Evacuation facility simulation system "COCOA"

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Abstract

Key point to operate evacuation facilities effectively is to manage the information sharing among disaster headquarters and sites of evacuation facilities or among families who need to know the life safety or location of evacuees. But, it was difficult to obtain and share the information in the 2011 Great East Japan Earthquake disaster. For examples, to create a refugee roster was difficult under the condition of a concentration of a lot of evacuees. And, a lot of inefficient operations to share the information such as the total number of evacuees in each facilities and those personal information, the needs and demands of refugees, etc. were seen in damaged areas. It is necessary to achieve effective and smooth operations of the evacuation facilities with sharing the information environments among stakeholders.

This study develop the evacuation facility system "COCOA" that can manage and support in accordance with conditions of each evacuation facilities by sharing the information such as the needs and demands, the number of evacuees and those personal information. "COCOA" can serve and collect the various personal conditions and manage the information of all evacuation facilities.

Keywords: information sharing, refugee, evacuation facility, ICT system, knowledge management

1. Introduction

During the 2011 Great East Japan Earthquake disaster in Japan, many victims were affected by the earthquake and the tsunami. They were forced to the evacuation facilities life for the long term, and a severe problem in evacuation facilities life was highlighted. By the prolongation of the evacuation facility life, it is necessary to care to elderly person, a person with a disability and infants. Based on a variety of problems in the refuge, a part of the Disaster Laws is revised in June, 2013, "The designated evacuation facilities by mayors, town managers and village head department (7 of Disaster Laws Article 49) and a rule about the maintenance of the living environment in the evacuation facility (6 of Disaster Laws Article 86)" was established. "The action guideline for the securing of good living environment in the evacuation facility (August, 2013) " is also revised and introduces the action to maintain the facilities by municipalities.

On the other hand, in case of immediately after disaster occurrence, the grasp and sharing of refugee information such as total number of refugee in each facilities and the details of sex, age was not easy. Making the refugee list is also difficult in each evacuation facility in real time. Therefore, problems of the information sharing for situation grasp were remarkable. In the master plan for disaster prevention, "The country (Ministry of Agriculture, Forestry and Fisheries, Ministry of Health, Labor and Welfare, Ministry of Economy, Trade and Industry, Fire and Disaster Management Agency, Ministry of Land, Infrastructure and Transport) can build organization to supply needs such as foods according to the number of the refugees every evacuation facility without waiting for a request in a certain period after occurring the disaster and to transport supplies to the damaged area."

But it is difficult to catch up "the number of the refugees". Even if it was able to grasp the number of refugees at each evacuation facility, it is difficult to communicate with the headquarters in municipalities. For example, there are more than 200 designated evacuation facilities in Ishinomaki city of Miyagi prefecture. Around 1,200 staffs of Ishinomaki city is needed to operate 200 designated evacuation facilities, but those number of staffs is difficult to be assigned due to the limitation of number of staffs. Inefficient staff assignment causes the ineffective emergency operations [1].

In Iinogawa first Elementary School of Ishinomaki city at the time of the 2011 Great East Japan Earthquake disaster, Notebooks were used to share the information about refugee list, problems and necessary items among management staffs (Fig. 1). This case shows a good operation to share the information even by notebooks. But other evacuation facilities is no records, it means that effective operation of evacuation facilities was not achieved.

In the headquarters for disaster management of the city, it is performed filing of papers including backing papers (Fig. 2). The sharing situations by the king paper file and oral communication for operations were limited to understand with all stakeholders. So, it was difficult to grasp perspective of the situation of each evacuation facility more than 200 places. Therefore, it was not able to grasp even "there were three meals" or "there was not food at all" about the situation of the supplies of each evacuation facility which opened regionally. This accurate levels of information is enough for initial emergency operations.

