175	554	148	89
Meal box	18	74	31	134	135	330	64	31	17	6	24	20	34	19	49	32	22	137	345	80	55	164	32	19
S. bag	3	32	5	68	102	26	25	20	10	10	6	8	16	5	30	12	8	60	235	62	18	112	25	13
Camp	2	3	4	16	11	16	11	2	14	3	0	3	9	2	11	3	5	1	20	9	1	0	5	4

Table 17.4 Number of relief material distributed to DC1 from supplier 6

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	72	228	75	404	514	1224	172	92	47	38	85	55	130	37	186	138	84	464	1340	234	189	539	125	85
Meal box	14	48	17	81	90	110	20	18	10	8	17	9	24	9	35	25	10	95	224	60	23	95	36	131
S. bag	8	31	5	47	54	160	12	12	3	5	7	4	3	4	18	7	5	27	164	36	19	66	21	10
Camp	7	1	3	9	5	9	6	4	5	1	1	0	3	0	4	4	7	0	16	7	1	4	5	4

Table 18.4 Number of relief material distributed to DC2 from supplier 6

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	68	234	82	437	520	1304	191	112	37	37	66	73	127	37	203	149	76	451	1314	241	175	570	140	92
Meal box	20	68	34	121	153	372	50	23	12	6	23	17	40	18	56	43	29	132	371	66	53	161	28	23
S. bag	2	28	7	60	96	259	33	15	8	8	7	5	10	4	30	14	14	62	231	64	15	115	28	15
Camp	10	5	0	20	10	18	7	2	4	2	2	1	8	1	6	2	3	1	22	3	1	6	2	6

Table 19.4 Number of relief material distributed to DC3 from supplier 6

Base on the number of relief materials above from 6 suppliers to 3 distribution center and to 24 disaster areas, the total cost of transportation result and time of action from each supplier to disaster areas can seen below. The results was compute by using Arena[TM] Software to calculate data in scenario test in order to optimize distribution of relief materials in case of catastrophe (earthquakes). Computational result may not be a significant issues existing in this phase because the process of searching optimal solution is not on the real situation, particularly in minimizing time action from each supplier to disaster areas related with infrastructure, availability of vehicles, personnel, and any other variables that can supports the actions in real time.

Taipei	DC1	DC2	DC3
Water	30184	27934	30238
Meal box	3417	2197,5	3611,2
S. bag	11640	7370	12089
Camp	5346	4061	6624

Taoyuan	DC1	DC2	DC3
Water	17041	15846	17122,4
Meal box	2016,3	1216,8	2118,2
S. bag	6993	3648	6903
Camp	3410	2560	3348

Hsinchu	DC1	DC2	DC3
Water	16038	15846	16115,2
Meal box	1476,8	838,8	1398
S. bag	6384	3388	5744
Camp	3660	2070	3161

Changhua	DC1	DC2	DC3
Water	7377,7	7212,7	7409,6
Meal box	1035	555,2	924,8
S. bag	2415	1584	2346
Camp	2448	1752	2875

Tainan	DC1	DC2	DC3
Water	12029	11885	12086,4
Meal box	1395,9	842,4	1361,7
S. bag	5439	3192	5369
Camp	3825	2650	3384

Kaohsiung	DC1	DC2	DC3
Water	8048,4	7868,4	7409,6
Meal box	1872,0	1088,1	1727,1
S. bag	9136,0	5096,0	9040,0
Camp	4239	2626	3692

Table 20.4 Summary of Transportation Cost from Supplier to Distribution Center

Taipei	2,0174	Hour
Taoyuan	1,1006	Hour
Hsinchu	0,7897	Hour
Changhua	0,2005	Hour
Tainan	1,2082	Hour
Kaohsiung	1,1805	Hour
Averages Time	**6,4969**	Hours

Table 21.4 Averages distribution times from supplier to disaster areas

Resource from supplier 1 (l = *US$*)

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	414	1421	484	2420	3084	7197	980	693	280	260	505	378	860	278	1290	934	575	3046	8813	1715	1285	3661	988	564
Meal box	41	119	59	237	282	594	99	63	34	27	61	53	88	26	117	103	36	302	823	139	122	317	91	61
S. bag	48	304	88	576	728	2120	286	90	54	45	63	54	90	81	288	110	121	682	2629	539	242	1320	385	121
Camp	490	70	70	665	490	490	525	148	185	37	0	37	185	37	333	0	266	0	798	342	152	266	152	152

