Process-based disaster management system "BOSS"

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ABSTRACT

This research defined the standard response process for the local governments and developed IT disaster management system based on the standard disaster response process. Developed IT system in this research was named BOSS (BOSai System, Bosai means the disaster management in Japanese). BOSS can show the total disaster process with database of historical disaster knowledge. About 500 processes are defined by the interview for staffs in Yabuki town in Fukushima prefecture and Ishinomaki city in Miyagi prefecture where was heavily damaged by the 2011 Tohoku disaster. And the database of people, houses, industry, law, land etc. are defined the relationship to the disaster responses. In post disaster phase, BOSS can be used the simulation of disaster responses to show the critical path and bottle neck response according to different cases of input conditions. Then stakeholders can understand all disaster processes with priority, difficulty or level for the effective human resources management.
For the verification of this system, the staffs of Ishinomaki city have used this system. The results show that the analyzed responses can clearly explain the role of each stakeholder in the emergency and recovery phase.
Over the whole Japan, as most local governments are small population (53% of local governments have less than 30,000 population), this small local governments don't have enough budget and knowledge to develop and manage their original IT system. Therefore, BOSS has huge potential to apply small local governments with the past knowledge in Japan.

Keywords: disaster process, knowledge, database, IT system

1. INTRODUCTION

Japan has suffered from many different kinds of natural disasters. And now the country has entered a seismically active period, damage mitigation is addressed as the major national issue. The 2011 Great East Japan Earthquake disaster has taught us the value of safety and sustaining the quality of life.
As one of the solutions to minimize damage, we suggest a total disaster response cycle featuring measures on the following: pre-disaster damage prevention, damage reduction, disaster prediction, alert system, damage assessment, emergency response according to damage assessment, and smooth recovery/reconstruction. Current efforts by regions and

organizations should be reviewed in terms of hard/software and disaster response, while different kinds of hazard and its levels (in terms of intensity, extension and frequency) should also be taken into consideration. Weak points in a region are analyzed after a regional survey. Extracted problems are improved under the limitations of time and budget. This process is the most effective and efficient way to solve the problems what they need to be in the future".

Our research aims to develop a process based “sustainable disaster/ emergency management system” to accomplish the above-mentioned process. By following this system, problems will be solved accurately, improvements made at ordinary times, alert will be heightened before urgent situation, damage precisely assessed after disaster, and damage response conducted appropriately according to the assessments. It realizes “seamless transfer from ordinary times to emergency situations”.
The biggest challenge lying ahead is to develop a "model which accurately estimates spatio-temporal disaster transition". Because no such model exists in Japan, many disaster management stakeholders have no idea what they should actually do or how their activities contribute to disaster reduction. When they all become aware of the meaning of their roles, effective disaster management cycle would be put into practice. The key factor in developing the spatio-temporal disaster transition model is to make accurate estimation ahead of time even from limited information, and then making the best response. Needless to say, no matter how well we grasp the spatio-temporal transition, it is essential that each stakeholder has the correct understanding of his/her assignment, or else appropriate disaster response will never be possible.
Effective initial responses in crisis management are important to reduce or minimize the impact of large-scale disasters such as the 2011 Great East Japan Earthquake for the prevention of secondary disasters and rescue.
However, it is difficult to operate initial disaster responses effectively for the disaster response headquarters just after the disasters under the condition of the limitation of human and product resources. In order to solve these problems, there are the current researches such as standardization and system of disaster responses[1,2)].

This research defined the standard response process for the local governments and developed IT disaster management system based on the standard disaster response process. Developed IT system in this research was named BOSS (BOSai System, Bosai means the disaster management in Japanese, Business Operation Support System). BOSS can show the total disaster process with database of historical disaster knowledge. About 500 processes are defined by the interview for staffs in Yabuki town of Fukushima prefecture and in Ishinomaki city of Miyagi prefecture where was heavily damaged by the 2011 Tohoku disaster. And the database of people, houses, industry, law, land etc. are defined the relationship to the disaster responses. In post disaster phase, BOSS can be used the simulation of disaster responses to show the critical path and bottle neck response according to different cases of input conditions. Then stakeholders can understand all disaster processes with priority, difficulty or level for the effective human resources management.

