Application of Information & Communication System for Better Coordination among the Emergency Responders

by

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ABSTRACT

Examples to use information system are seen in information gathering and sharing at the time of disaster in the Ministry of Land, Infrastructure and Transport. Some are effective and others are not. This study analyzes sample of both cases and selects crucial factors to put disaster information systems to practical use. In addition, solutions for obstacles in use of information systems are studied. Concretely, this study execute;(1) Defining disaster related information, (2) Reconstructing Operation model of disaster information sharing that contains information system, (3) Improving procedure to input data, and (4) Proposing interface to exchange data among systems. This paper shows the process and result of analysis of sample information system and these four concrete solutions.

Two more divisions in addition to authors execute this study.
3.3 is executed by Information Access Division, Geoinformation Department, Geographical Survey Institute. And 3.4 is executed by Information Technology Division, Research Center for Advanced Information Technology, NILIM. Corresponding contents described in this paper is results of their studies.

Keywords: Disaster information system, Business Model, Definition of disaster related information, Gazetteer, Interface among systems

1. INTRODUCTION

Information sharing among field staffs, work offices, regional bureaus and headquarters in the whole Ministry of Land, Infrastructure and Transport by means of advanced information and communication technologies does not realize at present. Regional bureaus and work offices level, disaster information sharing systems are already introduced. Some are effectively used and others are not at disasters unfortunately.
The Ministry recognizes the necessity to increase efficiency and certainty in gathering, conveying and sharing disaster related information, and also recognize that Information Technologies contribute to realize such needs. This study is based on such recognition and does not show only model case to build new disaster information system but reconstructs business model of crisis management including usage of information systems.

2. SELECTING PROBLEMS RELATING TO SHARING DISASTER RELATED INFORMATION

2.1 The Standpoint in Selecting Problems

The appropriate sharing of disaster related information is necessary to make appropriate decisions in crisis management in the event of a disaster, and to ensure disaster mitigation activities and local residents' evacuation implemented by front-line disaster reduction bodies. The importance of the effective use of IT in ensuring appropriate sharing of disaster related information was also emphasized in the Expert Panel Report of the Central Disaster Management Council's Special Boards of Inquiry on the sharing of disaster related information [1].

Although it only captures one aspect of the situation, Fig-1 shows the problems in the current situation regarding the sharing of disaster related information, and gives typical illustrations of a general scenario in which these problems are solved by a disaster information

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sharing system based on information technology (IT).

However, simply setting up such a system does not automatically ensure that disaster related information will actually be shared: as shown in Fig-2, there are obstacles that can prevent the system's benefits from being realized. In the light of this knowledge, Fig-3 shows, somewhat more specifically, the problems encountered in an actual investigation when a disaster information system was introduced and put to work, and indicates how problems that exists previously might be resolved. The illustrations listed in Fig-3 show that, in sharing disaster information, developing a functionally-outstanding IT-based disaster information system is only one of the challenges to be faced: these challenges include devising a mechanism for sharing all the disaster information contained in the disaster information system, and ensuring the reliability of the system.

Even if we confine ourselves to one aspect, as stated above, sharing disaster related information presents a broad range of problems. Our approach to selecting problems was to focus on the major problems which are unavoidable if appropriate information-sharing is to be achieved. The specific problems in this study are described below. In the following sections, we shall indicate where the problems lie, and give real-life illustrations.

(1) Problems in the unification of terminology and the definition of the disaster related information that should be shared
(2) Problems in the process of introducing the information-sharing system
(3) Human-factor problems relating to the use of the system

2.2 Problems in Defining the Disaster Related information That Should be Shared

" Sharing disaster related information" sounds easy enough, but in fact, there is variation, to a greater or lesser extent, between organizations and between individuals as to the range of data deemed to comprise disaster related information in the first place. Moreover, even if agreement were reached on this point, "disaster related information" is not homogenous: some of it will consist of information that has to be passed on to a higher level immediately, some of it might not require a decision from a higher level, but requires prompt action, while some of it does not need to be passed on or responded to immediately.

If disaster related information is passed on without discriminating between these categories, it may result in information overload: consequently, important points may be missed, and vital information omitted, and this may result in disruption of the disaster response.

Let us suppose that, when the disaster related information system is built, the necessary disaster related information is defined by various relevant organizations, and all the information is handled indiscriminately by the system. In this scenario, the data volume would become enormous, and it would not be feasible to input more than a fraction of it. If the information is simply aggregated, vital information is buried in a mountain of superfluous data.

Furthermore, different organizations use different terminology to refer to the same things, and even if they all used the same terminology, if it meant different things to the sender and the receiver, then this too would contribute to misunderstandings and confusion at the scene.

These are the problems involved in defining exactly what disaster related information should be shared. In section 3, one possible process for defining disaster information will be suggested.

2.3 Problems Involved in the Process of Introducing an Information-Sharing System

Although it hardly needs restating, introducing an information-sharing system making good use of IT is obviously an effective means of ensuring that disaster related information is shared in a disaster-response situation. This view is right, but does not assume that introducing such a system will automatically

result in the sharing of disaster related information. There are real-life cases where the system that has been introduced is not used to the full, or used at all, in the event of a disaster. Fig-4, based on interviews regarding a case where a system was introduced but did not prove to be adequately effective, sets out the factors that contributed to this situation. Some of these factors relate to problems that should have been addressed during the process of introducing the system.

2.4 Human Problems Involved in Effective Operation

It still happens that information systems using GIS are introduced at the national or local government level and fail to be used at all, or fall into disuse after two or three years. Aside from the factors previously covered, i.e. the definition of the information, the introduction process, and data maintenance and updating, this is due to human problems, mainly concerning the people who operate the system.

There seem to be two human factors: one is securing enough personnel for the system to function correctly (the quantitative factor), and the other is the ability of the personnel to operate the system (the qualitative factor). In the event of a disaster, a huge workload falls on the shoulders of a limited workforce, and the factors listed in Fig-4 – i.e. the fact that the importance of the system is not generally perceived, and that people who input the data gain no advantage through doing so – probably explain why the necessary manpower has not been made available. Another likely factor was the organization's failure to make clear how many people would be needed, or what they should do, to make the system work properly. These issues are probably relevant to the concretization of the disaster response operation and the system design at the time of introduction.

Fig-5 are based on the results of the same study as Fig-4, and summarize the contributory factors relating to the system function, in a case where the benefits of introducing the system proved to be small. The fact that the system was awkward to use, and the high incidence of input errors are classified as problems created by the system. However, unless the personnel are accustomed to using the system in non-emergency circumstances, even well-designed system often "goes down", and contains data full of input errors, then staff members will be reluctant to use it right from the outset. As a result, they will tend to rely on the old system instead.

3. SOLUTION FOR ABOVE PROBLEMS

For the problems that are described at 2, the following studies are executed in this project.

