7-18-2009

Analysis and design of earthquake relief virtual logistic information system

Chi Chen

WORLD MARITIME UNIVERSITY

Shanghai, China

ITL – 2009

Analysis and Design of Earthquake Relief Virtual Logistics Information System

By

Chen Chi

China

A research paper submitted to the World Maritime University in partial Fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE

In

INTERNATIONAL TRANSPORT AND LOGISTICS

DECLARATION

I certify that all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been conferred on me

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by the University.

(Signature):_______

(Date):___________

ACKNOWLEDGEMENT

First, I am thankful to the World Maritime University and Shanghai Maritime University for giving the chance to study international transportation and logistics

Second, I want to give my appreciation to my supervisor Professor Zhen Hong, who is a kind professor, he gives me lots of guidance and encouragement during the whole process of my paper work. I also get benefit a lot for the future from his attitude towards details to academic, which are not easy to be learned in book.

Third, I am thankful to Ms. Zhou Yingchun, Ms. Huang Ying, Ms. Hu Fangfang and all the others who working in the administration office. They give so much help both in study and in daily life. And thanks to all the professors who gave us excellent class and share the profound knowledge.

Finally, I would like to show my indebtedness to my beloved parents, who offered me full support and always encourage me during the whole studies in Shanghai.

ABASTRACT

Title of Dissertation：**Analysis and Design of Earthquake Relief Virtual Logistics Information System**

Degree: **Master of Science in International Transport and Logistics**

Abstract: As a kind of emergency, earthquakes lead a huge loss for society. For example, Great Sichuan Earthquake occurred on May 12, 2008 in Sichuan province of China and killed at least 68,000. The earthquake left about 2.8 million people homeless. In order to provide disaster relief, societies must transport a large mount of material. Logistics activities are organized at large scale and cross-regional.

Earthquake relief logistics are special logistics activities. They pursuit the most time benefits with the lowest disaster loss. It is a local logistics. For a nation, logistics demands can be satisfied. However, as a result of too complex operation and lacking of a effective logistics management system, logistics supporting abilities are hard to act.

This paper analyses the feathers of earthquake logistics. Based on these feathers, this article gives the structures and flow of emergency logistics. Combined with virtual organization theory, this paper offers flows of emergency (earthquake) virtual logistics system to deal with the problems that we meet in earthquake relief logistics.

Based on analysis of data demands, this paper makes sure the function and structure of earthquake relief virtual logistics information system. In this paper, earthquake relief virtual logistics information system is divided into four parts. And every part is realized logically by information flow diagram.

KEYWORDS: Emergency logistics, Virtual logistics, Information system, Information flow diagram

Table of contents

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1 INTRODUCTION

1.1 Backgrounds

With the rapid development of modern society, emergency usually has happened. When we enter 21 century, 911 terrorism attacks, SARS crisis, Bird Flu, Indian Ocean Tsunami and other emergency attract the world's eyes. In 2008, 5.12 Sichuan earthquakes cause a loss to 845 billion RMB. Especially, in china in 2008, according to data of UN, the total loss for nature disaster is up to $111 billion.

The huge loss for the disaster must needs a mount of emergency goods and materials to deal with medical aid, hygiene and quarantine, pos- disaster reconstruction and production recovery. At the same time, for some emergency such as earthquake, volcanic eruption, and infectious disease, forecasting is very different. When these kinds of emergency has happened, logistics is hard to completed because of the short time from forecasting to that happed.

For emergency logistic, its logistic need is local. To the country's whole logistic capacity, there is no problem to deal with it. But in emergency, time is limited, space is limited too. How to complete logistic mission in such short time and limited space is big question. For a long time, in China, we don't pay enough attention to emergency logistic. Our ability to cope with emergency is still weak. In order to reduce the loss to emergency and disaster relief cost, we should do the system research on intension, regulation, and safeguard mechanisms of emergency logistics to set up a suitable emergency logistics system. Based on these researches, we can see that virtual logistics system is the best choice for emergency.

1.2 Literature review

1.2.1 Recent research of resource virtual logistics system in emergency

Emergency virtual logistic system is a task oriented network logistic system, which can quickly response the emergency. Under the help of computer and network, this system integrates different factory, warehouse, and logistic companies distributed in different area into one logistic service provider to complete logistic task with the lowest logistic cost. Both in China and abroad have done many researches on emergency virtual logistic system's structure, MIS in emergency, and some supported technology such as data processing language (XML) and GPS/GIS.

First, researches on emergency virtual logistic system are abundant. Philip T. Evens (1999) did the research on emergency transshipment and order splitting and their effects to total logistic cost. S. M. Hong-Minh et al. (2000) used simulation method to research emergency transshipment in supply chain. They both focused on a real emergency logistic system, but this kind of research provided a foundation for virtual emergency logistic system. After SARS in 2003, virtual logistics system was more popular than before. Wang Yisheng, et al. (2004) discussed the basic organization structure of virtual logistics system in emergency. Dong Mingwang, et al. (2007) talked about emergency virtual logistics system's operation flow. Virtual logistics risk and control was mentioned by Jiang Rong (2008). These researches made emergency virtual logistics system's characters and flow clear, and give us a theoretic guide to set up a virtual logistics system.

The second important research aspect is about emergency logistics information management system. Han Yukuan (2004) emphasized the basic information function in emergency. Tong Xinshun (2008) gave us the designing principle of emergency logistics system, such as forecasting and quick responding, time is more important than economic benefits and so on. Wang Xuping, et al. (2005) designed 4 levels for emergency logistics information system. They are surrounding level, data level, decision level and control level. Information system's entities were defined by Meng Can, et al. (2006). Xie Xuyang, et al. (2006) discussed about the source of emergency information. In their article, they point which type of data should be input and which type of data would be output. They even discussed the advantage and disadvantage of B/S and C/S information system. Chen Ping (2003) talked about different communication methods of information in emergency virtual system. Based on these researches, we can build a virtual logistics system for emergency in logical.

The third important part to set up an emergency virtual logistic system need some support form GPS and GIS technology and decision making theory. There are a lot of researched of application GPS/GIS to emergency virtual logistics system both in China and abroad. Ander Zergerand, et al. (2003) talked about using GIS for real-time disaster decision support. Many experts gave us the optimized route choices by using topology method, such as Zhu Xiaoqing, et al (2001), Wu Qichang, et al (2005) (he based on Map Objective). At same time, some people do some research on combination of GIS and optimized route in order to set up a decision making system. Du Jiang (2005) designed a web-based public healthy control decision support system. Integration of GIS and DSS was also mentioned by Wang Jiayao, et al (2003). At the same time, some data interchange technology will help us to build this system better. For example, Zhang Gongxuan, et al. (2003) mentioned about XML language.

1.2.2 Existing problem

1. Although many people do a lot of research on emergency virtual logistics system about its system organization structure, the feature of information system and data input and output, little articles pay attention on specific operation platform. These articles just give a general analysis and logical modal from macro perspective. That is to say, these researches don't tell the different needs of specific emergency virtual logistics system.

This point has been mentioned by Fang Jing, et al (2008) and Wang Xing (2007). In their articles, they said that in China, the research on emergency virtual logistics system is just beginning. Detailed analysis of specific needs is not enough. Even more, Huang Jinhu (2007) indicated that when we research an emergency virtual logistics system, not only the main structure but also the environment of this system should also be pay attention, such as actual logistic system condition.

2. GPS/GIS have not well been integrated with Decision Support System.

GPS is a kind of position technology. It can provide in-time information of trucks, ships and other carrier tools. GIS is a large database to record geography information, such as road, mountain, and rivers and so on. So far, there is little research about application of decision making technology into GPS/GIS. Many researches is about how to find the optimized route based on GIS, but little research is on how to make a decision based on GPS/GIS. Li Jingyi (2006) pointed out that we can only using GPS/GIS system to record and inquires about information at that time. If we can apply decision making technology into GPS/GIS system, the speed of response to emergency would be increased.

3. In these articles, many authors offered the logical structures of emergency virtual logistic system. But none of them give a logical model of emergency virtual logistics system.

Offering structures may be much easier than a logical system model. When we implement a logical model, we must choose suitable software to explore it。We must consider which types of data could be input into this system, which data is useful, and which data is valid. According to different emergency, the emergency virtual logistic system is far different from each other. So designing a logical emergency logistic model is more difficult.

4. Many articles research on general concepts and structures. Little of them focus on concrete problems

In many articles, author preferred to do general research on emergency logistics system. But different emergencies have their own features. Their logistics demand is absolutely different. So, only some concepts and general structures are not enough.

In a word, the present research about emergency virtual is far from enough. We should implement these theories into concrete problems. At same time, we must to analysis the specific needs of the emergency to ensure system feasible and suitable.

1.3 Research objective, meaning and content

There are 4 research aims for this paper. They are

1. Analysis the features and status of every point in logistic chain to emergency logistics, such as storage, purchasing, transporting and information processing to find out the main factors which could effected logistic efficiency.

2. To conclude the principles for emergency virtual logistics system. Based on those principles, we can design a suitable emergency virtual logistic system to ensure to complete logistics mission in emergency with the shortest time and lowest cost.

3. From a technology perspective, this paper provides a method and approach to realize the emergency virtual logistics system.

4. Based on conclusion in this paper and other theoretic conclusions, using the software and other computer platform, this paper will give a earthquake relief virtual logistics information system to enhance the visible capacity and data processing ability of emergency virtual logistic system.

These aims in the paper are to effectively increase the coping capacity to emergency to a logistics system, reduce the impact that is brought by devastating and unstable factors to logistics system in order to provide a safe and high efficient support for saving activities

1.4 Methodology

In this paper, there are three main methodology will be used. They are literature study, qualitative analysis method, and simulation method.