2. Analysis of Initial response during the 2011 Great East Japan Earthquake disaster

To develop the BOSS, the balance of workload during initial responses needs to be analyzed. This paper provides the case study that the initial responses of Yabuki town in Fukushima prefecture are analyzed during the 5days after the Tohoku earthquake to achieve the effective disaster system. The analysis data in this paper is obtained from the staffs who worked for the disaster response immediately after the earthquake from 11th to 15th March 2011 for 5 days in Yabuki town of Fukushima prefecture.
The analysis data is obtained from staffs which are divided into six time sections for one day as the early morning, morning, daytime, afternoon, evening, night.
The around half numbers of staffs answered to that with the exception of the staffs who could not engage in disaster responses at the time and who have already left or retired after the earthquake. If the staffs transferred to the new department from the department at the disaster, we collected the data as that staffs belongs to previous department.
Table 1 shows the change of the time history of disaster emergency responses. The number inside of this table is the total number of working staffs during the time division. The vertical line is ordered from the higher total numbers of working staffs for a response category item.
According to this result, "food supply", "water supply", "damage investigation" and "evacuation management" are frequent in the order during the five days. 33 staffs worked for the damage investigation on March 11. Many staffs worked for the food supply from March 11.
The number of staffs gradually increased for the water supply and the most of the staffs worked for that on March 14. Because the water in the water tank on the roof of the government building was used up immediately after the disaster, it was necessary to supply water to the people. The water supply was carried out by the truck with water tank at the entrance of the government building.
For evacuation centers, in addition to the distribution of goods, the staffs walked around the all evacuation places to check the number of evacuee.
Due to the damage of JR (Japan railways), some passengers could not move on March 12. Yabuki town received the people who could not go home, and Yabuki town transferred the people to the Shinshirakwa station by the bus of town on the next day of the earthquake
We analyzed the disaster responses for the each department of the town. Table 2 shows that all numbers of working staffs for the each department during 5 days totally. The number in the table describes the working load in each department that the total working people times the total working hours (people × working hours) assumed as three hours for each time sections.

For the project management division, "food supply (138 [people × time])" is the highest, "water supply (90 [human × time])" followed by it. As the management of "Conference" is the one of the role of the disaster response headquarters, this was controlled by the project management division. The "meeting" by the school education division means that they discussed about how to response to the students and restart the classes.
The project management division takes a role of the wide-area supports from the municipalities located in outside of damaged area (9 [human × time]) as well. Yabuki town were received the supports from Mitaka city, Towada city, Kawaminami city and the others.

Table 1: Time history of disaster response (unit: number of people)

	2013/3/11				2013/3/12						2013/3/13						2013/3/14						2013/3/15						Sum
Response items	Immediately	Evening	Night	Midnight	Early morning	morning	Daytime	afternoon	Evening	Night	Early morning	morning	Daytime	afternoon	Evening	Night	Early morning	morning	Daytime	afternoon	Evening	Night	Early morning	morning	Daytime	afternoon	Evening	Night	
Food supply		6	8	8	13	6	9	8	9	9	12	1	14	1	12	8	13	1	16	12	14	11	7	11	13	13	13	9	284
Water supply		1	1		3	6	3	7	12	3	6	12	9	16	11	7	9	2	17	18	16	14	8	16	14	14	11	7	261
Damage investigation	33	13	8	6	4	16	17	11	7	5	2	6	6	3	4	5	2	4	9	9	5	7	5	8	4	7	5	3	214
Evacuation	1	7	11	5	4	6	3	5	4	8	4	11	9	9	4	2	5	7	4	5	5	5	5	6	5	6	6	9	161
Information collecting	4	1	8	7	5	2	4	5	3	4	4	2	1	2	2	3	5	4	3	2	2	4	4	2	5	4	4	4	109
Goods supply		2	2		2	2	4	3	2			2	3	3	1		1	3	4	4	3	3	2	3	5	6	5	1	66
Emergency safety check of house		1	1		2	3	3	3	3	1	2	3	3	3	3	2		2	2	2	2	2	2	3	3	3	3	1	58
Meeting		1	1	2	3	2			5	1	4	2	2	1	8	1	3	1		1	7	1	2	4	1	1	2	1	57
Staying at home			6	1	5	4	3	2	4	4	2	4	4	4	5	4	1						1	1				2	57
Restoration		2			1	1	3	3	2	1	2	2	2	3	2	1	1	2	1	2	2	2	1	4	4	4	4	3	55
Others	5	2	3	2	3	3	2	1	2	4	4	1	1	2	1	2	4	1		1			2	1		1		2	50
Safety check	1	2	2		6	5	7	6	3	1	3	2	3	1	1		1		1				1		1				47
Office counter work	2										1	2	1	1			1	3	2	3	3	3	2	3	3	3	2		35
Traffic control	2	5	4	1	1	1	1	1	1	1	1	1	1	1	1		2	1	1	1	1		1	1	1	1	1		34
Disaster wireless system	1	1	1		2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	28
Clearing up		1			1	2	2	4	3			4	2	2				1		1	1	1		1					26
A child's delivery	6	8	2																										16
Fire-fighting round		1	1		1	1	1	1	1	1	1	1	1	1	1	1													14
Disaster waste							1	1	1	1	1	1	1				1	1	1				1	1	1				13
Suffering certificate														1	1	1				1	1	1				1	1	1	9
Temporary house						1	1							1			1		1	1	1								7
Liaison and adjustment			1	1		2																			1	1	1		7
Acceptance wide-area support																				2	2	1		1					6
Evacuation guidance	4	1	1																										6
Parliamentary correspondence	1	1				1												2											5
Support disabled persons	1				1						1							1					1						5
Volunteer					1															1	1	1							4
Supply of food for school children								1	1						1			1											4
Information arrangement						1	1	1	1																				4
Installation of a temporary lavatory														1						1						1			3
Check a school road							1	1				1																	3
Victim unable to return home					1	1																							2
Defense				1																					1				2