(1) Definition of disaster related information
(2) Reconstructing Operation model that contains information system
(3) Improvement of procedure to input data
(4) Interface to exchange data among systems

3.1 Definition of Disaster Related Information

The need to define disaster information was discussed above. This section show one way to approach this definition, plus its process, and will present a scenario in which disaster related information is defined through this process. Each organization has its own ideas about the disaster information that needs to be defined, and its own methodology for defining it. One recent review will be used as a useful example, although no claim is being made that this is the best approach.

3.1.1 Defining Disaster Related Information: The Process Flow

Fig-6 shows the process flow for defining disaster related information. The first step is to identify what kind of information had been transmitted by what means in the event of a disaster (specific instance analysis). The exact nature of the disaster-response operation, and the nature of the disaster information required during that response, was then analyzed (disaster-response operation analysis). Meanwhile, the overall information needs of other disaster response organizations were investigated (identification of new information-transmission needs). The results of these analyses were integrated to arrive at a definition of the information to be conveyed, and the priority of these information was also

defined.

(1) Disaster-Response Operation Analysis
For the purposes of defining disaster related information, the important viewpoints are the time at which the information was used, and the use to which it was put. There are 3 basic uses: judgment, reporting (contributing to evaluation, reporting and announcement to be carried out by higher-level organizations), and publication (contributing to evaluation, reporting and supply by third parties or lower-level organizations). If we define the evaluation, reporting and supply required in the disaster response, this will lead to a definition of the disaster related information required for these purposes.

To end this, it is important to clarify things by analyzing the current state of the disaster-response operation, and picking out the problems involved. Fig-7 shows an example in which the current state of the disaster-response operation was analyzed, and the problems picked out, using Integrated DEFinition (IDEF) methodology. Developed in the US, IDEF is a technique for building consensus between organizations by modeling the operations involved in improving productivity through the introduction of IT.

By using IDEF modeling, an overall picture of the disaster-response operation is captured and regarded as the “AS IS” model, i.e. a model of the current situation. This “AS IS” model is analyzed to identify the problems in past disaster responses. By means of this analysis, improvements are clarified, and a new model of the operation as it should be (i.e. a proposed “TO BE” model), is constructed. If a consensus can be achieved regarding the proposed “TO BE” model, the latter will then become the new disaster response operation model. The information that should be evaluated, reported and supplied by each organization is defined by this model. This is the definition of the disaster related information.

This leaves the time perspective – i.e. when the reporting should happen. In the case of the review used in this example, the time line was broadly divided into three phases: the grouping phase immediately following the disaster, the system-construction phase, and the phase following system-construction. The importance and priority of information was then defined in each phase.

(2) Defined Disaster Related Information
Fig-8 shows an outline of disaster related information defined in the light of the results of the review process described above. The diagram correlates each organization’s obligations in terms of evaluation, reporting and instructions, in each phase of the disaster response by each organization, with the information that is required for these purposes, and must therefore be passed on and shared.

3.2 Reconstructing the Operation on the Basis of the Defined Disaster Related Information
If the main items of disaster related information could be defined by the process described above, the format, et cetera, for each item of information could then be defined in detail, and progress could be made in rendering the information usable by the disaster related information system and other tools for transmitting and sharing information. However, because the disaster related information has been redefined and the transmission-and-sharing tools have also changed, unless a new disaster reduction response operation is also defined accordingly, the data might not get input properly into the system, and the personnel needed to carry out the operation might not be deployed, and confusion between the old and new operation might arise, with the result that the transmission and sharing of disaster related information does not function properly. It is therefore necessary to reconstruct a new disaster-response operation.

Fig-9 shows the final new operation model (the TO BE model), which includes the defined disaster related information, defined further at the micro level. The technique used here is the “use case” prescribed by Unified Modeling Language (UML), which is a useful way to gain an intuitive understanding of the systems

specifications and process flow.

3.3 Improvement of Procedure to Input Data

One of most serious problems when disaster information system is used is that input work is time consuming and complicated. Therefore, the method to be able to input data as easily as possible is studied.

At this study, from two different aspects, development is being done. One is development of “gazetteer”, a reference database which translates an indirect spatial reference (e.g. address, milepost) into latitude and longitude. Another is automatic reading and positioning of paper documents that are sent by facsimile.

3.3.1 Development of Gazetteer

Roads and rivers which the Ministry of Land, Infrastructure and Transport manages own a coordinate of a milepost. Progress of facilities inspection at the time of a disaster and a position of a damage point are transmitted by a milepost from field staffs to higher-levels. Because a position is very important in reporting disaster information and evaluating situations, several kinds of maps are used at the communication between staffs. When an information system is introduced at the disaster response, latitude and longitude is necessary when damage positions are shown on an digital map. In general, field staffs memorize where it is by milepost. And on the contrary, staffs are not accustomed to the expression of latitude and longitude. Therefore, the mismatch becomes obstacle that latitude and longitude are needed to indicate positions of damaged facilities on an digital map while a milepost is used when information is conveyed in actual communication in disaster response.

To solve this problem, the database that converted a milepost into latitude and longitude is developed. In this study, indirect coordinates that are used generally were investigated. Then, it was found that not only a milepost but also popular place names and addresses are used. Therefore, database is developed to translate such indirect spatial references into longitude and latitude.

Because several databases already exist to exchange milepost to longitude and latitude, this study develops database with utilizing those existing databases as much as possible.

3.3.2 Automatic Reading and Positioning of Paper Documents on Maps

In communication between field staffs and higher-level bureaus at the time of a disaster, the first reports of damage discovery are sent on the telephone. And many of information after that are transmitted with facsimile. Facsimile is the tool that is easy to use at the time of a disaster because 1)it is used even everyday business, 2)anyone can use it and 3)it is wide spread. However, it is time-consuming to digitize paper documents sent by facsimile and link on a map.

To solve this problem, the device that can be digitized paper documents automatically and link the digitized data to a certain point on a digital map by only executing the same procedure as transmitting a paper document by facsimile is developed.

Facsimile has shortcomings as communication method in a disaster, which is shown in Fig-1. Even such a non-effective case is seen that a document which was input with word processors output once by paper and sent by facsimile, then the bureau which received the document inputs it with a word processor again.

By applying the device developed in this study, paper documents are easily digitized and linked to a map. And also, improvements of communication at a disaster response are expected such as 1) not being affected by line congestion, 2) being able to receive information from plural bureaus at the same time, 3) not being deterioration of images and 4)being able to search and arrange easily.

This study investigates new format of repot sheet as well as the development of devices. To change a report format is not expected on business side for disaster response. However, it is difficult to digitize position information automatically from the present report sheet. Therefore a style / the entry method how reading is possible with a scanner are investigated on the basis of present report styles. A sample of sheets examined is shown in Fig-10. In concrete, by using the computer-scored answer sheet system

and map divided into several mesh, new report format is going to being formed.