Table 22.4 Summary of transportation cost from supplier 1 through DC1 to disaster areas

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	410	1598	468	2593	3198	7718	1135	594	257	216	405	301	733	244	1133	949	525	2941	7966	1651	1178	3770	803	548
Meal box	40	79	38	169	202	227	72	41	18	14	33	24	42	11	69	46	30	218	554	102	64	266	64	334
S. bag	9	162	63	351	459	1467	216	32	48	16	56	40	88	32	152	77	44	594	2068	330	176	605	154	88
Camp	259	185	37	740	37	592	185	70	210	105	70	175	210	35	175	228	228	38	570	228	114	228	76	38

Table 23.4 Summary of transportation cost from supplier 1 through DC2 to disaster areas

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	487	1854	515	3035	3539	8753	1145	743	298	285	458	350	865	338	1293	746	409	2631	7179	1428	937	3133	724	513
Meal box	20	156	74	290	366	904	128	63	34	43	43	32	90	34	97	89	36	192	629	120	90	284	60	35
S. bag	66	319	88	693	1155	2937	297	99	63	54	72	45	90	81	333	104	96	424	1688	448	208	760	184	96
Camp	570	266	76	912	608	760	760	185	185	74	74	185	296	37	259	105	210	70	700	490	140	350	140	175

Table 24.4 Summary of transportation cost from supplier 1 through DC3 to disaster areas

Resource from supplier 2 (*l = US$)*

	DC1 to Disaster Area																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	258	835	311	1474	1755	4262	688	428	193	113	278	233	465	143	748	545	359	1874	5333	1077	710	2217	529	367
Meal box	15	101	17	132	186	449	69	44	20	14	27	20	63	14	71	59	46	177	534	105	86	302	67	42
S. bag	32	232	48	384	520	1336	160	99	36	45	45	45	63	72	252	33	55	385	2002	374	110	704	253	99
Camp	140	70	70	420	385	420	175	0	148	74	37	37	296	0	222	76	152	76	570	152	0	266	77	152

Table 25.4 Summary of transportation cost from supplier 2 through DC1 to disaster areas

	DC2 to Disaster Area																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	263	928	315	1530	1925	4668	638	337	154	121	224	191	495	114	598	595	317	1786	4937	933	772	2202	530	359
Meal box	13	47	23	130	142	144	59	24	21	3	17	11	32	8	63	28	30	88	366	62	54	142	24	222
S. bag	18	144	36	297	279	873	135	48	16	16	32	8	0	16	104	55	33	209	1188	264	88	528	99	44
Camp	111	0	0	555	222	259	259	0	175	0	0	140	140	35	140	76	76	38	418	76	38	114	76	76

Table 26.4 Summary of transportation cost from supplier 2 through DC2 to disaster areas

	DC3 to Disaster Area																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	238	1036	339	1840	2111	5373	753	485	210	118	298	208	548	155	758	420	231	1648	4209	847	572	1866	477	260
Meal box	17	142	34	206	276	554	80	32	24	19	19	15	56	10	75	53	29	143	464	86	42	177	36	27
S. bag	44	242	77	418	649	1793	143	126	54	27	81	63	81	63	198	96	24	336	1352	304	144	608	136	72
Camp	152	152	38	456	190	570	228	375	111	0	0	111	259	37	148	70	140	0	700	140	35	105	105	175

Table 27.4 Summary of transportation cost from supplier 2 through DC3 to disaster areas

Resource from supplier 3 ($l = US\$$)

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	219	922	251	1472	1725	4303	658	408	180	130	268	215	490	133	695	572	335	1898	5405	1021	718	2279	562	346
Meal box	21	66	18	95	113	371	42	29	12	9	20	14	39	12	75	27	21	154	409	101	49	179	44	25
S. bag	24	264	56	408	464	1336	184	108	54	36	90	27	36	63	153	88	77	341	2123	462	121	770	242	99
Camp	280	0	0	490	350	315	315	148	148	37	37	74	74	185	259	38	190	38	646	304	38	228	114	152