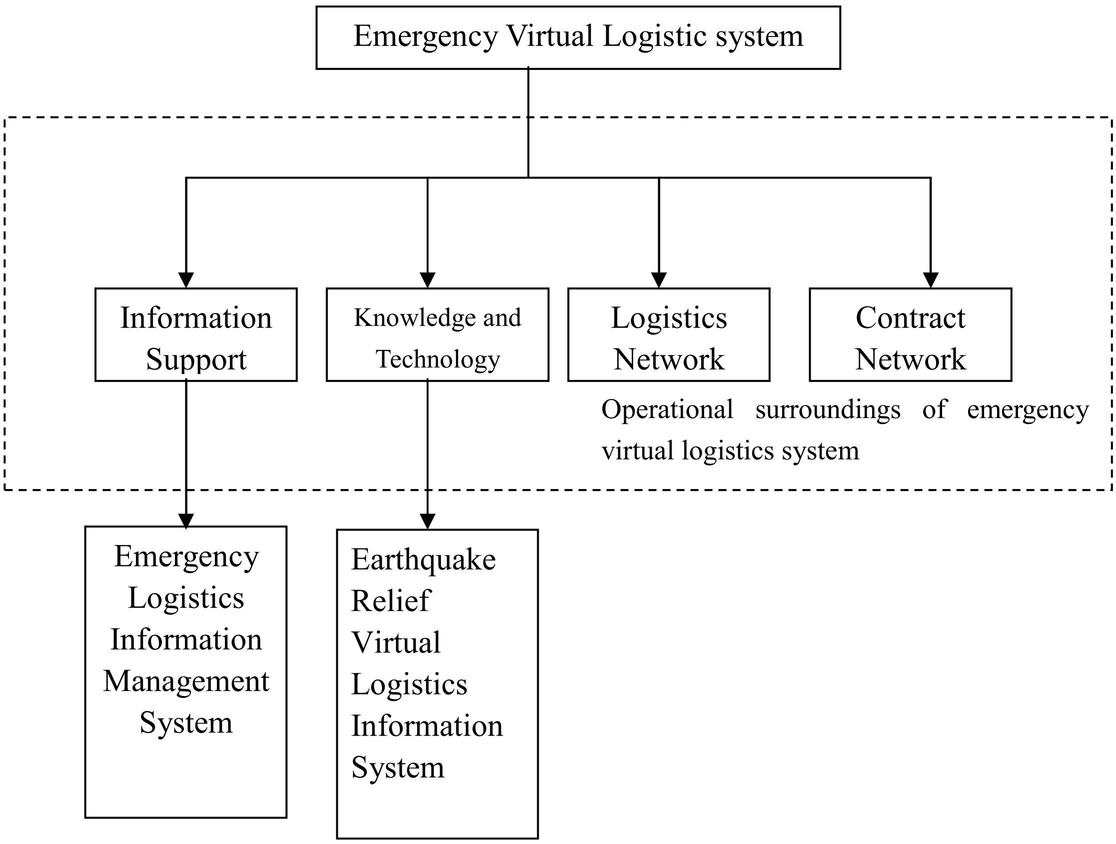
In the chapter 2 and chapter 3, this paper mainly discussed the features, principles, and definitions of emergency logistics system, emergency virtual logistics system, and other concepts. So, literature study and qualitative analysis methods are appropriate. Literature study can be used to get the knowledge of basic concepts and conclusion from other people about this topic. Combined these conclusion and qualitative analysis, we can reveal the relationship between every parties and give my own opinion.

In the 4thchapter, I will implement an earthquake relief virtual logistics system model both in logical. So simulation method would be used. After considering the real situation and needs of emergency logistics, I set up a logical emergency virtual logistics system model.

When I implement a logical earthquake virtual logistics system model, Objective Oriented method will be used. Objective oriented is one of System Development Methodologies. Generally speaking, Objective is an independent, asynchronous, intercurrent entity. It can "know something" (storage some kinds of information), "do some job" (encapsulate service), and "do team working with other objective" (by interchange information), in order to complete all system task. Objective Oriented method is a relative easy way to develop and maintain an information system. For objective oriented method, all entities are composed of several objectives. When they are building a system, they just put these objectives together. Emergency virtual logistics decision support system is the combination of decision support, virtual logistic system and GIS system. Objective Oriented method is appropriated for this system.

1.5 Structure of the research paper

This paper deeply analysis the features, statues, and deficiency of emergency logistics system. Based on this, it brings forward a concept—a virtual logistics system which is organized by virtual organization frame. All of this is based on network technology, database technology, GIS/GPS technology, and decision support technology and advantage modern logistics management knowledge. From aspects of information network and decision support, this paper does the research about how to develop a real emergency logistics system. The relationship of content like follow picture:



CHAPTER 2 EMERGENCY VIRTUAL LOGISTICS SYSTEMS

2.1 Basic concepts analysis

2.1.1 Concepts analysis of emergency

Emergency logistics refers to special logistics activities generated by satisfying emergency public events logistics needs. In Nation's contingency plan to emergency public events, China's government defined emergency as follows:

Emergency is natural disasters, accident disasters, public health events and social security incident which suddenly happen, leads to serious social risk, and some emergency actions should be taken to deal with it. In China, emergency has been classified to several items:

Table 2.1 Varieties of emergency

natural disaster	accident disaster	public health event	social security incident
water disaster meteorological disaster earthquake disaster marine disaster biological disaster forest steppe fire	production safety accident Transportation incident public utilities accident environmental pollution ecological damage incidents	infectious disease public agnogenic disease food safety hazard occupational hazard animal epidemics other big events which effects people healthy	terrorist attacks economic safety incident concerning foreign confliction

2.1.2 Features of emergency logistics

Emergency logistics is for providing emergency material. The aim for emergency logistics is to pursuit lowest disaster losses with highest time to benefit. Compared to normal logistics activities, it has several same points, such as fluid body, flow direction, flow rate, and flow route. However it still has some special features of itself:

The first one is slow speed. Accompany with emergency, there are depravation of transportation system. For example, after earthquake, road had been blocked. Speed of logistic is much lower than before.

The second one is the structure of fluid body has been changed suddenly. Demanded of some material would be fluctuating to a great extend. At beginning of earthquake relief, the needs for medicine are much more than other material. But a few days latter, the necessities of life are much more important than other materials.

The third one is uncertainty of demands. The uncertainty of emergency itself leads the uncertainty of emergency demands. Information of disaster area can not be achieved because of communication equipment's damaging. Disaster victims' migration also leads to increase of logistics uncertainty.

The fourth one is high timeliness. Emergency logistics material is for emergency rescue and disaster relief. These material are related to life saving and must be send to disaster area within the shortest time.

The fifth one is low economy. Normal logistics focus on both efficiency and benefits. But emergency logistics' primary goal is to satisfy material demands in anywhere at any time. The secondary target is as lower cost as possible.

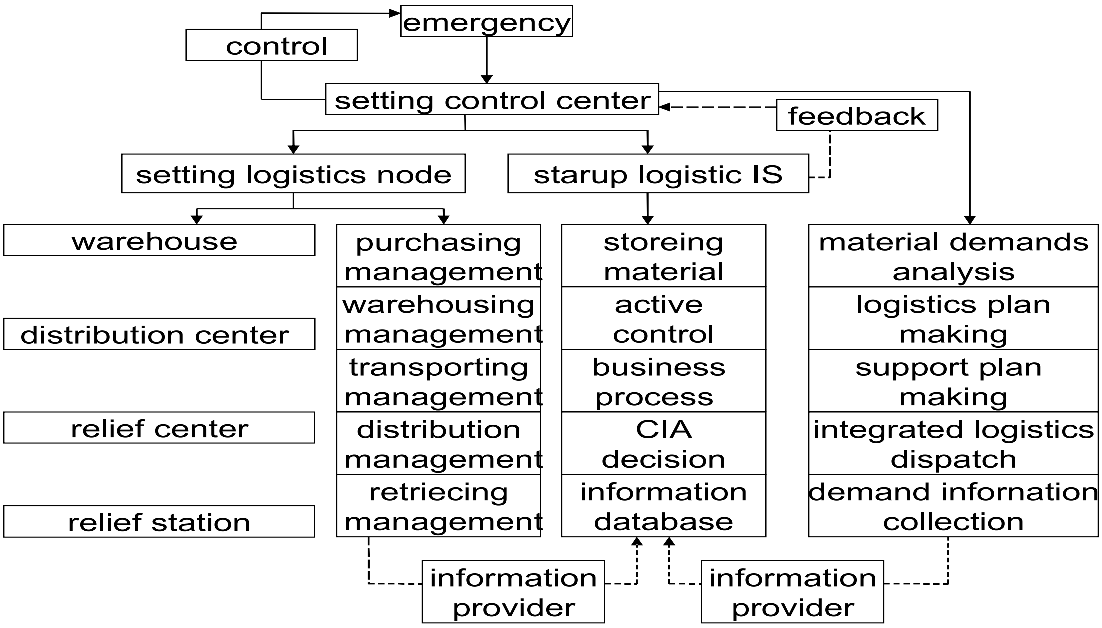
Table 2.2 Differences between Normal logistics and Emergency Logistics

factor	Normal logistic	Emergency logistic
fluid body	Normal material; different kinds of material; source of material is single.	Disaster relief materials， such as lifesaving material, life necessities and medical apparatus and instruments. These materials come from government reserve and social contribution.
carrier	Fixed location and installation	Fixed and mobile public location and installation
flow direction	Followed by customer demands. Flow direction is fixed; better arrangement	Direction towards recovery point; uncertainty target.
flow speed	Logistic speed is fixed	Logistic speed is much slower than normal
flow rate	Logistics rate is stable	Specified material increases suddenly, other kinds of materials reduced.
flow route	Designing logistics route followed by rule of reasonableness	Installments damaging, logistic route has been changed

2.2 Structure analysis of emergency logistics system

The design of emergency logistics system should concern quick reaction capacity, good openness and reconfigurable. It should be dissolution and reset quickly according to particular case. It is also very easy for social organization and government sectors to engage in it. Every sector in this system connects with each other closely to ensure good information transfer abilities. According to requirement above, emergency logistic system should be divided into three parts: emergency control center, emergency logistics node, and emergency logistics information system.

Figure 2.1 Structure of emergency logistics system



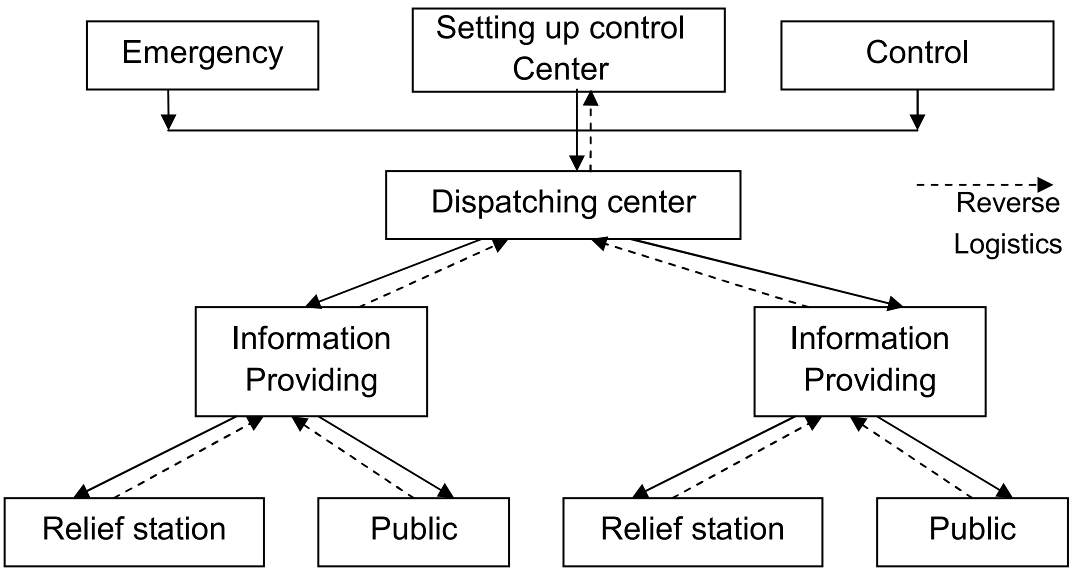
The main tasks of emergency control center are emergency materials demands analysis, emergency logistics plan making, coordination and supporting plan making, integrated emergency logistics dispatching, and materials supply & demand information collecting. Emergency logistics nodes contain material storage warehouse of government at all levels, emergency distribution center, relief center, and relief station. Logistics nodes are responsible for purchasing management, warehouse management, transportation management, dispatching management and retrieving management. Emergency logistics information system links all logistics sectors up. The main functions are emergency material storage, real time dynamic control, emergency business processing, CIA decision, and basic database.