3.4 Interface to Exchange Data among Systems

Some disaster related information are already dealt in information systems. And various information gathered at usual facility maintenance are also necessary for crisis management. Some of such information are also stocked by database systems. If data and information are conveyed among systems, communication is rapid, simple and accurate. And the problem shown in Fig-4-i.e.same data is input on different systems over and over, can be solved. To ensure efficiency of using information system, such an undesirable circumstance should be released. In these sense, normative specifications to exchange data among systems are developed in this study. One of the specifications is data dictionary and another is the specification of interface between systems.

Data dictionary defines the data attribute and the format of each attribute. In accordance with data dictionary each system is able to understand the meaning of received data uniformly. Fig-11 shows the example of a data dictionary.

The specification of interface among systems is the aggregation of commands to send and receive direction and data among systems. In this study, when a data is searched based on a key word, quarry action is executed to other linked information systems. At this point, communication language is needed among systems. Without the uniform language, a system has to send quarry message for each system to be able to understand. If specification of interface among systems exists, one message is enough to direct linked all systems to search target data. There already exist several specifications of interface among systems. This study constructs specification by referring to such specifications and filling up vacant message.

4.CONCLUSION

An examples of review of the disaster information definition process, including the use of IDEF and “use cases” to analyze the operation, and a visualization of the new disaster response operation is shown. And several concrete solutions developed in this study are described. Integrating these methods, this study aims at information sharing by IT technologies shown in Fig-12.

Chubu regional development bureau in the Ministry of Land, Infrastructure and Transport has the project to re-design their disaster information system and working group started at April 2005. In this meetings, results including shown in this paper is scheduled to be argued and examined on the basis of a disaster scenario. Through this process, verification of their efficacy and needed modification is going to be executed.

5.Reference

[1] Central Disaster Management Council’s Special Boards of Inquiry on the sharing of disaster related information, 2003. (http://www.bousai.go.jp/jishin/johokyoyu/index.html)

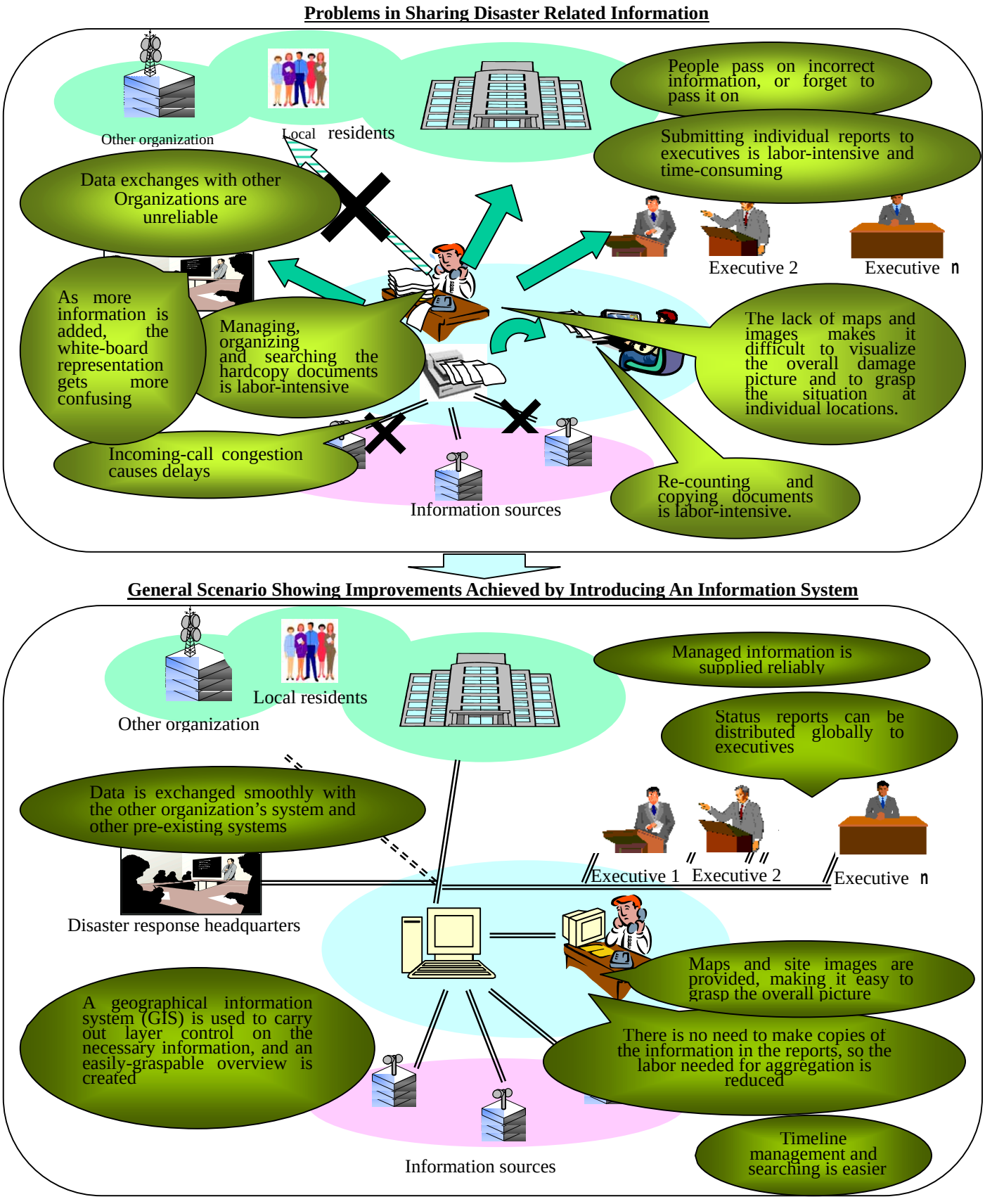


Fig –1 Problems in Sharing Disaster Related Information, And General Scenario Showing Improvements Achieved by Introducing An Information System