Fig. 1 – Notebooks used by evacuation facility administration of Iinogawa first Elementary School

Fig. 2 – File of the headquarter of the Ishinomaki city

Ministry of Internal Affairs and Communications introduces the public wireless LAN (Wi-Fi) for local governments. It is possible for the local government to collect and dispatch information from all evacuation facilities by Wi-Fi. In Ishinomaki city, Wi-Fi is installed in the evacuation facility more than 200 places so that information can be shared with the headquarters and each evacuation facility. Based on a lesson of the gathering information from the 2011 Great East Japan Earthquake disaster, immediately after the disaster, problems regarding to the information sharing can be solved. For the large-scale disaster, efficient initial operation is important to achieve the system to collect the situation of the evacuation facility quickly.

This study develop an evacuation facility information sharing system COCOA for the purpose of supporting information sharing of each evacuation facility and the headquarters for disaster operation. COCOA can grasp the number of the refugees in each evacuation facility in real time and can visualize those conditions with graphs and maps. COCOA build the environment that can carry out the effective evacuation facility administration under the changing situations. To use the COCOA, the responding method during initial operation can be changed for effective information management. COCOA can simulate the potential number of evacuee at each evacuation facility for initial information.

2. Past study and problem in the evacuation facility administration

The evacuation facility administration is a part in the whole of disaster response. Therefore, there are many studies of the information sharing about the disaster response including information support system by the GIS for emergency (Takao) [2], damage intelligence system at the time of the disaster using the cell-phone (Cheng) [3] and first action for medical treatment system (Ishibashi) [4]. At first of this chapter, past studies are shown on evacuation facility administration. At the second, studies about information system in the evacuation facility are shown.

(1) Study of the past when evacuation facility administration relates

Ishii shows the role of health medical care welfare system of the disaster area at the time of the great disaster [5]. According to this research, a problem is pointed out in the evacuation facility administration that a system about the administration of a person and the thing is not established well. Oshitani shows a problem of the health medical care welfare assumed in a large-scale disaster from the viewpoint of infectious disease [6]. According to this research, a public sanitation organization is not functioned well during the 2011 Great East Japan Earthquake disaster. Main organization is not clear with responsibility to cope with an infectious disease. In the 1995 Great Hanshin -Awaji Earthquake, it is difficult to provide people with disability such as elderly people with enough amount of goods [7]. Layout of the refuge facilities are proposed in the evacuation facility administration manual [8]. The management of the volunteer is also key issue to the evacuation facilities [9].

(2) Past Study of the evacuation facility administration by ICT

System registering and searching of the safety information of the refugee is developed based on the experience of the 1995 Great Hanshin -Awaji Earthquake [10]. Hamamura and others develop an evacuation facility support system using the Android terminal. This system shows evacuation facility support information (locations of evacuation facility, AED, vending machine, convenience store, others) with an icon on a map as for the contents [11, 12]. However, it cannot manage the information of supplies and the refugee on a map because only information of the refuge support information is shared.

Kojima develop a system supporting the communication in the evacuation facility [13] with Twitter (SNS) at every evacuation facility. However, it is difficult to communicate with headquarter and evacuation facilities. Ishida develops the safety information system using resilient information distribution system [14]. Even the situation that the Internet is not usable by using a smartphone as a para-server can be used in this system. However, it is only safety information that can be shared, and the efficiency of the refuge administration cannot be realized. Yuze develop a system supporting the providing of supplies [15]. Maeda make a system for disaster information data using Linked Open Data (LOD), and gathers the data [16]. It is made evacuation facility information by LOD, and it let to cooperate with damage information on Twitter showing on a map. It is developing a system that Oda evaluate the number of the refugees every evacuation facility based on the prediction of the evacuation facility course and analyze [17]. However, it cannot be accomplished how to manage the evacuation facility based on obtained data. Kawanabe develop a place of refuge estimating system at the time of the tsunami [18]. This system can predict the number of the approximate refugees. Ihara develop the application at a disaster using resilient with public Wi-Fi (even if the Internet is not connected, refuge instruction and safety confirmation information sharing are enacted) [19]. The Hiruta suggest a system sharing disaster information in a large-scale disaster [20]. This system uses a smartphone as a substitute for a server in the same way as the study of Ishida. There are many ideas but most of those systems cannot arrive at to develop. The Kim suggest a system collecting the information of the refugee at an android terminal [21]. It is an advantage to be available without the Internet. But, it also becomes only the suggestion. Matsui develop an evacuation facility administration training system (STEP) for the wide area disaster [22]. This can simulate the administration of the evacuation facility as a role playing game. It is effective to improve imagination capacity for the evacuation operations. Omoto develop a disaster information system ONIGIRI [23]. This system can grasp the location of the refugee. However, it cannot manage the situation of the supplies of each evacuation facility. Ueda develop the information support system of responsibility of assigned staffs for disaster [24]. Responsibilities can be monitored at every charge place of the evacuation facility on a map.

