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DETECTING WORKLOAD PATTERNS OF LIFE RECONSTRUCTION TASKS IN THE URBAN DISASTERS
-A Case Study of Ibaraki City at 2018 Osaka Northern Earthquake -

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Abstract

The Osaka Northern Earthquake occurred at 7:58 on June 18, 2018, with an epicenter in northern Osaka Prefecture, Japan. The magnitude of the earthquake is magnitude 6.1, and the depth of the epicenter is 13 kilometers). 6 lower of the Japan Meteorological Agency seismic intensity scale was observed in 5 wards of Osaka City and 4 Cities. Although the damage was local and limited, it was a disaster that occurred in the city, causing the specific problems such as the occurrence of people who were unable to return home and get off the elevators. In this paper, we clarified the actual situation of the local government operations and its workload patterns in the urban disasters from the case of Ibaraki City.

Ibaraki City, which suffered the most damaged buildings, provided the research team the dataset produced on the process of conducting the life reconstruction support works. We organized the dataset and performed the cluster analysis. Cluster analysis is an analysis for creating a cluster by gathering items with similar properties from a group of businesses with different properties. The purpose of the analysis is to detect a time-series pattern for the occurrence of the workload based on the cumulative frequency of each task. The implementation period of the target work was from July 23 to November 29 (130 days). The results were displayed as a dendrogram (in the form of a tree diagram showing how each individual was clustered in the cluster analysis).

As a result of analyzing the 22 jobs, we were able to read three clusters from the pattern of workload. When we examined the meaning of the three clusters, we found that “1) the work was concentrated in the emergency period”, “2) the work continued for a long time”, and “3) the work was concentrated on the specific days.” We found out that pattern 1, which amount of work was remarkably high immediately after the disaster and ends as the time had passed. “Call Center for General Info about Support Program”, “Consultation for Life Reconstruction”, “Issuance of Building Damage Certificate” and other 4 tasks were categorized in the pattern 1). For these operations, it was necessary to secure enough local government personnel immediately after the disaster, and considering large-scale dispatch of support staff from the local government outside of the impacted area. For “2) long-term work”, the amount of work occurs not only in the emergency period but also in the long-term, and the amount of work continued. “Procedure for Applying for Public Housing”, “Work for Housing Repair Program”, “Work for Reduction of and Exemption for Water Leaks” and 9 tasks were categorized in the Pattern 2). These operations were “necessary to secure the personnel in the mid- to long-term period”, and it was necessary to provide a certain amount of personnel over the medium to long term. The “3) concentrated work on a specific day” meant the work concentrated on a certain date or day of the week instead of every day. “Granting of Relief Money”, “Support Program for Urgent Repair on the damaged home” and the other tasks were categorized in the pattern 3. For these tasks, it was considered that “team-based support was necessary”.

Keywords: Cluster Analysis; Workload Patterns; Life Reconstruction; Urban Disaster

1. Introduction

Many local governments, in the recent cases such as the 2011 Great East Japan Earthquake and the 2016 Kumamoto Earthquake, were unable to respond effectively to the ever-changing situation, such as setting up a disaster response headquarters, gathering staff, and gathering information [1]. The external factor of this problem is that the disaster is a phenomenon that expands and links in time and space [2], and it is difficult to grasp the actual situation, so the work target of disaster response is hard to specify either. As an internal factor on the response side, standardization of disaster response work flow has not been established well and has not been also shared among disaster responders well. The more scale of disasters expands, the harder the responders work together in one team.
The effort of clarifying the disaster response work had been done in the several research papers. Nagamatsu showed the volume of the disaster response work flow using the analysis of the resources [3]. Inaba proposed "disaster response activities estimation equation" for estimating the workloads of disaster response activities [4]. Inoguchi conducted the research on the work flow of implementing the life recovery support program [5], and studied the simulation tool for the work volume of the life recovery support assistance [6]. This paper, taking the case of the Northern Osaka Earthquake in 2017 as an example, clarify the disaster response work flow in the real situation based on the analysis of how the city of Ibaraki, delivered the disaster response along the actual situation.