Table 28.4 Summary of transportation cost from supplier 3 through DC1 to disaster areas

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	273	893	340	1598	1923	4703	690	356	194	106	224	183	471	123	620	554	296	1781	4911	991	660	2179	489	364
Meal box	13	59	13	85	94	110	38	21	12	3	15	9	17	9	27	18	12	98	288	48	22	90	50	166
S. bag	18	126	36	333	261	1053	108	48	24	16	8	24	32	16	88	55	33	286	1155	231	33	561	198	55
Camp	111	24	74	370	148	370	222	70	70	35	70	105	35	35	210	26	76	38	76	76	38	228	76	26

Table 29.4 Summary of transportation cost from supplier 3 through DC2 to disaster areas

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	249	899	381	1820	2234	5225	770	478	178	130	325	215	530	155	755	438	275	1573	4253	814	594	1932	469	282
Meal box	10	98	28	150	160	450	54	36	19	10	9	22	48	17	43	35	23	131	353	72	48	120	48	21
S. bag	66	297	55	451	616	1661	209	81	54	45	45	18	72	54	180	48	80	352	1256	272	176	408	176	72
Camp	266	152	76	722	266	266	152	74	74	0	74	0	148	0	259	140	140	35	595	175	35	175	35	105

Table 30.4 Summary of transportation cost from supplier 3 through DC3 to disaster areas

Resource from supplier 4 (*l = US$)*

DC1 to Disaster Area																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	115	419	164	697	960	2380	297	230	90	74	170	126	246	82	382	297	139	1023	2930	546	372	1217	326	218
Meal box	23	47	22	91	113	244	46	17	13	4	14	17	27	13	42	42	35	144	363	72	51	142	29	16
S. bag	21	63	7	140	259	476	42	24	8	24	48	8	16	24	96	70	30	180	760	160	60	290	110	40
Camp	90	60	30	360	210	330	270	96	96	32	32	64	128	0	96	99	99	0	792	66	0	99	0	165

Table 31.4 Summary of transportation cost from supplier 4 through DC1 to disaster areas

DC2 to Disaster Area																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	114	466	156	894	974	2426	394	168	73	71	128	105	216	52	320	286	191	1023	2764	487	355	1107	286	176
Meal box	14	38	5	51	77	96	36	11	11	8	8	10	24	5	29	34	14	94	209	46	27	90	34	134
S. bag	8	40	8	144	200	536	32	14	7	7	7	14	28	28	21	20	0	130	580	170	40	260	20	30
Camp	64	0	32	384	128	160	224	60	90	0	0	180	90	0	120	66	165	0	297	132	0	66	0	66

Table 32.4 Summary of transportation cost from supplier 4 through DC2 to disaster areas

DC3 to Disaster Area																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	179	603	207	941	1265	2898	400	190	108	60	110	96	280	110	404	253	131	806	2219	457	318	964	201	150
Meal box	20	68	34	145	138	383	56	25	11	10	11	20	29	10	32	26	22	78	304	53	38	116	20	14
S. bag	20	80	40	190	240	910	80	40	16	16	16	48	56	56	64	35	35	154	602	161	35	252	56	42
Camp	264	99	99	396	363	231	561	64	96	96	96	32	128	0	256	0	150	60	450	210	90	120	90	30

Table 33.4 Summary of transportation cost from supplier 4 through DC3 to disaster areas

Resource from supplier 5 (*l = US$)*

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	166	673	250	1145	1393	3427	533	336	176	114	232	172	416	122	582	447	218	1591	4277	844	506	1800	464	268
Meal box	18	85	20	110	155	365	38	38	17	15	14	18	53	17	52	56	32	186	475	106	54	176	51	34
S. bag	14	147	63	259	434	1239	133	80	40	24	88	40	40	48	144	120	50	490	1750	360	190	670	130	110
Camp	300	120	30	450	150	360	420	192	192	160	96	128	192	32	256	66	99	132	462	297	66	396	99	132

Table 34.4 Summary of transportation cost from supplier 5 through DC1 to disaster areas