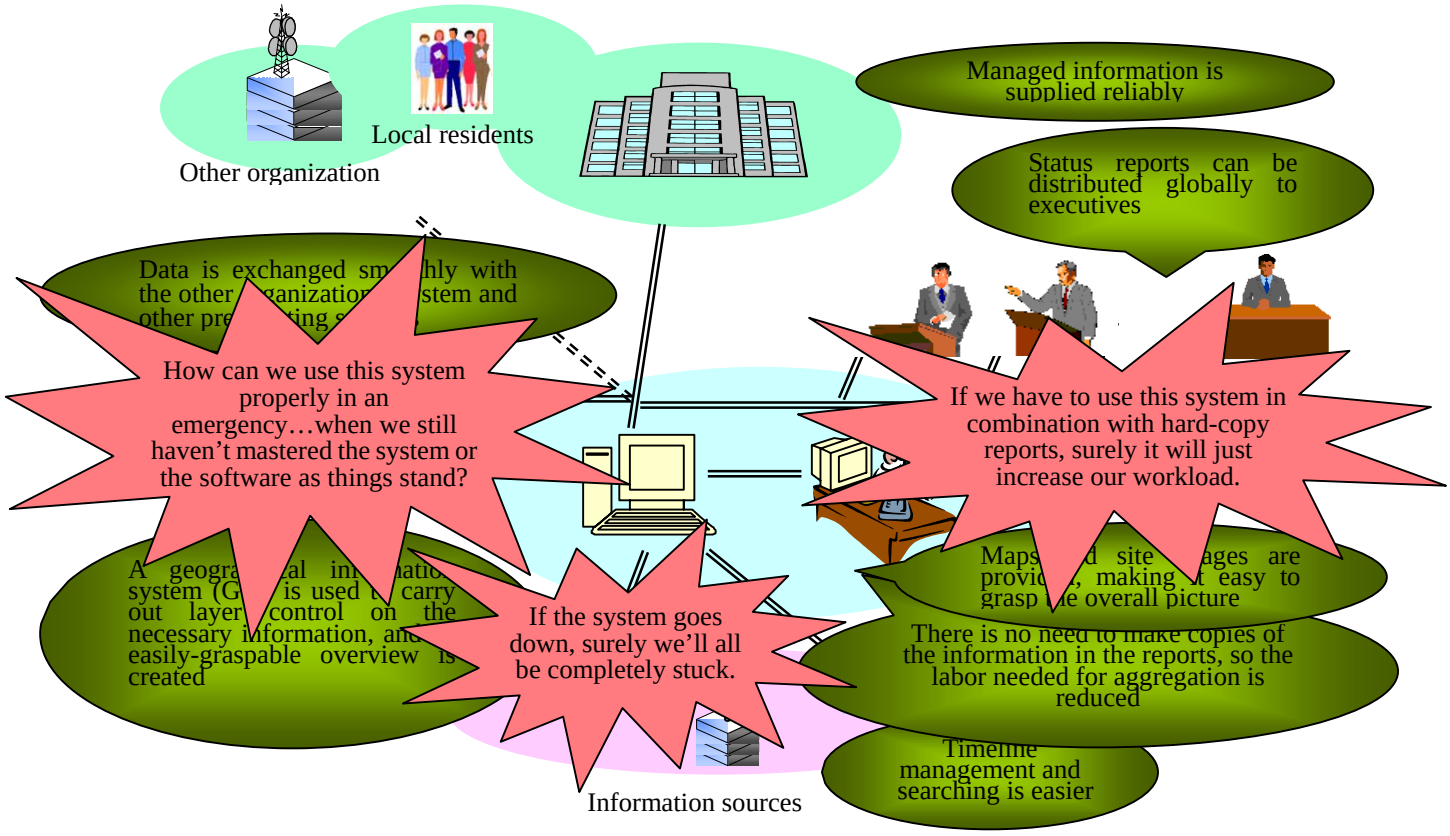


Fig-2 Examples of Problems That Can Hinder The Trouble-Free Use of Disaster Reduction Information