When emergency has happened, government should set up an emergency control center to monitor the real time situation of disaster area. According to emergency's nature, sphere of influence, and seasonal factors, emergency control center makes a primary material demand analysis, inquires about detail information of emergency material resource, such as emergency material distributing. In emergency logistics, information which is generated by control center or collected by emergency logistics nodes would be input into emergency logistics information system. After processed, this information would feed back into emergency control center for decision aids.

2.3 Emergency logistic flow analysis

Emergency logistics flow mainly contains purchasing, storage, transporting, dispatching, and retrieving. Very sector plays an important role in emergency logistics. They are both significant sectors for emergency logistics to improve emergency logistics efficiency and reduce cost.

Figure 2.2 Emergency logistics flow



1. Emergency purchasing sector. When some serious emergency happen, materials restored by government are not enough to deal with disaster. At same time, many kinds of life necessaries and medicals are not suitable large-scale storing. So, emergency reserve could contain material reserve and contract reserve. Before emergency happens, the civil affairs department signs a contract for purchase with supplier. Once emergency happens, the companies signing contract with government quickly provide materials with low cost and good quality. So that, inventory cost will much lower and price fluctuating of disaster relief material can be avoided.

2. Emergency logistic storage sector. Besides cotton quilt and tent, government should increase quantity of medical apparatus, protective equipment, and life necessaries which could be frequently used at beginning of relief step. In addition, storage department should improve store management and handling mechanization, optimize warehouse space and store plan.

3. Emergency logistics transporting sector. Emergency control center organizes different kinds of logistics companies to a fleet. In normal time, fleet belongs to their own company. Once emergency happened, they gather together to form an integrated transportation unit. In order to compensate emergency fleet, emergency control center should set up special fund for fleet. When fleet on the road during transportation, emergency control center could do real time monitoring to get real time information about transportation under the help of GIS and GPS technology. At the same time, government should offer better service for emergency logistics fleet, such as fist planning, first loading and discharging, first transporting, and tolling free. Transportation department is responsible for security work of emergency transportation. They deal with dangerous situation in transporting to ensure transporting safe.

4. Emergency logistics dispatching sector. Dispatching center is not only responsible for relief material dispatching but also responsible for emergency material retrieving and sorting. After finishing disaster area rebuilding task, dispatching center removes these material to all level of warehouse. Besides that, dispatching center is also an information hub for supply and demand. Then it sends this information back to control center ordered by material importance. In fact, some donation goods would be directly sent to dispatch center. These goods would be sorted and packed, and then dispatched to relief station according to actual situation. For that not urgently needed material, they should be sent back to warehouse. Through dispatching center's operation, collection effects of social donation will be improved and invalid relief will be avoided.

5. Emergency material handing out sector. Relief center and relief station are the place where emergency materials hand out. Handing out should be given an overall consideration. Essential goods must be handed out firstly; others could be handed out later. Material storage place should be separated from public life area. Every kind of emergency material should have its own access way to avoid handing out chaos.

6. Emergency logistic retrieving sector. Tents and other recycling materials need to be clean, mended and retrieved. Government will also design a retrieving plan and refine retrieving logistics network to remind the public make good use of recycling materials. Repair and retrieve rate should be increased and processing cost of non-repairable material should be reduced.

2.4 Definition of emergency virtual logistics

In order to satisfy emergency logistics demand of emergency material storage and supply, by using computer, communications network, and supply chain management technologies, emergency material warehouse, manufacturing enterprise, logistics center are linked up with emergency control center to form a material storage and control organization with the same target and flow. All kinds of emergency material can be managed and allocated in differ status, space and time.

As a new organization model, emergency virtual logistics system is more suitable for emergency logistic environment because of its flexible network structure, creative coordination mechanism, and strong information transmission. There are several underlying dimensions in emergency virtual logistics system. They are: 1. Virtual competence. It is a team divided by capacity variance. It is only a virtual unit in network management. 2. Virtual work team. It is a workgroup based on temporary needs. It automatically disbanded when mission finished. 3. Information processing center. It is an integrated department which is responsible for collecting and forecasting disaster information and coordinating and monitoring entire logistics network and public relations.

2.5 Operational scheme of emergency virtual logistics system

Emergency virtual logistics system is a task oriented organization. It can adapt changeable logistics demand with its good reconfigurability. According to decision program, emergency control center chooses a set of appropriate companies and logistics enterprises to be a virtual union in order to finish emergency support task. When this task completed, the union broke apart. During this time, emergency virtual logistics system can be quickly adjusted and restructured according to the condition of a disaster and staged accomplishment. Based on mission's lifecycle (start, operate, and end), emergency virtual logistics system could be divided into four stages: mission identification and definition, mission design and member select, mission implement and mission dissolution and liquidation. First two stages are called emergency virtual logistics system building stage. During this stage, key factors that affect emergency virtual logistics system are mission (emergency strength, types, and context), demand analysis, material storage ability, and member selection. Emergency virtual logistics system's operation process is a self-organization process.

1. Mission identification and definition.

The target in this stage is to initiatively find and respond to emergency support mission. Firstly, intelligence department collects all kinds of information from department of disaster monitor such as department of earthquake, meteorological, health, and environment. Based on different kinds of disaster information, intelligence department timely and accurately analyses this information to find new emergency supporting mission. Then this information and result are immediately sent to emergency information management center and special material management department in order to get ready for material supporting in advance. Secondly, information center and special material management departments forecast the volume and kinds of disaster relief materials based on based on information that is been provided by information department. And these two departments advice the medicine, food, quilt related department to make material purchasing arrangements in order to have a good preparation before disaster breaks out and expand. So, relief materials could be cent to disaster area and victims in shortest time.

2. Mission design and member select.

Information center of virtual logistics makes optimized solutions according to mission demand and storage situation of emergency materials warehouse, such as disaster relief material warehouse storage, emergency logistics manufacturing companies and situation of logistics companies equipment, stuff, operation, transportation capacity and warehouse capacity. Based on this optimized solution, information center chooses the enterprises which are engaged in emergency logistics supporting mission and make a good arrangement of disaster relief material's purchasing, transportation and dispatching. It is a key sector to choose companies which take emergency logistics supporting mission. The consideration factors contain effective communication network, good credit standing and respectability. In addition, whether these companies have core competence and whether their products compliance to national technology, safety, and environment standards should also be considered.

3. Mission implement.

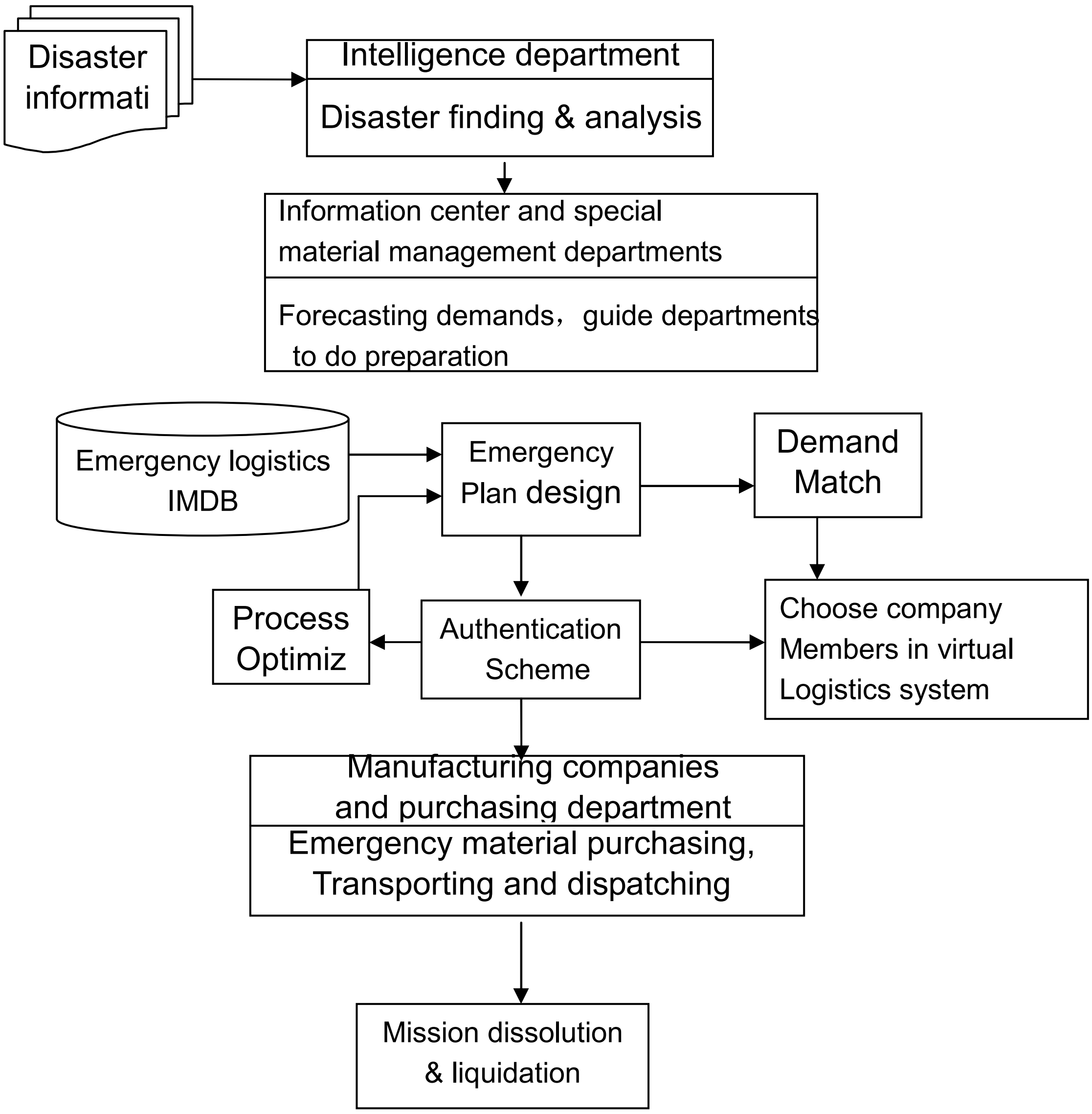
There are two main functions of mission implement. One is to form a coordination center by emergency logistics decision department and the companies which engage in emergency logistics supporting mission. This coordination center is responsible for dealing with special activities such as emergency material purchasing, transporting and dispatching. The other one is to sign collaboration agreement to define liabilities and rights of both sides, such as scope of every company duty, promise to quality of service, and coordination of operation and responsibility accountability when mission dissolution.

4. Mission dissolution and liquidation

When mission disappeared, mission dissolution and liquidation have to be carried out.

The main task of this sector is to retrieve, repair and scrap emergency logistics material and equipment. According contracts, requisition material should be compensated.