For the effective evacuation facility operation, the requirements for the information system which can manage a person, supplies or facilities, the evacuation facility manual are necessary. The system should be improved based on the past problems regarding to evacuation facility administration. And the whole job description process of evacuation facility administration is defined in the system. However, present system cannot be developed with all necessary functions for evacuation management operations.

This study develop the information sharing system with the functions of visualizing the situation in real time for covering all damaged area.

3. Evacuation facility simulation system "COCOA"

Evacuation facility simulation system "COCOA" is developed in this research for the information sharing among all stakeholders in the evacuation facility administration and to simulate the potential number of evacuee. The meaning of the name of COCOA derives from the cocoa of the drink. A relaxation effect, an arteriosclerosis protective effect, cancer protective effect, an anemia improvement effect and so on are included in cocoa [25]. COCOA is suitable for the drink in emergency operations. This research can provide the environment to save the energy to collect and share information about disaster situations, then the relaxation can be served to the all stakeholders with effective information sharing.

To defined the system requirements, this research interview to the staffs of Ishinomaki city and Ministry of Justice who engaged in the evacuation operations during the 2011 Great East Japan Earthquake disaster. The problems to operate the evacuation facilities are clarified by the interview based on their experiences (Fig. 3). Ministry of Justice functioned during the disaster in Ishinomaki city to support the operations of evacuation facilities. They recorded the activities by notebooks (Fig. 1).

The following points are clarified to develop COCOA by evacuation facility administration by this interview.

・Information of the refugee is putted more concretely (e.g.: Such as a refugee with an obstacle, the chronic disease acting violently).

・Function to share the information (the correspondence situation of the earthquake disaster) with outside of the evacuation facility to an evacuation facility operator.

・Information to know the expiration date of supplies.

・Considering the demand of the refugee to the maximum when it is decided the layout of the evacuation facility.

・Visualize the situation regionally without making a certain cities, towns and villages-limited to share a management credit in information between the local governments

COCOA reflected the problem that the staff of Ministry of Justice experienced by a point provided by this interview, it is a practical system by the evacuation facility administration.

Fig. 3 – Image at the time of the interview

Programming language PHP (Hypertext Preprocessor) is used for COCOA and the server is at Institute of Industrial Science, the University of Tokyo. In addition, the visualization of the number of the refugees uses Data Driven-Document (D3).

The big characteristic of COCOA can manage information of people, supplies or facilities, the refuge manual generally. In addition, the registration of the refugee can input full names newly, but it utilize personal number and extract data from Basic Resident Register and it is possible to be used for the registration of the evacuation facility. It compile various information into a database, and headquarter for disaster control, each evacuation facility, a refugee allow information to cooperate mutually（Fig. 4）. The users are classified in three categories. User1 is people in headquarter for disaster operation and applies to the administrative staff mainly. In the

headquarters, information of all evacuation facilities and refugees are collected and support the decision making such as directive orders of the correspondence. User 2 is an evacuation facility operator at each location. The municipal staffs are assigned basically at the evacuation facility. But as the total number of the staffs are limited, residents who mainly leads the facility can be user 2. User 3 is a refugee. People can use COCOA to search family and etc. spreading in other evacuation facilities. There is no need to go around all possible evacuation places to find their family.