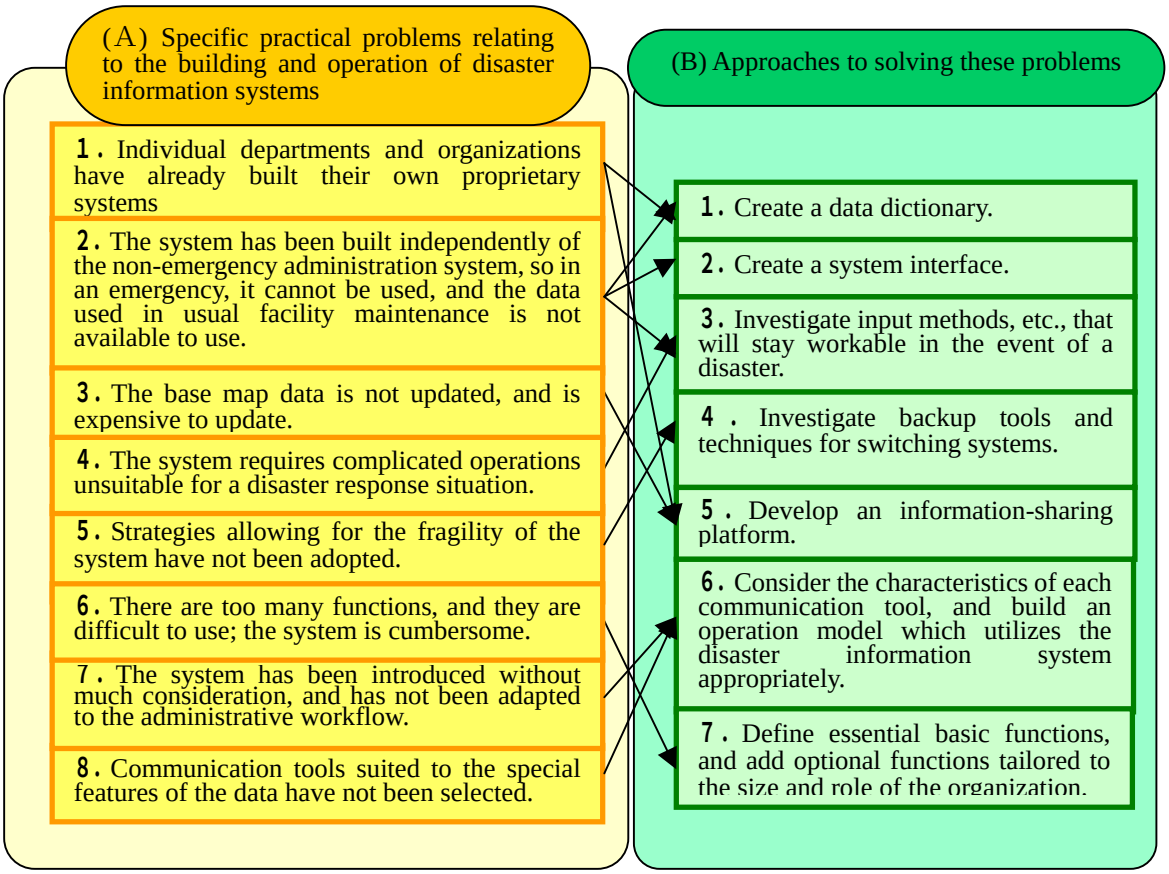


Fig-3 Approaches to Solving The Problems Relating to Practical Operation

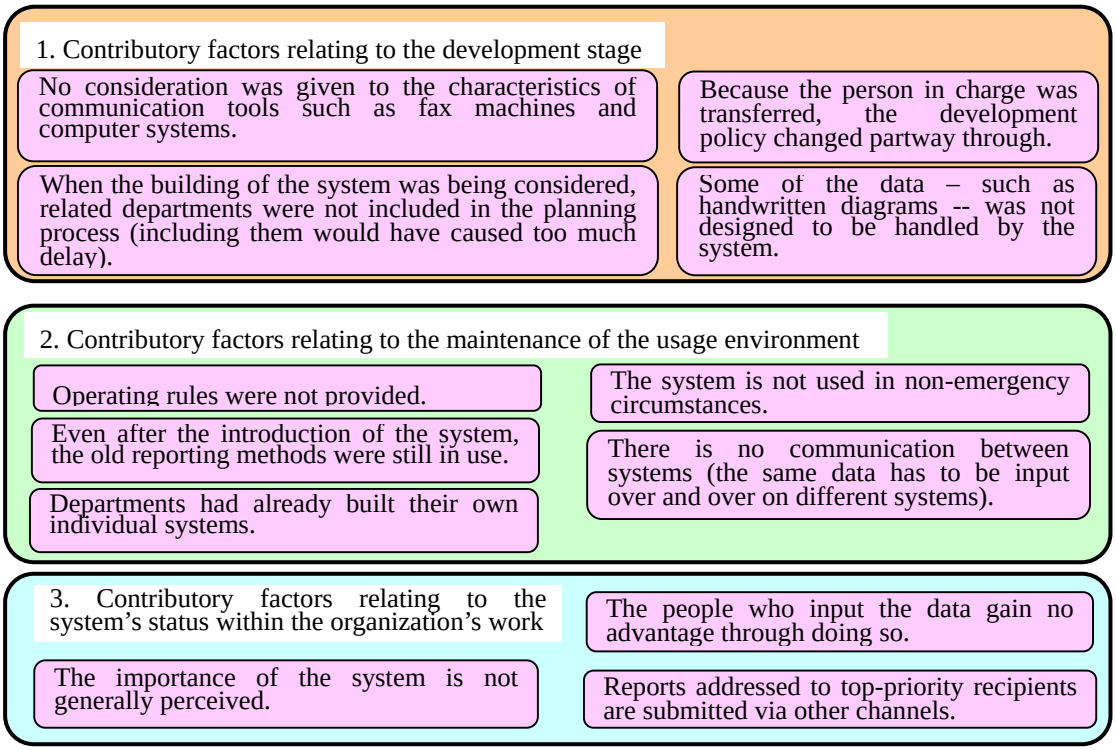


Fig-4 Contributory Factors in A Case Where The Benefits of Introducing The System Proved To Be Low
(Factors Concerning The Development And Operation of The System)

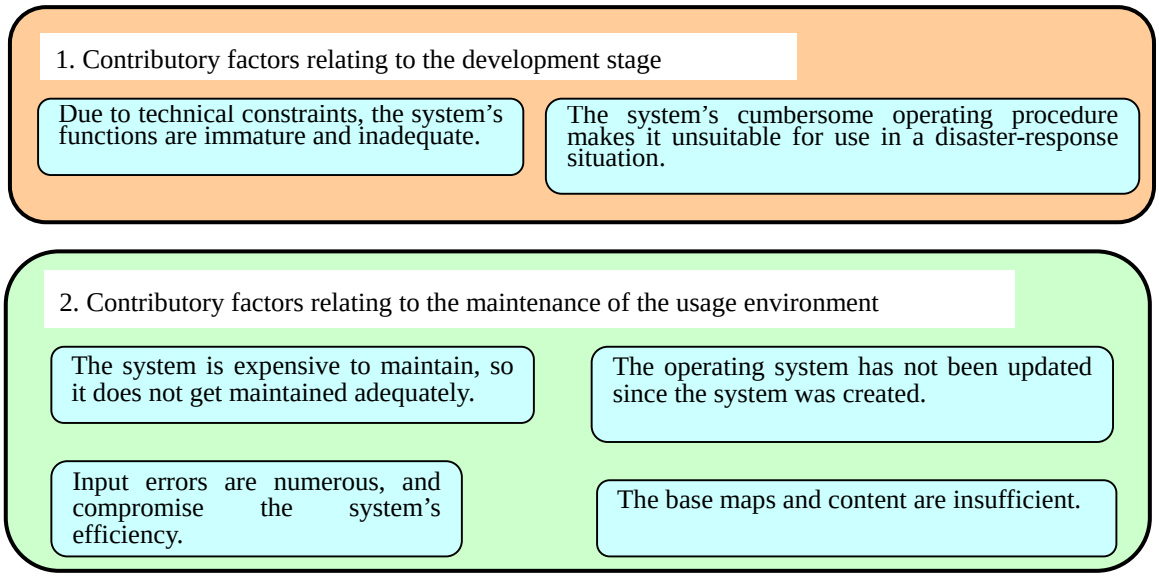


Fig-5 Contributory Factors in A Case Where The Benefits of Introducing The System Proved To Be Low
(Factors Relating to The System Functions)