Figure 2.3 Operational processes of emergency virtual logistics



CHAPTER 3 EARTHQUAKE RELIEF VIRTUAL LOGISTICS INFORMATION SYSTEM

Earthquake relief virtual logistic information system is an unconsolidated logistics alliance which is composed of lots of entity logistic companies, manufacturing companies and warehouse. The members of this system obey single direction and coordination under logistic conduction department and it is coved all field and section of logistics. Earthquake relief logistics conduction center and virtual logistics members share information and function by Earthquake relief virtual logistic information system.

3.1 Logistics information in earthquake relief

Logistics is a field to generate a lot of information. The information concludes forecasting, planning and other logistics relative dynamic activities. Logistics information has some features as follow: (1) Volume of information is more. Extent which information covered is greater. Information original point is more. (2) More dynamicity. Information value fades quickly. Information timeliness is more important. Information processing rate is quicker. (3) More variety of information. On only in information system internally there are many different kinds of information but also externally, there are more kinds of information related to this system. (4) Earthquake relief logistics involve a great number of volume and kinds of relief material. Single logistics unit is hard to complete logistics mission. In this situation, cross-regional logistics activities are needed. In order to organized logistic activities effectively, logistics control center sets up logistics node in different areas. These nodes coordinate and collaborate with each other effectively under logistics control center in different area. Because of the features of logistics system, the structure of virtual logistics information system is also space network.

As the result of cross-regional logistics activities and a mount of logistics information, a strong logistics information system is needed to building on a national scale. By this information platform, logistics companies and manufacturing companies in different area are connected to collect proper basic information which is needed by system. The database is replenished constantly in order to earthquake disaster information can be timely mastered and optimized solution would be formed. Based on this, we can monitor dynamic process.

3.2 Functions of earthquake relief virtual logistic information system

Earthquake relief virtual logistic information system is guarantee for high efficiency, flexibility and reliability. It provides timely and accurate information support for earthquake relief scientific decision-making. It shows at seven aspects as follow:

(1) Information integration

In earthquake relief virtual logistics information system, we establish a more rapid multipoint-to-multipoint communication with a greater number of information channels that significantly reduce the informational delays. More information channels provide the possibility of increasing and accommodating and integrating data for more network node. They eliminate the information overload of a particular bottleneck, and then also strengthen the network of information distribution. As providing more members of the virtual logistics systems data and using computer information processing, information accuracy and durability will be able to continue to improve, resulting in better emergency logistics decision-making and addressing of the issue of more co-ordination and abilities of dealing with greater complexity.

(2) Information sharing and consistent decision

In order to ensure the earthquake relief virtual logistics systems could run highly efficient and reliable, we must make the action of the member enterprises in the whole integration. Information technology provide the basis for achieving information sharing and group's decision-making of different locations, and ensure consistency in decision-making, and facilitate integration actions.

(3) Enlarge the scale of emergency support

Ubiquitous network connectivity could make emergency command structure able to find allocation of resources in the global market, greatly expanding emergencies logistics coverage.

(4) Diminish asymmetry of information

As information technology reduced management levels, virtual earthquake relief logistics information management system can monitor the details of low-level directly, thereby reducing the information asymmetry.

(5) Merge internal structure

The integration of virtual logistics network organization of earthquake disaster relief systems can control over all members in the organization by using information technology. Horizontal linkages with many internal structure of information technology potentially even out the organizational level by re-distributing resources and weakening the status of differences with resources, decision-making power and authority.

(6) Eliminate status differences

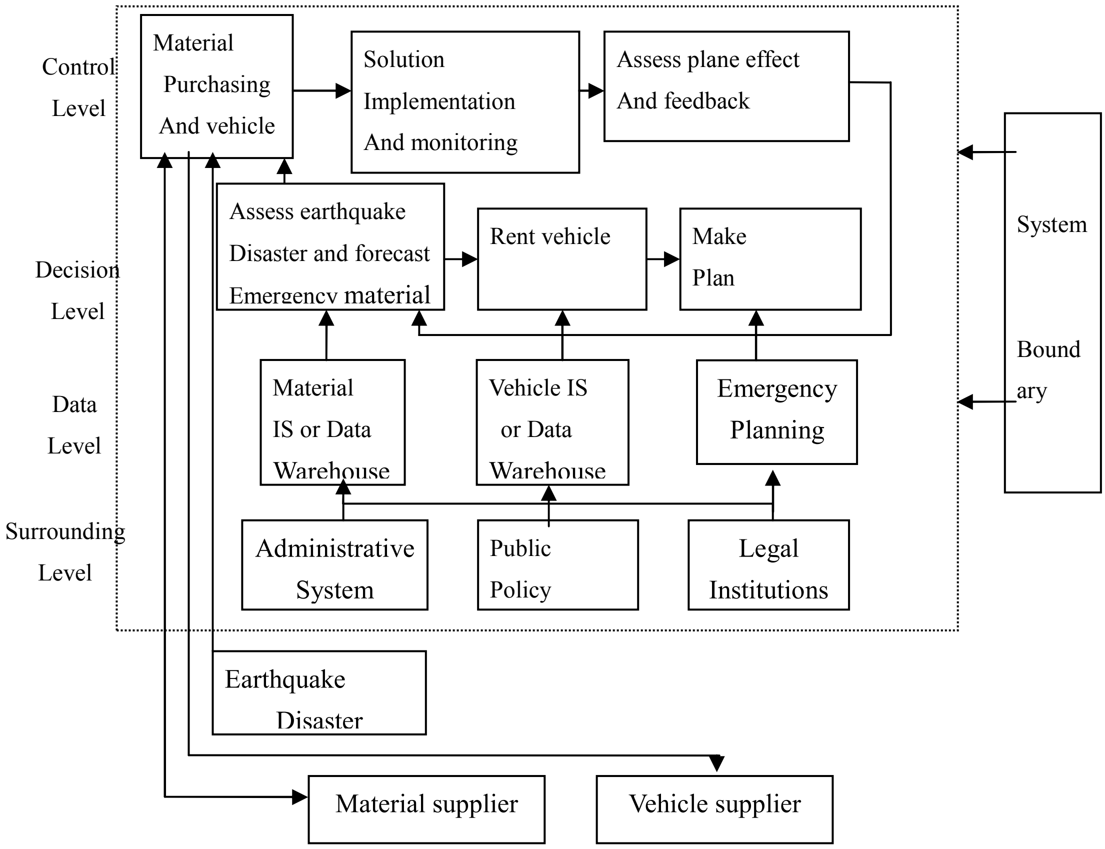
The power and influence of earthquake relief virtual logistics system organizations will not derive from the hierarchy but from an interpretation of convincing other people to accept data. Expertise is increasingly becoming a critical key. As a result of real-time feedback, the decision-making become more scientifically

(7) Promote organizational learning

Information technology can be widely distributed and able to quickly disseminate information to promote organizational learning. The ever-increasing information-sharing may be better to form the basis for decision making and learning-curve effect. However, distribution of information through information technology are not the only element to support organizing learning, information technology can also enlarge the network members through the process of grafting, in order to enlarge the process of knowledge acquisition. Organizational memory-based technology could reduce the partners' potential losses which lead to loss of learning potential. So it greatly improves the management of intellectual capital. Information technology for emergencies virtual logistics system provides the organizational structure and an important complement of learning.

3.3 Earthquake disaster relief virtual information system structure

Figure 3.1 Earthquake disaster relief virtual information system structure



The structure contain all the logistics emergency activities of the earthquake disaster, such as earthquake relief goods transportation, storage, handling, packaging, processing, distribution, logistics facilities , the usage of equipment, management of equipment and information processing. In the structure, basic level is the environment, mainly constructed by the administrative system, public policy and legal systems. It represents a norm of the whole system. The database layer is above the environment layer. It collects data for the entire system. Decision-making layer is on the top of Data layers. The data that provided by decision-making system is supported by database. The most top-level control layer is control layer, which controls every emergency logistics work.

3.3.1 Database requirement analysis

Database is the foundation of building information management systems of the earthquake disaster relief logistics, it timely provides the earthquake disaster relief logistics decision-making resources accurate information, and constantly updated the data to immediately adjust and coordinate logistics activities among different enterprises by logistics activities' dynamic monitoring of information. Based on the above analysis, the earthquake disaster relief information system should include the contents of the following:

(1) Basic database. It should include roads, railways, waterways, sea, air and other transportation information. Specific information is divided into nodes (cities and towns, railway stations, ports, airports), parameter information (line name, length, grade, capacity, transportation costs) and infrastructure information (bridges, culverts, tunnels, dams, etc.)

(2) Disaster database. It should include the intensity of the earthquake, affected region, the geographical distribution of the population, the demand for status goods.

(3) Enterprise Agreement database. According to the business model, this database can be divided into production-oriented enterprise database (that is, to provide emergency supplies of production enterprises or reserve storage, etc.) and

service-oriented enterprise database (that is, the provision of logistics services of logistics center or transport companies, warehouses, etc.). Besides the database of basic business information and the distribution of information, it also includes items' information, specifically for variety and specifications of materials, current inventory and production capacity, as well as logistics facilities information, specifically for the transport resources (vehicles, ships, etc.), storage resources (storage, yard, etc.) and tools resources (trailers, forklifts, containers, etc.).

(4) Member enterprises database. The database based on matching and optimization is formed by screening and second packaging the agreement enterprise's information database. It contains the actual logistics emergency activities of all enterprise information.

(5) Task process database. This database is primarily for emergency logistics command to master the dynamics information and coordinates the work of the members. It is a dynamic and needs to update and manages the database, ending with the end of the task. Enterprise is awarded the corresponding access rights to the database, and uploads the information to update the data; it also could import RFID, positioning systems (GPS) and other information by integrating into the supply chain information, such as equipment, material procurement, production, inventory information, shipment information and delivery information etc. Therefore the enterprise achieves real-time monitoring of the whole emergency events' logistics cycle. Through accessing to this information, the emergency event logistics command could timely adjusts strategy in accordance with the situation, ensuring the efficiency of and accuracy of the logistics activities.

3.3.2 Decision-making

Decision-making layer based on the database layer is the key part of making a logistics plan. The layer should give serious consideration to the real situation of the procurement of goods production, and make reasonable physical plan. Specific decision-making process should include the following points:

(1) Material procurement decision-making: Based on the location of the earthquake, the disaster size, population distribution and the impact of the region, the layer estimates the demand for relief supplies and makes out the procurement plans. In the plan, it is necessary to clear the type of material procurement, the quantities of the material and the order of material procurement. The layer should procure the most needed shortage materials.

(2) Rental of transport decision-making: Based on the damage level of roads, waterways, airports in earthquake location, the layer selects the appropriate means of transport. Then based on the required materials that are needed, the layer make the decision of rental of transport including motor vehicles, ships and aircraft. It should identify the source of the rental vehicle, the required the number and the time of rental of transport.

(3) Logistics solutions decision-making: On the base of the above two decision-making and logistics plans, logistics solutions mainly solves multiple rescues and the optimal path of the logistics plan. Because the large scale of the earthquake disaster and the great demand for relief supplies, a material reserve center can not meet the needs. So it requires different material reserve center to cooperate, synchronous transfer of materials in order to meet the material needs of the affected

areas. Considering all of the material reserve centers as a whole, it makes the optimal materials out and transport path plan, which can greatly reduce the level of logistics costs, conserve social resources, and also guarantee the supply of goods in greatest degree.