2. Method

2.1 Case of Disaster; The Osaka Northern Earthquake

The Osaka Northern Earthquake occurred at 7:58 on June 18, 2018 with an epicenter in northern Osaka Prefecture, Japan. The magnitude of the earthquake is magnitude 6.1, and the depth of the epicenter is 13 kilometers). 6 lower of the Japan Meteorological Agency seismic intensity scale was observed in 5 wards of Osaka City and 4 Cities. Six people died, two of whom died in the collapse of a brick wall. Regarding damage to dwellings, 21 buildings were completely destroyed, 454 were partially destroyed, and about 57,000 were partially damaged (Table 1).
Regarding the infrastructure, although a maximum of about 170,000 homes (Osaka and Hyogo prefectures) lost power, they were restored in the morning on the day of the earthquake, and the water outages were resolved the following day. Up to about 110,000 gas supplies were temporarily suspended in four cities in northern Osaka (Ibaraki, Takatsuki, Settsu, Suita), but all were restored within one week and there is a limit in responding based on experience to infrequently occurring disasters. Although the damage was localized and limited, the characteristic situation of urban disaster was observed.

Table 1 – Damaged Buildings

Name of Cities and Towns	# of Damaged Buildings	Name of Cities and Towns	# of Damaged Buildings	Name of Cities and Towns	# of Damaged Buildings
Ibaraki	3,481	Moriguchi	125	Shijyonawate	34
Takatsuki	1,560	Osaka	125	Ikeda	19
Hirakata	591	Minoh	108	Shimamoto	9
Toyonaka	450	Neyagawa	82	Nose	6
Settsu	300	Katano	60	Kawachinaganc	1

2.2 Case of the Impacted Local Government: Ibaraki City

The research team asked Ibaraki City, where the most numbers of the building were damaged, to cooperate in the research project and to offer the data related with the disaster response of the Osaka Northern

Earthquake. In Ibaraki City 2,646 information files were generated in the process of disaster response. Those files were generated in the Emergency Operating Center (EOC); 1,077 excel files,526word files and others (Table 2).

Table 2 – Ibaraki City EOC Data Format

File Format	EXCEL	WORD	PDF	TEXT	IMAGE	PPT	VOICE	OTHERS	Related DATA	Total
# of Files	1,077	526	243	63	41	20	11	161	504	2,646

2.3 Method of Analysis

Many municipalities in Japan do not have a well-defined agreement on how to collect and organize information during a disaster response. 1) Some of the files are duplicated, 2) The amount of information required for analysis is not properly stored, and 3) Some information cannot be organized sufficiently in time series because there is no time stamp. The situation is similar in Ibaraki City. Therefore, the quality and quantity of Ibaraki's data was different for each folder. Focusing on the contents of the digital files were classified into 21 categories. In this paper, we selected Content # 5 "Life Recovery Assistance" as the target of the analysis (Table 3).

Table 3 – Data File Classification by Contents

Content ID	Data File Classification by Contents	# of Files
1	Related Information with Emergency Management Headquarters	1,604
2	Damage Situation Report	479
3	Certification of the Degree of Building Damages	206
4	Hearings of Commnity Based Organization	145
5	Life Recovery Assistance	51
6	Record of Emergency Management Headquarters Meeting	42
7	Situation Report	34
8	List of Suvivors Support Menue	28
9	Relief Supplies	11
10	Infrastruture Damage & Restoration	9
11	Related Papers with Disaster Relief Act	7
12	Osaka Prefecture Report	7
13	Self-Defense Army's Relief	5
14	Support for Evacuees	4
15	Call Center for Survivors' Support	3
16	Quick Inspection of Damaged Building	3
17	Mayor's Report	3
18	Budget Planning	3
19	Report to City Coucil	1
20	Other	1
	Total	2,646

The procedures of analysis are as follows; 1) a timeline of disaster response work volume, 2) a cluster analysis of the patterns for work frequency. This paper conducts the timeline analysis of disaster response work volume in order to compare and visualize the change of the life recorvry support services per a day for four months from the occurrence of disaster to the end of November. This paper also conducts a cluster analysis in order to detect the grouping of the life recovery support services and to profile the characteristics of the group.