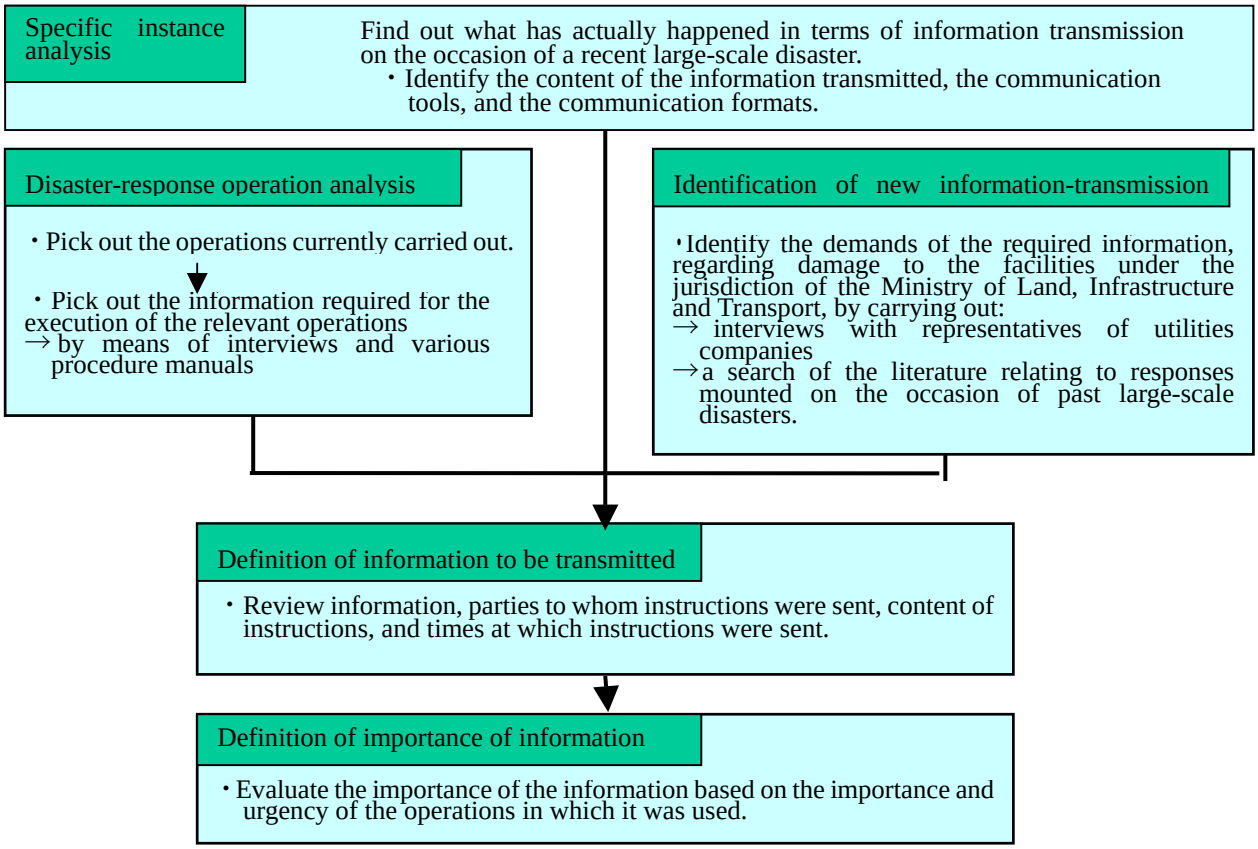


Fig-6 Disaster Information Definition Process Flow

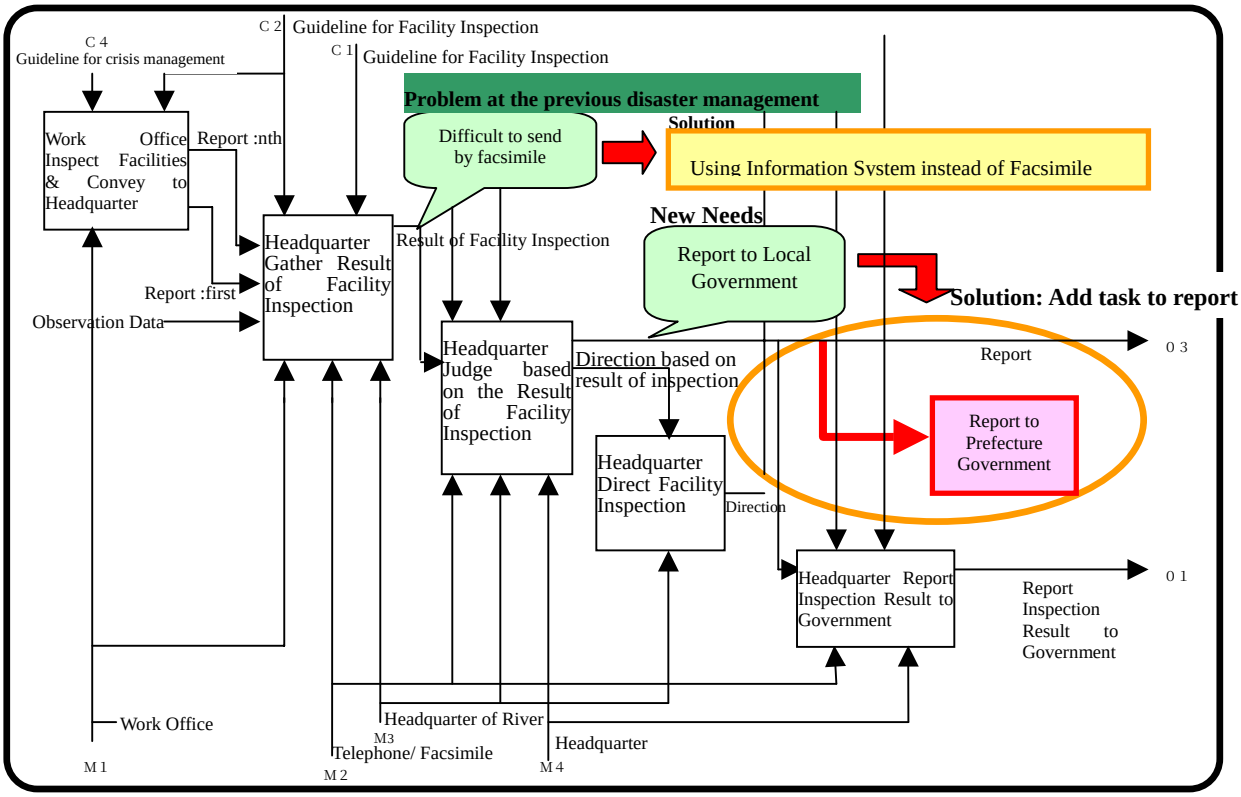
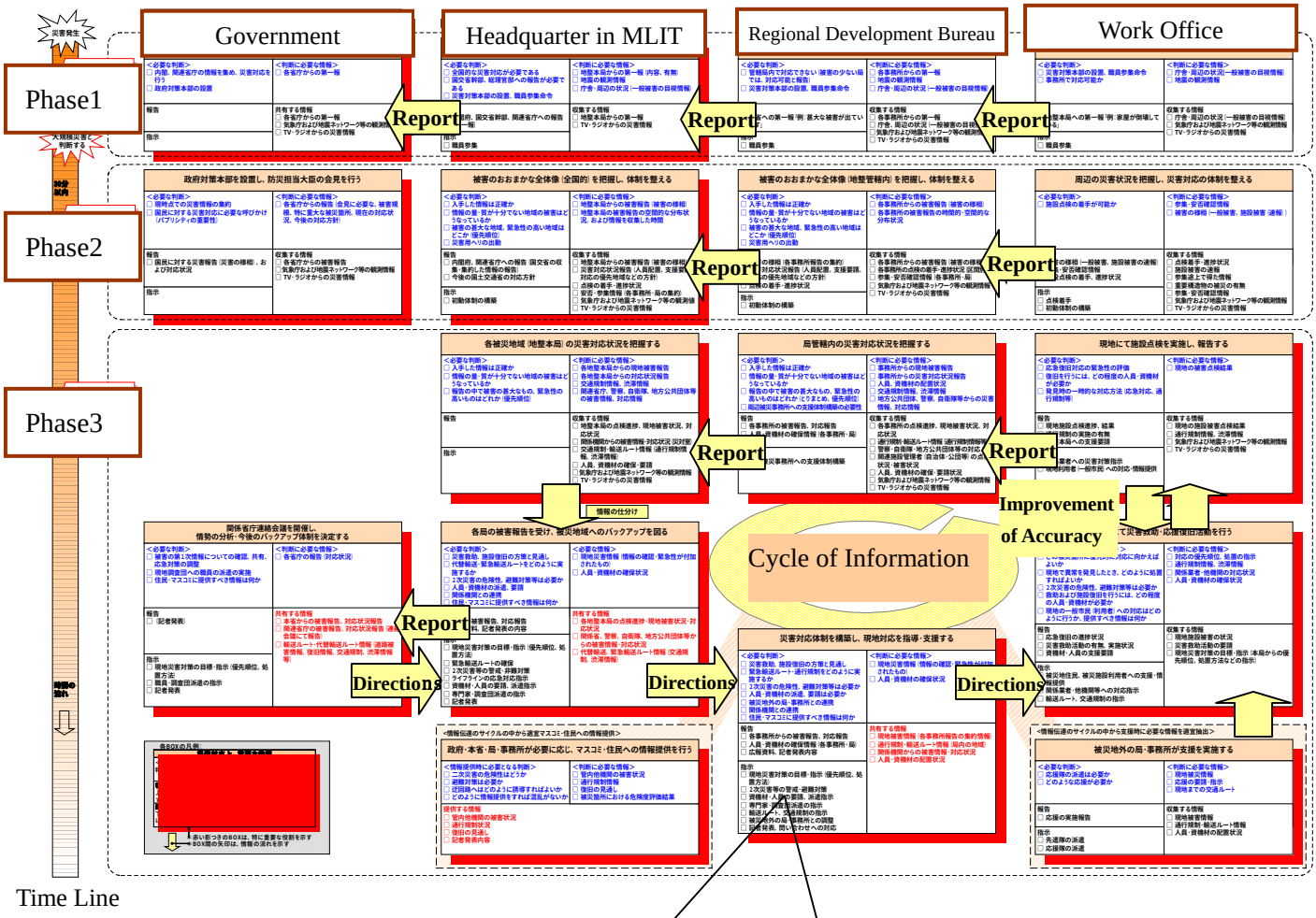