3.4 Software system design of emergency virtual logistics information system

3.4.1 Selection of calculation mode

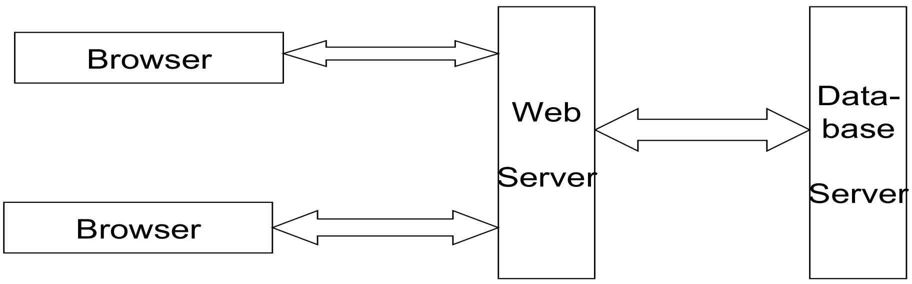
The distribution mode of data and application program in computer application system is called computer application system calculation mode or information calculation mode. In general, there are four kinds of calculation modes: Host/Terminal, File Server, Client/Server(C/S), and Browser/Server (B/S). Because of limited choice and no guaranteed hard ware investment, Host/Terminal is out of fashion. File Server is only suitable for small scaled LAN. For big volume of consumer and data, its bottleneck is obviously. Especially, it can not satisfy users' demands on internet. For C/S in emergency logistics virtual logistics information system, there are several limitations: (1) High developing cost and overstaffed clients. (2) Difficult to transplant. Applications programs developed by different development tools are not compatible with each other. They can not be transplanted to other computer platform. (3) Different user interface styles. (4) Complex maintenance and updating. So, we choose Browser/Service as information system calculation mode.

B/S mode developed from C/S mode. The driving force of this development comes from increasing business scale and more flexible business process requirement. The solution for this problem is to add a middle application level (business logic level) into traditional C/S mode. B/S mode is 3 levels structure.

Figure 3.2 Three level structure

Customer express level: It locates in client and contains system express logic. Its target is that web browser provides requests to the web service on net. After verification of identity, web server sent HTML or XML documents to client. Business logic level: It locates in web service and contains system business process logic. Its target is to receive customer requests. Firstly it connects relative extension program and database with SQL to sent request. Database server sent processed results to web server, and then these results are sent to client by web server. Database level: It locates in database server and contains system database processing logic. Its target is to receive operation request provided by web server. It can inquire, modify and update database and sent the results to web server.

Figure 3.3 Computer application system structure of B/S mode



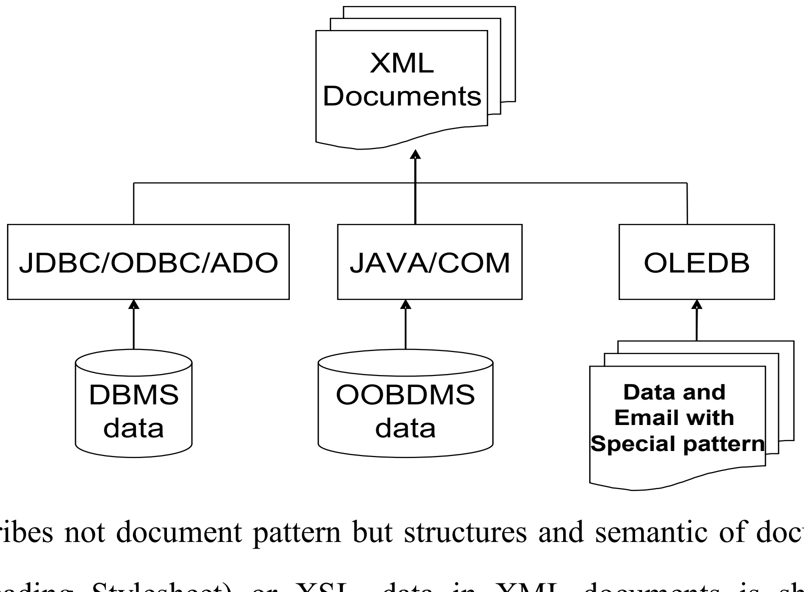
B/S mode is above mentioned three levels structure. It is composed of browser/web server/database server. From above chart, we can find that client is installed in commonly used browser, such as Microsoft IE and Netscape, but application programs are installed in web server in order to reduce the workload of client maintenance. It is easy for customer to use. Emergency virtual logistics system is a task oriented dynamic system. According to emergency task demands, some enterprises or warehouse are added into this virtual work team. So, it should be easy for us to connect any company at anywhere to earthquake relief logistics information system by computer network. We can inquire about relative information in limited function boundary and complete the task of information transporting and processing. "Thin" client of B/S is suitable for quickly adding and spinning nodes in earthquake virtual logistics information system. It is also of advantage to enlarge covering for emergency virtual logistics information system.

3.4.2 Realization of data exchanging technology

In earthquake relief virtual logistic information system, information is needed to restructure because of its agility and dynamicity. Compared to traditional information system, this information system should be fully distributed, dynamic restructuring and quick adaptive from information, structure and function aspects. Due to information reconstruction between different kinds of web databases, information system should be adjusted and reconstructed and the function of application program should be improved. Data exchanging is a key sector in earthquake relief virtual logistics information system. In this system, every entity is dynamic. Their operation time, place and existing cycle are uncertain. This kind of uncertainty needs a new data exchanging language for different kinds of web database communicating web database and web application program. XML (eXtensible Markup Language) is base of reliable and flexible communication between different kinds of database. It transforms all kinds of data into XML. After processing, XML is transformed into another mode to store.

XML is a common used standard in computer language formulated by World Wide Web Consortium in 1998. It has three elements: DTD (Document Type Definition) is to regulate logic structure of documents; XSL (eXtensible Stylesheet Language) is to regulate documents type; XLL (eXtensible Link Language) is to extend existing simple links on internet. There are three kinds of data sources: (1) Plain text XML documents. (2) Database such as relational database and object oriented database. (2) Some application data with special pattern such as Email, diagram, list. Different data source transform into XML with different technologies.

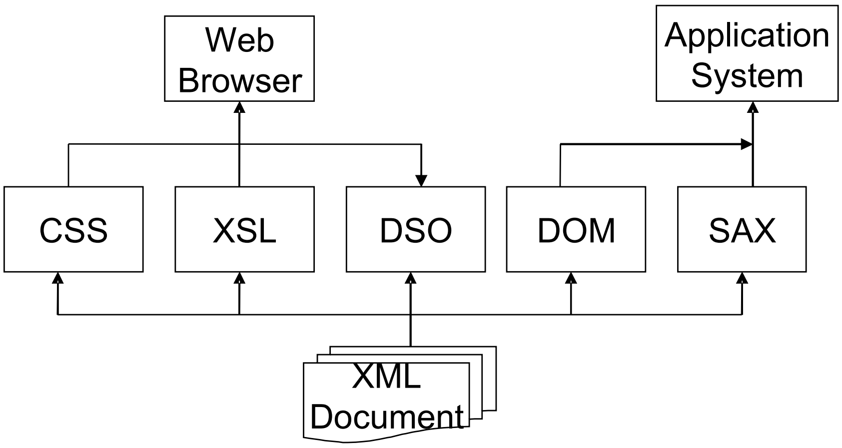
Figure 3.4 Generating XML documents



XML describes not document pattern but structures and semantic of documents. By CSS (Cascading Stylesheet) or XSL, data in XML documents is showed with predesigned pattern. By DSO (Data Source Object), XML can be easily linked with HTML. The last results as showed on web browser. Application system achieves

XML data by DOM or SAX technology.

Figure 3.5 Processing XML documents

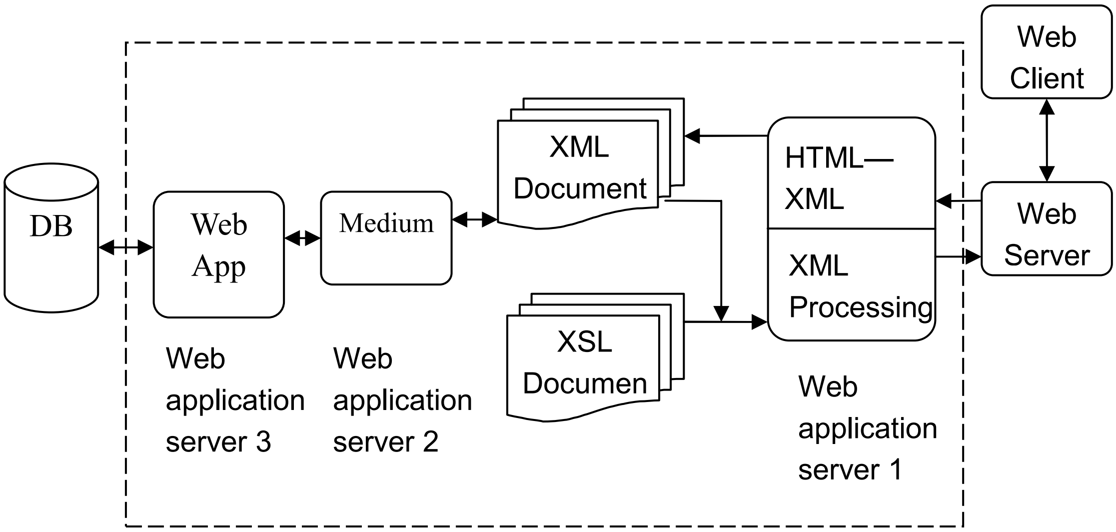


3.4.3 B/S calculation mode based on XML

According to above analysis, the combination of three levels B/S calculation mode and XML technology is the best choice for such a huge information system like earthquake relief virtual logistics information system. With B/S calculation mode based on XML, earthquake relief virtual logistics information system can be quickly reconstructed according to earthquake relief logistics system demands. It provides timely, accurate information. It is also integrated with existing information in order to realize information sharing on multi-dimensions and levels. For a request sent by client, its data format is changed by database medium supporting XML between web database and web server. After exchanging, medium sent XML documents to Servlet of web application server. Servlet is responsible for regulation verifying to documents through DTD (Document Type Definition). For valid XML documents, they are exchanged into HTML or XML or other documents supported by browser and then showed on client. Showed as follower chart, medium programs and XSL processor are respectively run by net application server 1 and net application server 2.

In addition, application server 1 completes format conversation form HTML to XML. In factor, it is a bi-direction mapping between XML and HTML.

Figure 3.6 Information transferring in B/S mode based on XML



Advantages of B/S calculation mode based on XML:

(1) Database service (data accessing), application logic (data describing and exchanging), and customer expressing (data expressing) are separated form each other effectively. Both of them are mutual independence and interrelation. It is easy to maintain and extend for network application.

(2) It reduces processing overhead of server to a very real extent. It makes a network load balancing between server and client.