3. Result

3.1 A Timeline of Disaster Response Work Volume

The data set to be analyzed was selected to create an actual timeline in the "Survivors Support Team Information" provided by Ibaraki City. The selection criteria are as follows: 1) there are a plurality of data files for implementing a plurality of tasks for the same purpose, 2) it contains time-series information, and 3) it contains spatial information. Of the 19 folders, the data set with the largest number of files suitable this condition was 15.

"Life Recovery Assistance" consisted of 51 files. There were 35 files for Excel, 3 files for Word and 13 files for PDF. Among them there were the Life Recovery Assistance Report, which reports the number of cases for daily life reconstruction support and consists of files from the 1st to the 18th (7 / 23-11 / 29). However, since the twelfth session was conducted twice, a total of 19 files were targeted. The reasons why this paper chose 19 files were1) all those files let us know the work flow of conducting disaster survivors' support, 2) the progress of work was reported in chronological order according to the template of the meeting report, 3) some data was selected because it contains spatial information.

Work volume data was reorganized in chronological order, and a series of values obtained by continuously (or discontinuously at regular intervals) observing changes over time in the implementation of disaster response operations were graphed. Stacked graph was used to list the achievements over time.

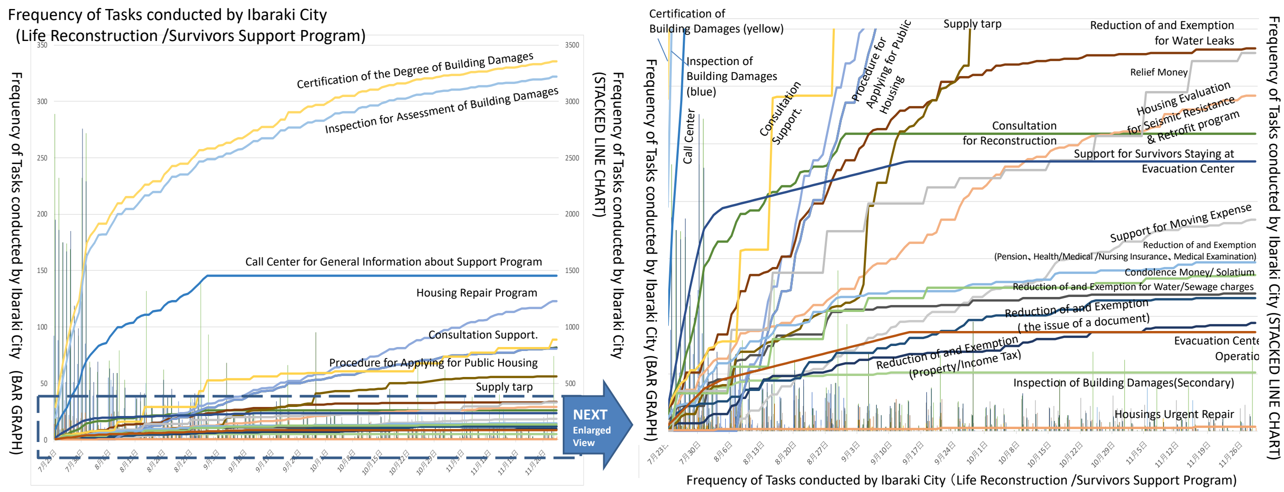

Figure 1 – Work volume of Life Recovery Assistance

The figure on the right is an enlargement of the part with less frequency in the graph on the left. By doing in this way, the work with a small amount of work as a whole and the amount of work every day are leveled, and you can see in more detail the work without sudden changes in the graph (Figure 1).

3.2 A Cluster Analysis of the Patterns for Work Frequency

The task of grouping a set of objects in such a way that objects in the same group (called a cluster) are more similar (in some sense) to each other than to those in other groups (clusters). The task of grouping a set of objects that objects in the same group (called a cluster) are more similar (in some sense) to each other than to those in other groups (clusters). This analysis let the patterns for work frequency clear and visualize the variation of the occurrence of work in Life Recovery Assistance Program.

The result of cluster analysis was shown as the dendrogram, the diagram representing a tree. This diagrammatic representation is frequently used in different contexts. From the results of the dendrogram, we were able to divide the 21 tasks into three groups. Interpreting the meaning of these groups is; 1) Long-term works, those which are needed to secure medium- & long-term human resources, 2) short-term works, those which are needed to secure human resources right after the disaster occurrence, 3)works concentrated on the specific days, those which are needed human resources in team formation (Figure 2).