All information is exchanged with each user with PC or smartphone through DB (database). In this way, at anywhere, anytime all over the country, COCOA can collect and share the information in every damaged area. Normally Wi-Fi is available and if it is not available, COCOA can use the network of mobile phone even during disaster occurrence.

■User1:Headquarters
Input: Correspondence from each evacuation facility to a demand and the supplies
Output: Situation confirmation of each evacuation facility and refugee, Confirmation of a demand and the question, Confirmation of the transfer book, Management of various certificates

■User3:Refugees
Input: A demand and question to an evacuation facility
Output: Safety confirmation

Database
Refugee personal information, Shift of each staff
The situation of the refugee
The situation of the evacuation facility
A demand and question
Supplies information, Facilities information
Layout of each evacuation facility
Transfer book
A lot of correspondence certificate on the mind side of the refugee
Various manuals
Safety information

■User2:Evacuation facility
Input: Registration of the refugee, Advisory of the evacuation facility, Registration of the safety information, Making of the transfer book, Publication of various certificates, Making of the staff shift, Registration of the facilities information, making of the evacuation facility layout, input of the situation of supplies
Output: Refugee personal information, A question and demand from a refugee, Supplies information, Shift of the staff, Layout of facilities and the evacuation facility, Certificate
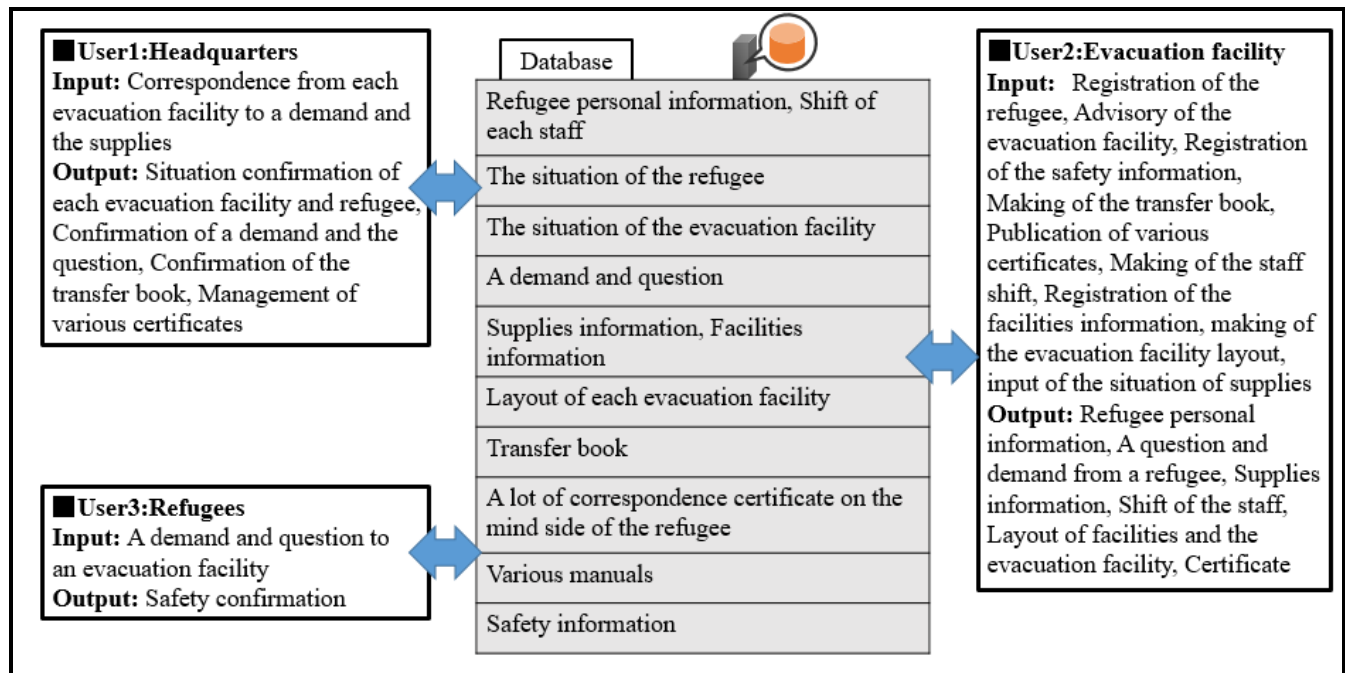
Fig. 4 – COCOA data system