(3) Network transmission bandwidth is lower. It is proved by experiment that average bandwidth by which XML and its samples are transported is much lower than bandwidth of which HTML needed.

(4) It is beneficial for data to keep its independence form system platform. The XML

document is used by several different client platforms.

3.5 Basic function of earthquake relief logistics information system

Earthquake relief logistics information system is a very important virtual place for earthquake relief headquarters to set up emergency support work team. In this system, logistics headquarter shares logistics resources and functions with different kinds of manufacturing companies and logistics enterprises. For example: earthquake headquarters can publish the information about logistics demands on information platform's BBS; they can find out the distribution of social resources and support abilities of every company through statistics and inquiring functions; it can choose suitable enterprises to set up a task oriented emergency virtual logistics system enterprises alliance. According to demands analysis above, earthquake relief virtual logistics information system should provide sweeping service from purchasing to storing to dispatching to management. It should contains several functions such as material information query, logistics plan making, material storage, material dispatching, member and supply chain management in earthquake relief virtual logistics information system.

(1) Material information query

Earthquake relief virtual logistics information system stories information into different categories. This information is about material storied in entity warehouse, material in relevant markets, and material in transporting and manufacturing. It provides query service for material demand customers and manufacturing companies to make sure earthquake relief information run smoothly.

(2) Emergency material purchasing.

Under the help of database and bid inciting system, earthquake relief headquarters can mast the latest material trends and price information in markets. It publishes electronic purchasing lists of emergency materials and provides electronic purchasing bidding documents to realize online competitive bidding. As the results of automation and paperless of bidding data processing, efficiency and quality of material selection are improved. By remote purchasing and internet payment system, trading on the internet is becoming safe. Information exchanging between relief headquarters and supplier is becoming convenient. Business is high efficiency, safe, and fast. At the same time, costs have reduced. Information flow and capital flow consolidate well with each other.

(3) Emergency materials storage

By storage management system, earthquake relief headquarters are easy to manage storage locations, quantities, varieties, and production status of materials distributing at different areas in emergency supporting system. According to actual situations such as change in demands, the distance between entity warehouse and destinations, storage costs and storage capacities of entity warehouses, and traffic and transportation conditions, supported by expert decision supporting systems, earthquake relief headquarters control materials to receipt to / dispatch from a warehouse and make inventory updating plans and purchasing plans. Through this system, members companies manage the business related to emergency materials production and storage. Business data such as storage statements are uploaded in real-time. Emergency tasks are always under the supervision of earthquake relief headquarters to ensure earthquake relief virtual logistics information system running in good conditions overall.

(4) Emergency material dispatching

Through dispatching information system, earthquake relief headquarters optimize the allocation of dispatching resources, such as logistics center, transportation enterprises, and freight forwarding companies which are located surrounding various entity warehouses and manufacturing enterprises. For very logistics task, dispatching information center chooses suitable logistics enterprises and make dispatching plans with the most time effective and relatively lower logistics costs. In addition, dispatching information centers are responsible for remote digital surveillance and management of transportation stage by using GPS positioning system to ensure safe, efficient and rapid emergency material delivery to meet the demands.

(5) Member and supply chain management

Under the controlling and management of emergency logistics headquarters, Material support missions of earthquake relief system are completed by a high degree of collaboration of agreement of system members. Relying on members and supply chain management system, emergency logistics headquarters can inquire the basic information about members companies. The information is about companies' location, staffs, business level, material varieties, and equipment status. This system analyses enterprises business overall situation and material distribution. According to specific requirements, it adds new members into member lists or deletes unqualified ones out of member lists in order to implement business process reengineering and control material qualities.

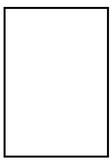
CHAPTER 4 EARTHQUAKE RELIEF VIRTUAL LOGISTICS INFORMATION SYSTEM ANALYSIS AND DESIGN

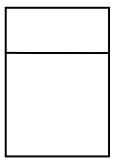
Earthquake relief virtual logistics information system is composed of 4 subsystems. They are system building subsystem, storage and purchasing subsystem, transportation and allocation subsystem, and dispatching and retrieving subsystem. These four system are not only independent form each other relatively but also corporation with each other. It is continually improved and perfect to solve the problem of information backup and lack global views. It can reduces logistics costs and increase logistics efficiency.

In the following parts of paper, I will give four systems' information flow diagram. In the diagrams, there are four basic factors

(1) Data flow: It looks like a pipe to transport a set of information with same structures.

(2) Data documents:  Data is stores in it temporarily.

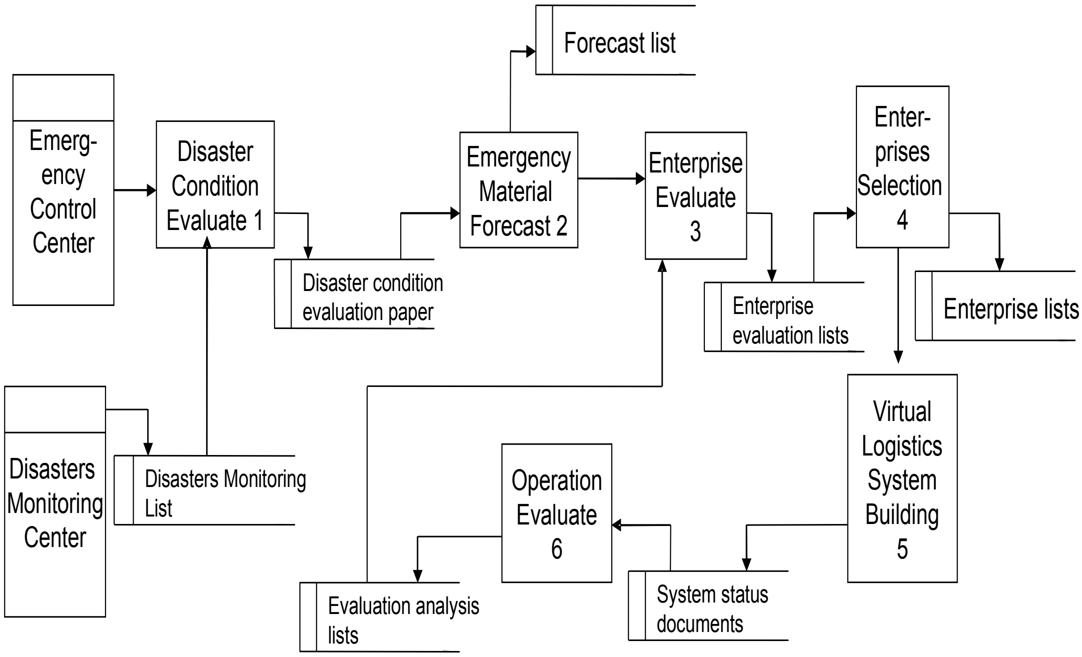
(3) Processing:  Processing is a kind of operation to data. It changes Data-In into Data-Out.

(4) Data source/ends:  Data source/ ends shows data source and destination. It is people or organizations which are in or out of the system.

4.1 Virtual logistics system building subsystem

4.1.1 Information flow diagram of virtual logistics system building subsystem.

Figure 4.1 Information flow diagram of virtual logistics system building subsystem



4.1.2 The main task of this subsystem

There are four main tasks in this subsystem. The first one is evaluating the condition of earthquake disaster. Earthquake relief headquarters forecast varieties and quantities of emergency. After checking stock in storage, headquarters make a decision about what kinds of material should be purchased and how many transportation tools should be taken over for used. The second task is choosing suitable manufacturing enterprises but also logistics enterprises. Before making sure which enterprises are engaged into emergency logistics support system, headquarters would evaluate these companies form production capacities, production qualities and other aspects. The third task is building virtual logistics information system. Headquarters set up an information platform to publish demands information and open it to manufacturing and logistics enterprises. These enterprises also open their information system related to emergency material supporting to connect with emergency virtual platform. The fourth task is evaluating these enterprises performance. These companies which can not meet the earthquake relief demands should be given up from this emergency supporting system in order to make sure provide qualified material for disaster area and disaster victims.

4.1.3 Description of information flow diagram

In information flow diagram, processing is a key node in it. In the following description, I take processing as a core to illustrate the flow of this system.

(1) Disaster condition evaluation. Based on disaster monitoring lists provided by disasters monitoring center, this processing evaluates the conditions of disasters. Output information is disaster condition evaluation paper. It contains earthquake location, earthquake intensity, and population in disaster area, weather condition, blocking point, and airport condition.

(2) Emergency material forecast. In this processing, input information is disaster condition paper. Headquarters make a forecasting about what kinds of material and how many materials are needed. Output information is forecast material lists. This

list contains material number, material name, and place for demands, material quantity and variety.

(3) Enterprise evaluates. The input information is material in short lists. Headquarters find the enterprises who produce these materials and the logistics companies which can provide logistics service. The output information is enterprise evaluation lists. This list contains company number, name, production capacities, locations, and locations.

(4) Enterprise selection. Based on the information form enterprise evaluation list, headquarters make sure which companies are chose. Selection standers are enterprise production capacities, produces qualities, locations, and their reputations. Output information is enterprise list. This list contains enterprise number, name, capacities, locations and material number and name.

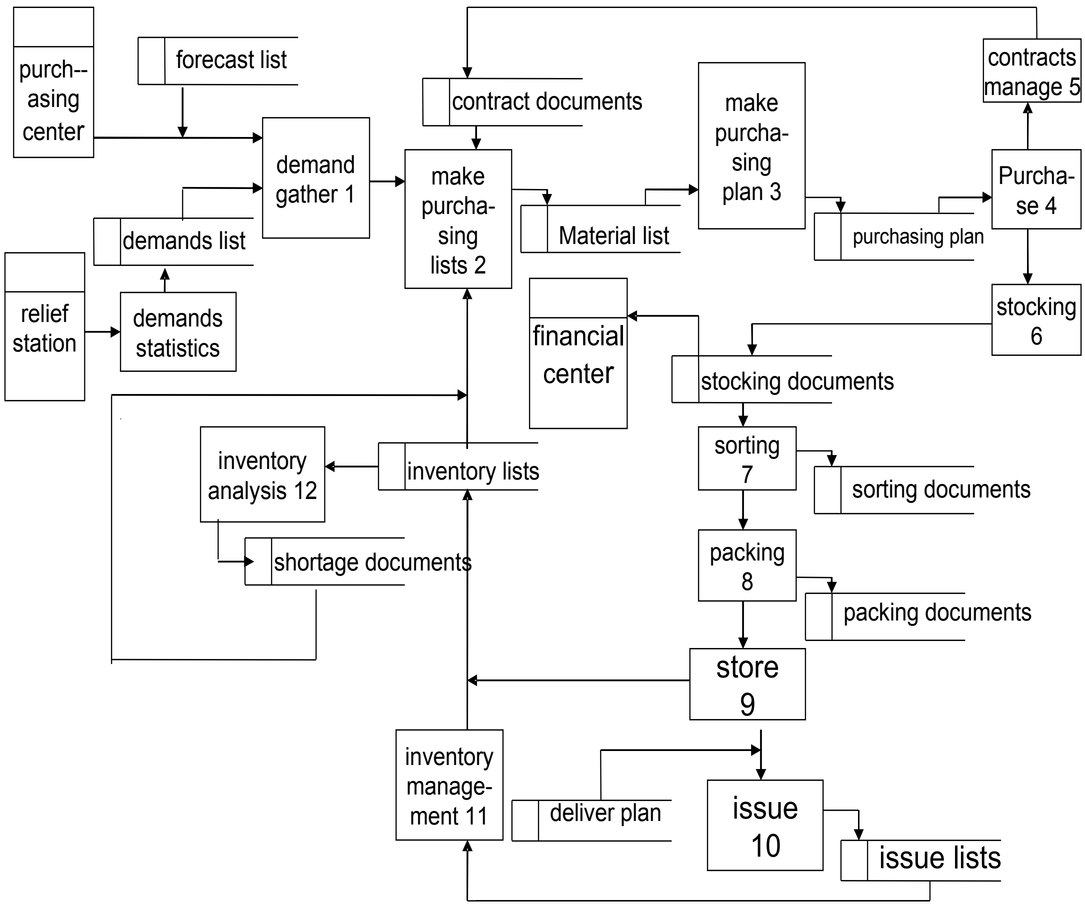
(5) Virtual logistics system building. Headquarters build an information platform for both manufacturing and logistics enterprises. Demands and supplies meet on this platform. The operation status is recorded into system status documents. It contains amount of enterprise, order form response time, and order form processing numbers.