Table 2: disaster response and division (unit: people times hours)

Division	Food supply	Water supply	Damage investigation	Evacuation	Information collecting	Goods supply	Emergency safety check of house	Meeting	Restoration	Safety check	Office counter work	Traffic control	Disaster wireless system	A child's delivery	Fire-fighting round	Disaster waste	Suffering certificate	Temporary house	Liaison and adjustment	Acceptance wide-area support	Evacuation guidance	Parliamentary correspondence	Support disabled persons	Volunteer	Supply of food for school children	Information arrangement	Installation of a temporary lavatory	Check a school road	Victim unable to return home	Defense	Sum
Project management	138	90	15	27	9	15	0	33	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	12	0	0	0	3	351
General Affairs	3	96	30	42	6	90	0	0	93	0	0	6	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	6	0	375
Tax	75	186	24	99	9	33	0	0	3	0	0	3	0	0	42	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	477
Residential life	81	6	6	0	3	0	36	0	0	0	30	3	84	0	0	39	27	0	6	0	0	0	0	0	0	0	0	0	0	0	321
Health and Welfare	39	45	3	129	6	21	0	3	0	6	48	0	0	0	0	0	0	0	15	0	3	0	15	9	0	0	0	0	0	0	342
Industrial development	21	123	84	24	24	0	0	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	297
Urban construction	0	0	183	0	0	0	138	0	18	6	0	72	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	438
School education	99	36	222	90	150	0	0	120	18	15	0	0	0	15	0	0	0	0	0	0	0	3	0	0	12	0	0	9	0	0	789
Lifelong learning	42	111	66	36	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	291
Kindergarten	234	75	9	36	84	39	0	9	3	114	3	0	0	33	0	0	0	0	0	9	12	0	0	0	0	0	9	0	0	0	669
Parliamentary office work	0	15	0	0	0	0	0	6	30	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	0	0	0	0	63
Teller's cage	120	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	144

The General Affairs Division mainly worked for "water supply", "goods supply", "Recovery". In addition, the operation of evacuation centers and the understanding of the number of the evacuees are managed. The Tax Division mainly worked for water supply, operation of evacuation centers and food supply. The evacuation guidance shows that the division induced the people who came to the governmental building just after the earthquake. The residential life division mainly worked for the community wireless system, food supply, building inspection survey, disposal of wastes, issuances of a victim's certificate. With regard to the community wireless system, three kinds of those systems those of Yabuki town, volunteer fire group and Fukushima prefecture were used.
On March 11, information was provided to the people in every one hour, and then on March 12 the frequency of information was provided in every two hours.
Immediately after the disaster, information about severed road was send to the government from a volunteer fire group, and then the staff in the room of the community wireless system sends its information to the urban construction division. The room of the community wireless system played the role of the information hub in the town. The Health and Welfare Division worked for care of evacuees and provide food in evacuation centers. The Industrial Promotion Division conducted a damage survey and water supply mainly. For damage investigation, they checked the function of agricultural related facilities. The Urban construction division conducted a damaged survey of infrastructures, recovery of infrastructures. The School Education Division conducted a damage survey of school facilities, food supply, and operation of evacuation center.

3. Overview of Process-based disaster management system “BOSS”

To analyze what kinds of disaster responses are experienced or not experienced is important for effective disaster responses. It is necessary to build the regional disaster prevention plans according to the experiences.
The standard response process for the local governments is defined following to the interview for staffs in Yabuki town of Fukushima prefecture and in Ishinomaki city of Miyagi prefecture.
We found that many officials worked for the responses (food supply, water supply, and etc.) most of those are available not only government people.
Then, we can apply the responses in accordance with the characteristics.
In this paper, the disaster responses are divided into four types.
(1) the responses by everyone can work immediately after disaster such as such as management of the Volunteer Center etc., (2) the responses by government staff at first stage of disaster but gradually shifting to the other people such as food supply, water supply etc. (3) the responses by every government staff such as residents support, issuance of certificate, etc., (4) the responses by government staff with a special skills such as restoration of infrastructure and lifelines, health issues etc.
It is important to make a category for each disaster response according to these kinds of types in a regional disaster prevention plan. Then we can understand what kinds of disaster responses are necessary by staffs with special skills or without those, and manage the limited resources effectively.