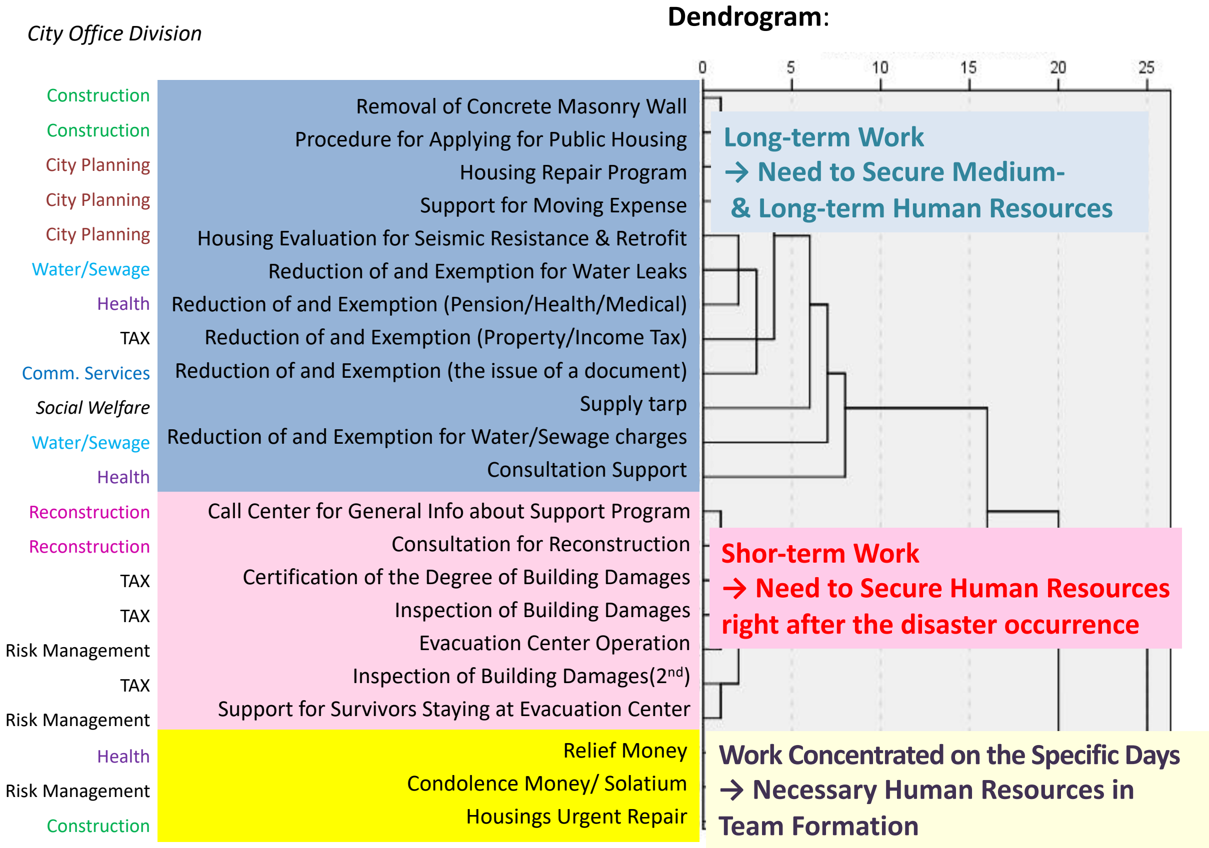

Figure 2 – A Cluster Analysis of the Patterns for Work Frequency in Life Recovery Assistance

4. Conclusion

This paper indicated about the work volume and pattern using the data of Ibaraki-city Emergency Operation Center which activated when the urban earthquake named Osaka Northern Earthquake occurred. These results will help to estimate the workload and patterns in the event of a disaster in the future. Returning to the issues in the first place, 1) there are few cases where the data related to disaster response can be obtained systematically, 2) data construction and management are not performed in disaster response systematically, in any disasters in the past. the research team plans to use the results of this research in the standardization of disaster response work in the future and encourage the disaster response agencies to construct and manage the data generated on the process of disaster response in a proactive manner.

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