(6) Operation evaluation. This processing is to evaluate every company's performance to decide which one should be moved and which one should be kept in. The output information is evaluation analysis lists. It contains enterprise number, name, capacity, and order list response time, and material mane, quality.

4.2 Storage and purchasing subsystem

4.2.1 Information flow diagram of storage and purchasing subsystem

Figure 4.2 Information flow diagram of storage and purchasing subsystem



4.2.2 The main tasks of this subsystem

This system is to complete purchasing and storage problems. Firstly, system would make sure what kinds of materials should be purchased. This decision is not only based on demands form disaster areas but also based on material supply. Earthquake disaster relief doesn't provide everything disaster areas need but emergency materials. Second task is purchasing. According to the demands, purchasing center decide an order of purchasing. Urgently needed material should be purchased firstly, such as medicine and life saving equipment. The third task is purchasing. That is to buy materials from manufacturers. The fourth task is stocking. We put materials into warehouse. After sorting and packing, materials are put at right locations in warehouse. During this period, material information is input into system digitally. After it receiving deliver plan, materials remove out of warehouse. The fifth task is to analysis storage status. It can show which materials are sufficient and which kinds of material are in shortage.

4.2.3 Description of information flow diagram

This subsystem is an operation function system. It is responsible for material purchasing and storage. The basic information is input into logistics system during this period. It provides material support for earthquake relief.

(1) Demands gather. Purchasing center gathers demand information both from forecasting list and demands lists form relief station. After demands analysis,

purchasing center make sure which material is urgent for disaster area. The output information is material gathering list. It contains material mane, number, demand amount and place.

(2) Make purchasing list. After demands are clear, the next step is checking storage to find which materials are in storage and we can supply immediately. For the material in shortage, we should purchase form the manufacturing enterprise which are engaged in emergency supporting system. The output information is material list. It contains material name, number, amount, and manufacturer name and location.

(3) Make purchasing plan. In this processing, the most important task is to make sure the purchasing orders. The urgent materials should be purchased first. How to regulate this order is depend on actual situations. The output information is purchasing plan document. It contains material name, number, amount, and purchasing order, and manufacturer name and location.

(4) Purchase. In this processing, signing a contract means a purchasing completion. So, the output information is contract list and material list. Contract list contains contract content and signing time. Material list contains material number, material mane, manufacturer mane, purchasing time, and amount.

(5) Contracts management. Based on contracts list, contracts paper is stored in order to evaluate companies' performance. The output information is contract document. It contains contract content, signing time, contract number.

(6) [(7) (8) (9)] Stocking (sorting, packing and store). In these processing, materials are changed into an entity from outside of system to inside of system. Material is put

in storage in this processing. Firstly material would be classified into different categories. Then material is packed. We add bar code on the material. It is convenient for transportation center to control during transportation. Then material is put away at right place in warehouse. The output information is stocking documents, sorting documents, and packing documents. They contain material number, amount, name, category, bar code number.

(10) Issue. This process records issue information, after receive deliver plan. The output information is issue lists. It contains material number, name, destination, issue data, and amount.

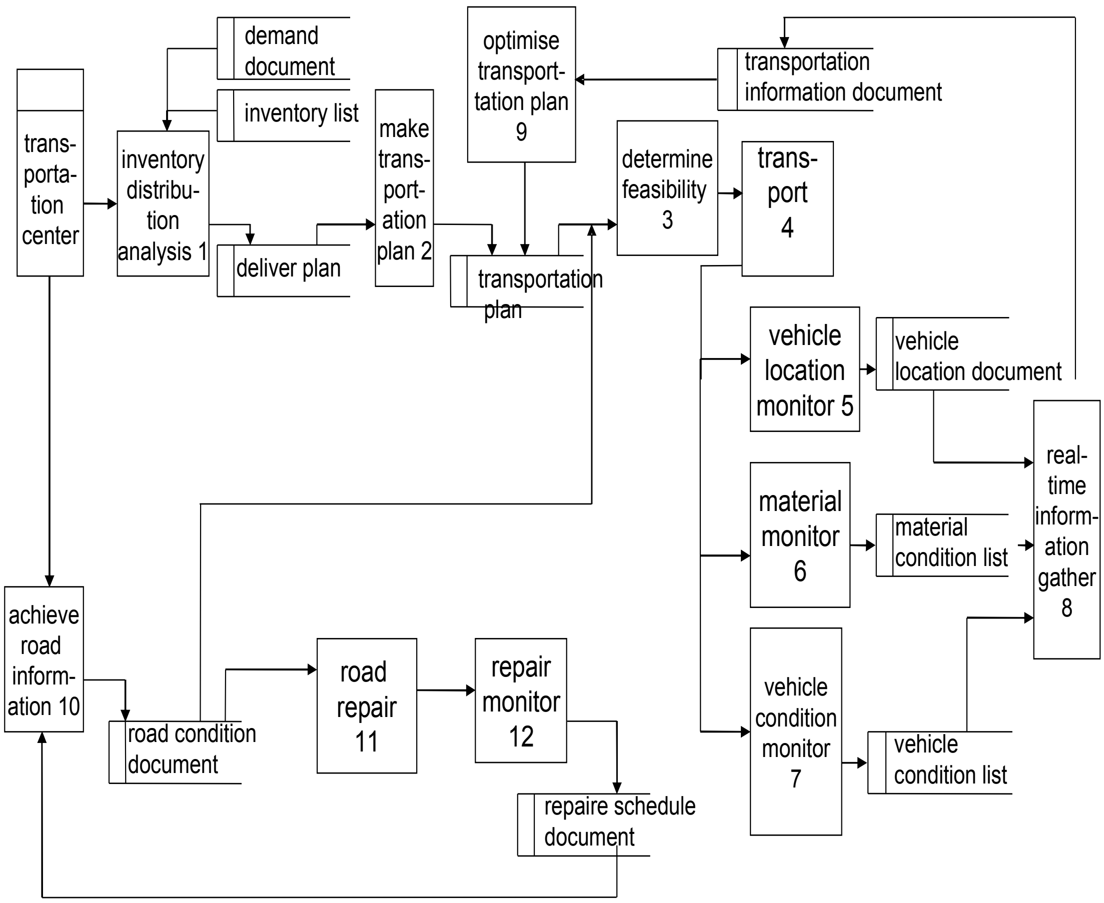
(11) Inventory management. This processing is to record inventory status. And sent the results to purchasing 2: make purchasing list. The output information is inventory lists. It contains material name, number, amount, bar code, manufacturer name, store data, issue data, delivery destination and warehousing location.

(12) Inventory analysis. This processing evaluates inventory structure to find which kinds of material are in short. The output information is shortage document. It contain material name, number, amount of shortage.

4.3 Transportation and allocation subsystem

4.3.1 Information flow of transportation and allocation subsystem

Figure 4.3 Information flow diagram of transportation and allocation subsystem



4.3.2 The main tasks of this subsystem

This subsystem is designed for earthquake relief material transportation. In this subsystem there are several tasks to be completed. The first one is to make sure warehouses from where materials are sent. In earthquake, the demands of relief are much more than other emergency. One warehouse can not able to provide enough material. The warehouses at different locations should cooperate with each other to provide enough relief material. In this situation, costs of transportation are not the priority consideration. Time-efficiency and demands satisfaction should be the priority consideration. The second task is to get road conditions information in real time, and arrange repair plan. In earthquake, roads network are destroyed. In order to support transportation, we should know which part of road can be used and which parts of them must be repaired. According to it, we choose a property transportation route for logistics companies. The third task is to process monitor. During transportation, vehicles and relief material is monitored by GIS/GPS. Transportation center will get the real time information of them, such as location, statues. When some unexpected things happen, transportation center can adjust plans to ensure task can be completed.

4.3.3 Description of information flow diagram

This subsystem is a very crucial part in earthquake relief virtual logistics information system. It is responsible for transporting relief material from warehouses to relief distribution center.

(1) Inventory distribution analysis. Based on inventory list and demand documents, Transportation center makes decisions about delivery. Relief material is distributed in different warehouse. Transportation center makes decision which kinds of material should be sent out from which warehouse. The output is delivery plan document. It contains material number, name, destination, warehouse number.

(2) Make transportation plan. When deliver plan has been make, transportation center is going to make transportation plan. This processing is to choose proper logistics enterprises and enlist transportation tools to transport relief material. It is also responsible for making transportation routes for vehicles. The output information is transportation plan. It contains material number, name, transportation route, and delivery vehicle.

(3) Determine feasibility. According to road condition document, transportation center checks that if transportation plan document is feasible. Only for that feasible plan, they can be cent to logistics enterprises to start material transportation. The output information is feasibility analysis report. It contains transportation route and whether acceptable.

(4) Transport. This processing is the most basic function in earthquake relief virtual logistics system. In this period, material is transported from warehouse to distribution center in disaster areas. The output information is transportation list. It contains material number, amount, name, and destination, route, and start time.

(5) (6) (7) Transportation monitor. By GIS /GPS technologies, transportation center can get real time information of vehicles and materials on road. When some unexpected things happen, transportation can quickly find results and give solutions

in order to ensure complete transportation task. The output information is vehicle location document, material condition list and vehicle condition list. It contains vehicle location, transportation time, distance, destination, vehicle status.

(8) Real time information gather. In this process, on road information of vehicles can be transmitted back to transportation center by GIS/GPS system and gathered into transportation information document. This document reflects transportation rate. And it is also basis for transportation center to optimize transportation plan.

(9) Optimize transportation plan. On the way during transportation, everything could be happened. In order to adapt actual situation, transportation plan should be changed into a new one.

(10) Achieve road information. GIS system is responsible for providing road information for transportation center. The output information is road condition document. It contains road number, blocked part, passable part, and blocking reason.