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	184	720	242	1238	1586	3750	520	281	124	56	165	136	354	83	483	395	267	1470	4055	804	605	1720	435	319
Meal box	21	56	17	114	123	119	38	17	6	8	11	13	25	7	31	29	9	99	284	53	46	134	41	179
S. bag	40	152	8	240	200	824	80	63	42	7	28	28	28	21	98	70	30	230	1050	230	30	370	120	50
Camp	96	128	64	512	96	192	96	150	210	30	0	0	90	0	240	66	66	33	594	264	33	231	99	99

Table 35.4 Summary of transportation cost from supplier 5 through DC2 to disaster areas

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	248	865	274	1509	1691	4269	621	356	144	104	242	180	400	102	610	367	205	1199	3284	621	515	1557	350	202
Meal box	26	90	43	162	209	515	90	39	15	10	29	11	41	15	52	41	25	137	334	64	31	154	36	20
S. bag	50	160	30	460	590	1610	260	80	56	16	72	24	40	64	176	84	49	238	1218	294	91	497	154	70
Camp	330	132	33	594	297	363	396	96	224	96	0	192	192	32	256	90	60	30	510	120	30	240	0	180

Table 36.4 Summary of transportation cost from supplier 5 through DC3 to disaster areas

Resource from supplier 6 ($l = US\$$)

	DC1 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	122	475	139	736	972	2252	310	204	108	72	118	108	288	92	364	297	172	1014	2935	605	238	1218	326	196
Meal box	22	89	37	161	162	396	77	44	24	8	34	28	48	26	69	51	35	219	552	128	88	262	51	30
S. bag	21	224	35	476	714	1799	175	160	80	80	48	64	128	40	240	120	80	600	2350	620	180	1120	250	130
Camp	60	90	120	480	330	480	390	64	448	96	0	96	288	64	352	99	165	33	660	297	33	0	165	132

Table 37.4 Summary of transportation cost from supplier 6 through DC1 to disaster areas

	DC2 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	144	456	150	808	1028	2448	344	156	80	65	145	94	221	63	316	152	176	974	2814	491	397	1132	263	179
Meal box	21	72	26	122	135	165	30	22	12	10	20	11	29	11	42	25	17	162	381	102	39	162	61	223
S. bag	64	248	40	376	432	120	96	84	21	35	49	28	21	28	126	42	50	270	1640	360	190	660	210	100
Camp	256	32	96	320	160	320	192	150	180	30	30	0	120	0	150	39	165	0	396	165	33	99	132	99

Table 38.4 Summary of transportation cost from supplier 6 through DC2 to disaster areas

	DC3 to Disaster Area																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Water	156	538	189	1005	1196	2999	439	224	74	74	132	146	254	74	406	253	129	767	2234	410	298	969	238	156
Meal box	34	116	82	206	260	632	85	32	17	9	32	24	56	25	78	52	35	158	445	79	64	193	34	28
S. bag	20	280	70	600	960	2590	330	120	64	64	56	40	80	32	240	98	98	434	1617	448	105	805	196	105
Camp	330	165	0	660	330	594	231	64	128	64	64	32	256	32	192	60	90	30	660	90	30	180	60	180

Table 39.4 Summary of transportation cost from supplier 6 through DC3 to disaster areas

After aforementioned in distribution relief materials to disaster areas, the urgent relief supply and distribution operations were implemented following the optimal solutions determined by the models embedded in this phase. The problems defined in both phases relief supply channels and relief distribution channels was formulated with a total of 360 decision variables (i.e.,4 x (6 x 3 + 3 x 24)), involving 1932 + 138 constraints, respectively.

To quantitatively asses the the efficiency of the method, particularly in quickly responding to relief demand in the affected areas and coordinating multiple relief supply sources in diverse disaster severity, criteria are proposed.

(1) *AT*, which represent the average time difference between succesive relief arrivals to a given affected areas in a day.

(2) *TC*, represent the total emergency logistic cost including the corresponding increase in inventory costs at relief distribution center in three days period.