Fig-7 Current State of The Disaster Response Operation



A sample enlargement of box shown above

Carry out an on-site facilities check, and submit report → Contents of Obligation

<Evaluations required > ☐Urgency of emergency recovery response ☐Number and qualifications of staff and resources needed to carry out the recovery operation ☐Provisional response methods when damage is first discovered (emergency response, traffic restrictions, etc.)	<Information needed in order to carry out evaluations> ☐Results of on-site damage inspection
<Reports > ☐Progress and results of on-site inspection ☐Status (in force or not) of traffic restrictions ☐Request for support sent to regional development bureau	<Information to be collected > ☐Results of on-site inspection of damage to facilities ☐Information on traffic restrictions and tailbacks ☐Observation data from Japan Meteorological Agency, earthquake network, etc ☐Damage information from TV and radio
<Instructions > ☐Disaster-response instructions sent to relevant companies ☐Handling of and provision of information for local users (general public)	

Each item as shown ☐ is detail of <Title>

Fig-8 Defined Disaster Related Information

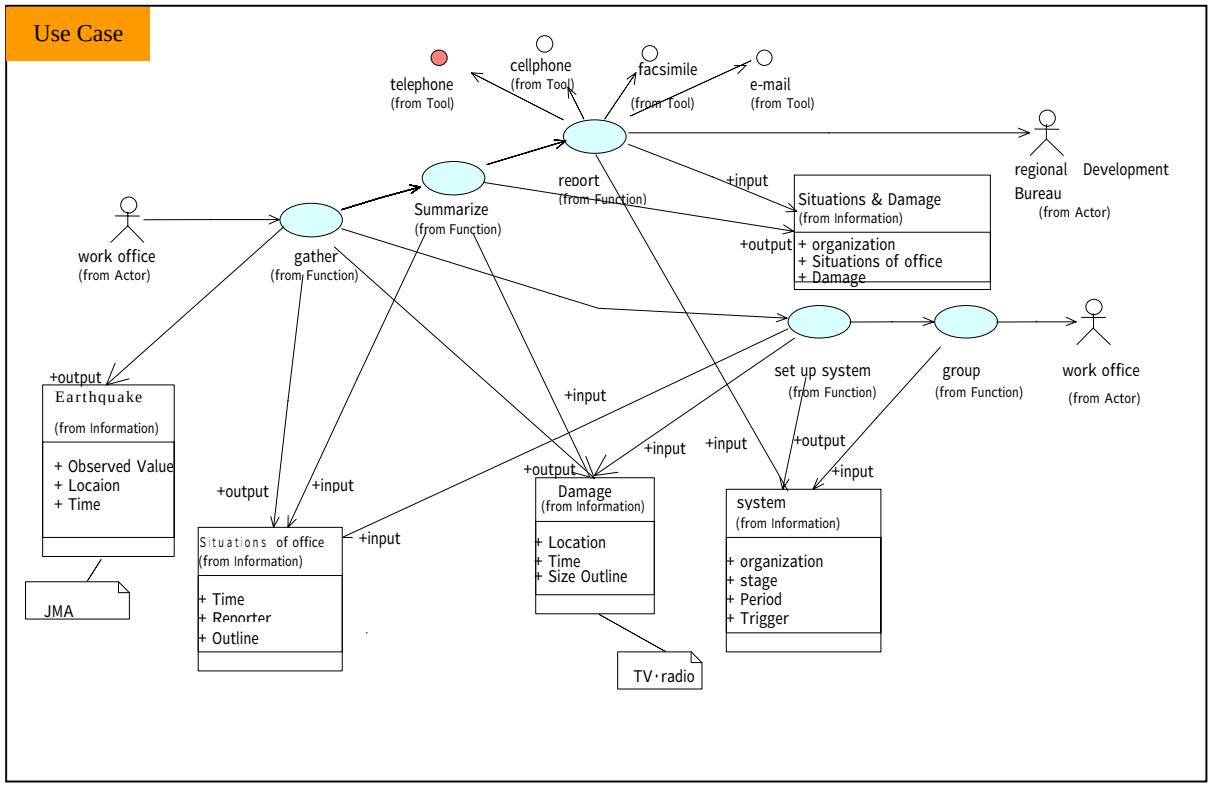


Fig-9 A Sample of The New Operation Model