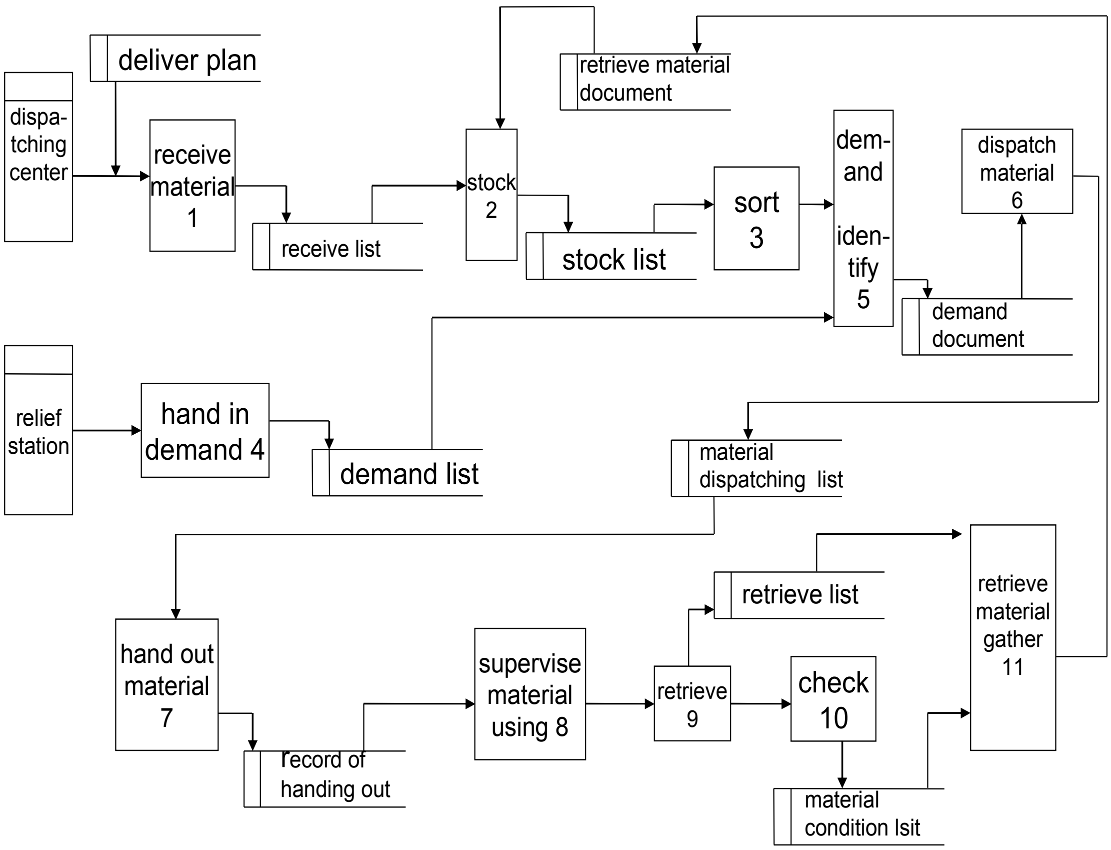
(11) Road repair. In this process, according to road condition document, transportation center make repair plan and record contractor information into repair plan document. It contains road number, block reason, contract name, and repair time.

(12) Repair monitor. This processing receives road repairing information and records it into repair schedule document. Repair document is sent back to transportation center to update road condition document. The output information is repair schedule document. It mainly contains repair schedule.

4.4 Dispatching and retrieving subsystem

4.4.1 Information flow of dispatching and retrieving subsystem

Figure 4.4 Information flow diagram of dispatching and retrieving subsystem



4.2.2 The main tasks of this subsystem

In this subsystem, there are two tasks. They are material dispatching and receiving. When relief materials arrive at distribution center in earthquake areas, distribution center should store these materials into their warehouses. At the same time, relief stations provide the demand list to distribution center. After demands identification, distribution center decides which kinds of and how much materials are dispatched into relief stations. The second task is material retrieving. In earthquake relief, many kinds of material can be used more than one times, such as tents, blankets, and life saving equipment. When relief mission is completed, this material should be retrieved for next emergency. During material in service, relief station will supervise material using and remind publics to protect the material. After materials are retrieved, it should be checked. Those materials in good conditions can be sent back to distribution center's warehouse. Those materials in broken should be repaired then sent to warehouse.

4.4.3 Description of information flow diagram

Material dispatching and retrieving subsystem is designed for material dispatching and retrieving. It is a connection between disaster victims and relief stations.

(1) Receive material. Dispatching center receives relief materials form logistic companies. Compared with delivery plan, distribution center checks and accepts relief materials. Transportation task is completed. The output of information is

receive list. It contains material number, name, amount, manufacturer name, transportation data, warehouse of delivery, and logistic company.

(2) Stock. After receiving material, dispatching center put these materials into their warehouse. Input information is receive list and output information is stock list. It contains material number, name, stock date, and stowed location.

(3) Sort. According to relief material variety and demands of disaster areas, distribution center divides the material into different groups in order to make good preparation of dispatching. The output information is material assortment list. It contains material number, name, and amount, variety, and storage methods.

(4) Hand in demand. Relief stations collect material demand information and hand it in to dispatching center. This is the key connections between disaster victims and relief information system. This information makes a very important role in the whole system. The output information is demand list. It contains material number, name, demand amount, location of relief station.

(5) Demand identify. Demands of disaster victims are not be satisfied entirely because of material shortage. So, distribution center should identify these demands and makes sure the most urgent material dispatched to relief station. The output information is demand document. It contains material number, name, demand amount, location of relief station.

(6) Dispatch. Based on demand document and material assortment list, dispatching center makes a dispatching plan. It plans which kinds of and what amount of material should be dispatched to which relief center at what time. The output information is

material dispatching list. It contains material number, name, dispatching data, amount, relief station name and location.

(7) Hand out material. When relief material is dispatched to relief station, these materials are then handed out to disaster victims. In this processing, article claimer and article date should be record. The output information is record of handing out. It contains article claimer, article date, article amount, material number, and name.

(8) Supervise material using. For relief, especially for recyclable relief material, such as tents and blankets, their information should be input into information system. Due to this information, retrieving can be more convenient. The output information is material number, name, article claimer, status.

(9) Retrieve. When relief mission completed, recyclable should be retrieved. In this processing, relief station records retrieve date, material number, and amount such information into retrieve list.

(10) Check. This processing is to check the status of retrieving materials. The materials which are not in good condition should be repaired. The output information is material condition list. It mainly contains condition information of recyclable materials.

(11) Retrieve material gather. Relief stations gather all of the information of retrieved material into retrieve material document. This processing is the records of retrieved material which are sent to delivery center. It contains material number, amount, retrieve date, and, repairing records.

CHAPTER 5 CONCLUSION

This dissertation deeply analyses emergency logistics and the features of emergency logistics system. Based on this analysis, applying network technology, database technology, GIS/GPS technology, and virtual organization theory to emergency logistics system, this paper gives technology framework and theory of the virtual logistics system. Applying these theories and technologies, I design a logical model of virtual logistics information system for earthquake relief. The main conclusions of this dissertation are as follows:

(1) This paper analyses the features of emergency logistics management. Based on construction analysis of emergency logistics, I make emergent logistics flow clear.

(2) Combined crisis management with virtual organization theory, this paper applies them to emergency logistics management and creatively offers a concept of virtual logistics. Then it intensively studies on building process, operation mode, operating conditions.

(3) This dissertation gives a framework of earthquake relief virtual logistics system. Though comparison between many calculation modes, we choose B/S calculation mode based on XML as calculation mode and illustrate the basic data demands and functions of earthquake relief virtual logistics system.

(4) This dissertation designs a logical model for earthquake relief virtual logistics system. In this paper, earthquake relief virtual logistics information system is divided

into four parts. Information flow diagram is given to illustrate the operational process of earthquake relief virtual logistics system.

Reference

Andre Zergerand David Ingle Smith(2003). Impediments to using GIS for real-time disaster decision support. Computers, *Environment and UrbanS ystems*, 2003(27), 123-141

Chen Ping(2003). Information exchanging-the key point of responding to emergency. Healthy Dialy, 2007.07.08

Dong Mingwang, Yan Xinping&Gu Rong (2007). Setting up a virtual logistics system for emergency. *Wuhan University of technology(social science edition)*, 2007, 20(1), 27-29

Du Jiang(2005). Public healthy safety control decision support system based on webGIS. Jiang Su University, 2005.6

Fang Jing, Chen Jianxiao(2008). Exploration and analysis of China's emergency logistics system. Transportation Enterprise Management, 2008(8), 1-3

Han Yukuan(2004). Basic function of information to emergency. *Journal of Beijing Insititue of Technology(social science edition)*, 2004, 6(4), 9-12

Huang Jinhu(2007). The research and implementation of some emergency logistics' key technology. ShangHai Jiaotong University, 2007.05.11

Jiang Rong, Hao Zuoluo(2008). Virtual logistics risks and control. *Logistics Sci-Tech*, 2008(5), 38-40

Li Jingyi(2006). Application of GIS in emergency logistics. *Market modernization*, 2006(10),117-118

Li Yingtang(2008). Idea of Establishing Emergency Logistics System initiated by the Wenchuan Earthquake. *Logistics Technology*, 2008, Vol.27(8), 8-10

Meng Can, Wang Changqiong(2006). Analysis and management of opertation process in emergency logistics system. *Logistic technology*, 2006(9), 15-17

Philip T. Evers(1999). Filling Customer Orders from Multiple Locations: A Comparison of Pooling Methods. Journal of Business Logistics, 1999, Vo.l 20 Issue 1, p121, 19p, 9 Charts.

S.M.Hong-Minh, S.M.Disney&M.M.Naim(2000). The Dynamics of Emergency Transshipment Supply Chains. Inter-national Journal of Physical Distribution & Logistics Management, 2000, Vo.l 30 Issue 9, p788, 29p.

Tong Xinshun(2008). System analysis and implement for emergency logistics. *Storage transportation & preservation of commodities*, 2008,30(2), 39-40

Wang Xing(2007). Study of supplies distribution model in relief logistics. Beijing Jiaotong University, 2007.08.18

Wang Xuping, Fu Kejun&Hu Xiangpei(2005). Emergency logistic system and its quick responding. *Enterprise Stretagy*, 2005(6), 127-131

Wang Yisheng, Wang Feng&Jiang Dali (2004). Structure analysis and design of virture logistics infornmation platform. *Storage, transportation & preservation of commodities*, 2004(3), 7-11

Xie Yangxu, Deng Yunfeng&Li Qun(2006). Emergency MIS structure discusses. *Journal of safety science and technology*, 2006, 2(6), 27-29

Zhang Gongxuan, Ling Yongfeng&Ge Jiangfang(2003). Data processing based on XML. Journal of Nanjing University of Science and technology, 2003,27(1), 11-15

Zhang Jing, Liu Zongxi(2008). Construction of earthquake disaster logistics system in China based on Wen Chuan Earthquake. *Logistics Technology*, 2008, Vol.27(20), 33-36