The database of people, houses, industry, law, land etc. are defined the relationship to the disaster responses. In post disaster phase, BOSS can be used the simulation of disaster responses to show the critical path and bottle neck response according to different cases of input conditions. BOSS can show (1) Evaluation of amount of work (work load), (2) Effective distribution of human resources with skill level and work load and (3) Management of response schedule. Figure 1 shows the web based BOSS system. After the hazard level is estimated, the damage level is calculated by the hazard level. Then, the work load, time schedule of staffs and the flow of responses are shown by BOSS. Then stakeholders can understand all disaster processes with priority, difficulty or level for the effective human resources management.

Table 3 explains the effects of BOSS in the points of quality, cost and duration/deliver. Quality can be achieved in (1) Prioritizing responses and (2) Difficulty of responses (required qualification and skill). Cost can be reduced by (1) Response that requires large human resource (2) Spending on Equipment purchases, support for residents to recover from disaster. Duration can be described with (1) Duration of response, (2) Retention time between processes and (3) Gap between supply and demand.

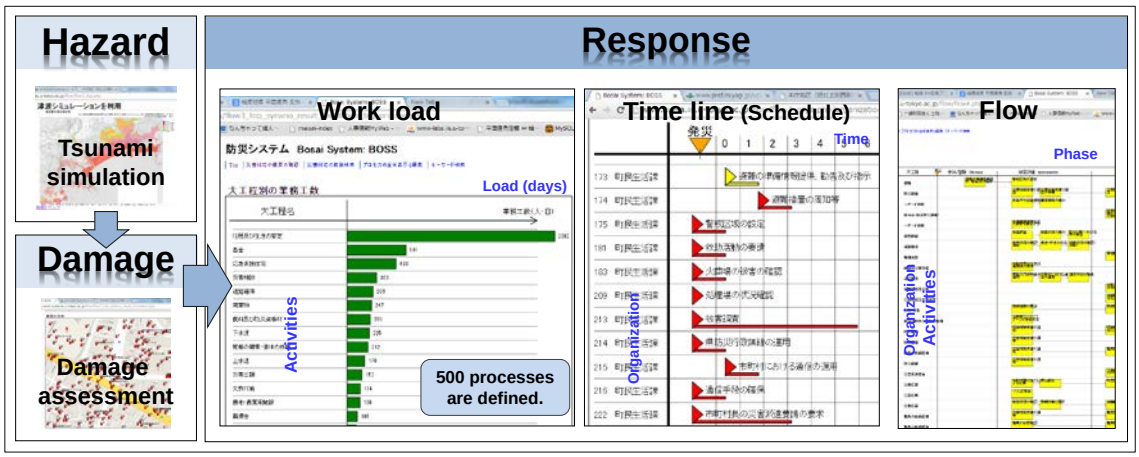

Figure 1: Web based BOSS system

Table 3: Effects of BOSS system

QCD	SUMMARY
Q quality	(1) Prioritizing responses (2) Difficulty of responses (required qualification and skill) Effective and necessary support for residents can be achieved by effective deployment of staff by this system. Considering support staff from other municipalities, prioritizing responses and level of difficulties, this system is used for efficient human resource allocation.
C cost	(1) Response that requires large human resource (2) Spending on Equipment purchases, support for residents to recover from disaster Activities like disaster risk assessments of buildings, post disaster damage evaluation etc. responses with large human resources. Securing financial resources through government expenditure (not for

	personal fee). Also, implementing mitigations for proper evaluation of these cost-effective measures.
D duration	(1) Duration of response (2) Retention time between processes (3) Gap between supply and demand The completion of responses in a shorter period of time depends on the improvement of time during the bottlenecked work schedule. Supply/demand variation is the difference in occurrence time of demand and the actual supply time to completely meet the demand. It is a situation where the changing need of goods are not met by the left over goods.

4. CONCLUSIONS

Our research aims to develop a “sustainable disaster/emergency management system” to accomplish the above-mentioned process. By following this system, problems will be sorted out accurately, improvements made at ordinary times, alert will be heightened before urgent danger, damage precisely assessed after disaster, and damage response conducted appropriately according to the assessments. It realizes “seamless transfer from ordinary times to emergency situations”.
This study analyze the patterning the kinds of disaster response, defining its flow and evaluating its amount of volume which are expected in advance to build effective the spatio-temporal disaster responses model. By understand these operations for each different actors, it will be possible to carry out disaster responses4immediately under the condition of confused disaster phase.
Over the whole Japan, as most local governments are small population (53% of local governments have less than 30,000 population), this small local governments don’t have enough budget and knowledge to develop and manage their original IT system. Therefore, BOSS has huge potential to apply small local governments with the past knowledge in Japan.

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