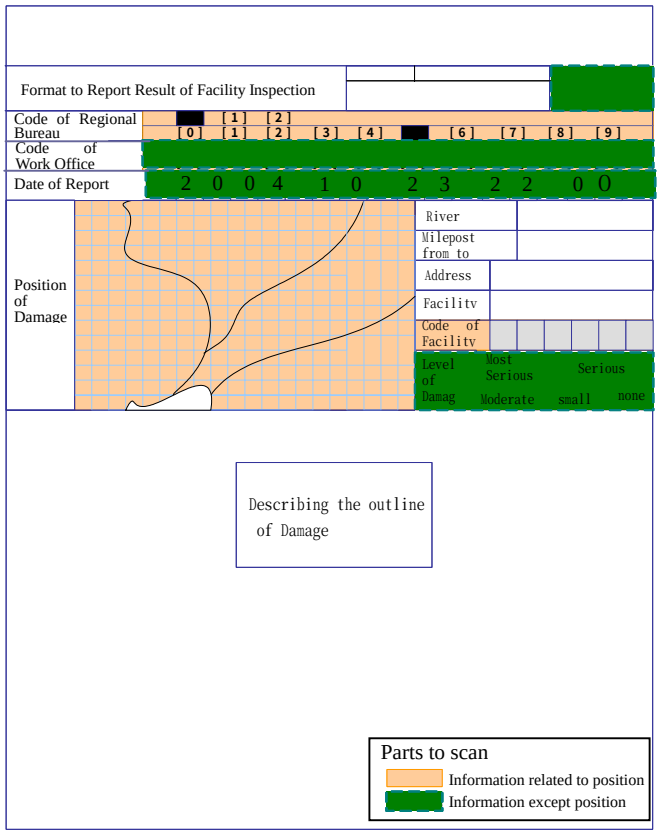


Fig-10 A Sample of Sheet for Automatic Reading & Positioning

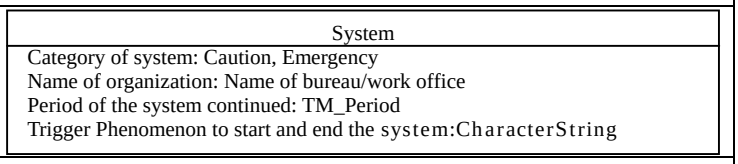
Data		System
	Tag	DisasterSystem
	Code	D0020001
Class Figure		
Upper Type		Disaster Information
Abstraction/concrete		Concrete
Definiton		System at the regional development bureau and work office
Attributes	Name	Category of system
	Tag Name	type
	Definition	Variation of system
	Type	System Code 10070084
	Range	Based on the “System Code” in the Road Communication Standard
	Frequency	1
	Order	No
Attributes	Name	Name of organization
	Tag Name	Name
	Definition	Name of organization that establish the system
	Type	Name of organization 1101005
	Range	Based on the “System Code” in the Road Communication Standards
	Frequency	1
	Order	No
Attributes	Name	Period of the system continued
	Tag Name	period
	Definition	Time from when the system starts to when the system end
	Type	TM_Period
	Range	Based on the JPGIS
	Frequency	1
	Order	No
Attributes	Name	Trigger Phenomenon to start and end the system
	Tag Name	basis
	Definition	Reason to start and end the system
	Type	CharacterString

Fig-11 Example of Data Dictionary

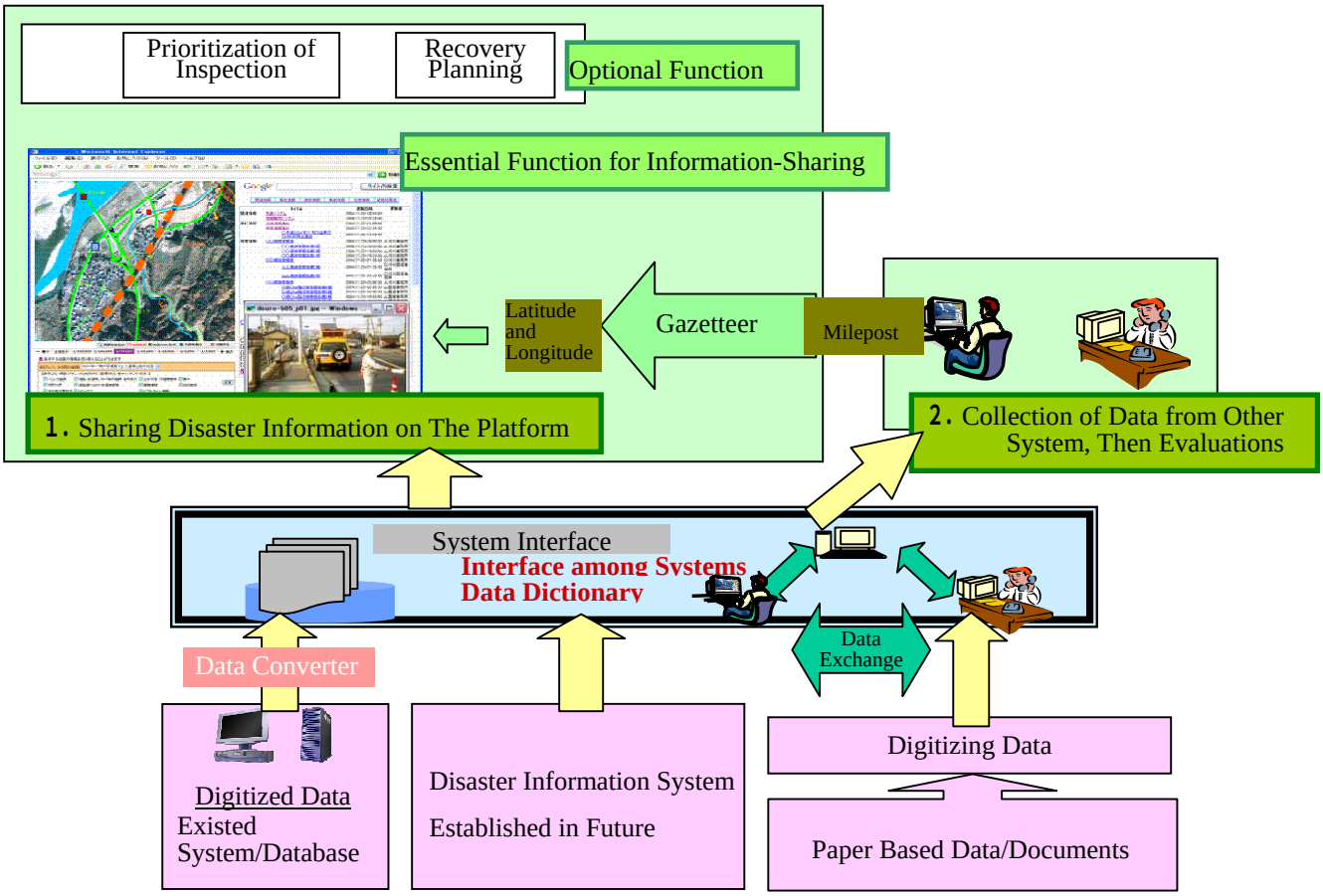


Fig-12 Outline of Disaster Information System Aimed in This Study