(3) *CT*, represent the computing times in the test scenario using the system

In addition, to evaluate the relative performance of the present method, this study compared numerical result with obtained under the condition that all relief distribution center and supply sources resulting in the references articles. As can see in the table below, the aggregate relative improvement in the system performance result mainly from the time saving in continuously distributing relief to the affected areas during the crucial rescue period. In the study case the average time headway of relief supply to a given affected areas is 6,5 which is improved significantly by 13,33%, upon employing the proposed method. Such a numerical result is meaningful particulary for the application in emergency logistic management. It should be noted that differing from general bussines logistics and supply chain management, the efficiency of relief supply to affected areas determines not only the operational performance of emergency logistics system in the supply side but also the survival of trapped people in the affected areas. From physical point of view, shortening the time headway of the supplied relief arrivals to affected areas may create the image of governmental attempt in rescue and also firm up the will power of trapped people therefore the government can stabilizing the disaster effects.

The coordination between the layers of relief supply and demand through the relief distribution center is vital in relief logistics control. As mentioned previously, the problem of relief demand imbalance is a common critical issues existing in emergency logistic management. However, through the integration of relief demand forecast and demand driven pull base relief supply strategies the aggregate emergency cost can not reduced during three days rescue period. Due to reason of emergency logistics distribution to relief demand areas at the time of disaster occurred, minimizing the cost of relief distribution to disaster areas is not become a priority rather than time arrivals of relief distribution it self.

Criteria strategy	AT (h)	TC (US$)	CT Averages (h)
The existing strategy	7.5	2.3	-
The study case	6.5	3.6	0,4508
Relative improvement (%)	13.33	- 0.02	-

Table 40.4 Comparison of system performance in three day period

In addition, the number of vehicles available at each suppliers and at each distribution center appears to be critical factor in determining the system performance of the relief distribution. As observed from the result of experimental scenario, the reduction the number of vehicles associated with each supplier and each distribution center has caused significant negative effect on the entire system performance, particularly in both the average time headway of relief arrivals to a given affected areas *(AT)* and *(TC)* in system performance on the program to find better time headway comparing to the existing head time. This may infer that the sufficient number of vehicles serving relief distribution to affected areas. In this study number of vehicle was set as 12. In the experimental scenario, reducing the number of vehicle can make time performance is longer than existing strategy. Thus, determined number of vehicle can improve serving performance to quick response in emergency logistic distribution

Overall, the measure of relative result of transportation cost and improvement of time head way shown above have indicated that the method on this study permits serving a decision support tool of emergency logistic distribution, particularly for quick response to urgent need of relief in the large scale disaster affected areas.

CHAPTER V
CONCLUSION

This paper has presented a Simulation of emergency logistic distribution in case of earthquake disaster and approach for quick responding to the urgent relief demand of the affected areas during search and rescue period. Based on three layers approach the flow of emergency logistics, relief can be distribute efficiently and fairly to disaster areas. Centralizing the action through distribution center is the main proposed model to avoid imbalance supply-demand in emergency logistic distribution. First action is started from the relief supply channels side which has different sources from six different areas to distribute the relief emergency logistic supply to distribution center. Second action is relief distribution channels which is distribute the relief emergency logistic to 24 affected areas.

Using Arena Simulation, Modeling and Analysis program is the tools of this study case. The result show that the time headway for distributing the relief can be reduced comparing with the existing strategy. Relative improvement in the system performance indicate the better result comparing to the existing approach. This study can not comparing for the transportation cost because in this study only building a model and simulate for one scenario, but the references article has made by 9 scenario in order to find the best optimization result. Related to the system performance on Arena Software with entering more than 1932 variables decision of 4 type relief materials related to 6 suppliers resources through 3 given distribution center to 24 affected areas the result of transportation cost indeed show higher than existing cost. Average of computing time (*CT*) using arena simulation and modeling system reach 1,4968 hours. Optimizing the emergency logistic distribution from relief supply by minimizing time is very important in quick response to urgent relief demand when dissaster occurred, but over estimates and wrong forecasting from the supply side has become a scourge in controlling budget. Therefore, this study case may lead a relief management system in real emergency logistic distribution to optimize relief emergency distribution in limited time frame.

Finally, it expected that the method in this study case of the emergency logistic distribution approach can make benefits available not only for improving the performance of emergency logistic management, but also making the important coordination among relief supply members for examples the relief supply sources and distribution center in quick response to real situation and needs of the affected areas in a relief supply network .

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