Functions of COCOA are shown bellows following COCOA window.

a) Management of the refugee information

By the management of the refugee information, all evacuation facilities archived in COCOA is listed up at top page (Fig. 5 (a)). Information to the evacuation facility of the refugee and conditions (physical condition and mental condition) for every refugee at each evacuation facility visualize (Fig. 5 (b)).

b) Assignment of staffs

To manage the staffs to assign to all evacuation facilities are difficult. COCOA can make a schedule to assign staffs effectively. Normally to keep enough staffs to assign them to all evacuation facilities are difficult. To manage effective staffs operation is required. To cooperate with people from NGO, NPO and volunteer is need to share the staff assignment.

c) Management of supplies

For the management of supplies during disasters, COCOA can collect quickly four levels of supplies at each evacuation facility, (1) "Enough hot foods with 3 times for one day", (2) "Just foods with three times for one day", (3) Foods with 1-2 times for one day"; (4) Almost nothing. These conditions are selected by the radio button in COCOA.

Headquarters can quickly grasp which evacuation facilities are provided enough supplies or not enough.

In addition, headquarter as for disaster operation can respond according to the needs and demands with the number of people at each evacuation facility considering with personal characteristics (child, elderly person, sex).

d) Management of facilities

Before the disaster, an evacuation facility prepare the materials for real disaster such as food stock, emergency electricity generator, and other materials. COCOA can manage the material lists and its layout before disasters. People can understand how much each evacuation places are prepared. To show the layout of evacuation places is important to understand the location of facilities on a map. Because most assigned staffs from municipality are first time to visit the school, community center to manage it as for the evacuation facility, they don't understand the location of necessary materials.

e) Making administration of the manual

Operation manual for each evacuation facility is needed for effective emergency management. Some municipalities try to make manuals with residential people. The operation manual need to include the check list for necessary materials prepared. Work flow with organization can control for many kinds of stakeholders. Layout to stay with many evacuee at same place is needed to design before disaster. To update the operation manual, COCOA can revise it using mobile devise at the location.

f) Management of the transfer book

Staffs to work for the evacuation place need to share the problems or situations with staffs assigned to next turn. The transfer book can be created in COCOA and to share the problems and situations with other people. Then, staffs can start with sharing the current situations for the evacuation place where the staff is assigned (Fig. 7).

Fig. 5 (a) −All evacuation list

Fig. 5 (b) – Top page at an evacuation facility

Fig. 6 – Refugee registration screen

Fig. 7 –Transfer screen

4. Verification of "COCOA"

Developed COCOA in this research is verified by the drill in Ishinomaki city and at Institute of Industrial Science of the University of Tokyo.

(1) COCOA is tested at a general disaster prevention drill in Ishinomaki city on November 15, 2015.

Eleven members with five students (three foreign students), five staffs from the city and one inhabitant operated COCOA in this drill. The refugee information is registerd by the members with distributed iPad to each individual, and used a virtual refugee list for registration. The radio wave used the radio wave of the cell-phone. In addition, it was performed the briefing session about this system after an experiment and performed questionary survey.

By this experiment, it is verified about the following items.

a) It could input a refugee, an injured person, supplies information in each evacuation facility, or the person in charge assumed the real situation in the registration of the refugee by the virtual list and an injured person, supplies information in each evacuation facility (Fig. 5 (b), Fig. 8 and 9).

b) Registration of the refugee by My Number (National personal number as for ID)

Virtual my number list is used for the registration of the refugee. In case of registration, the registrant devised the input of personal number (Fig. 6).

c) Input of the information using the smartphone of inhabitants

Inhabitants can register their own information into COCOA. Now most inhabitants have a smart phone, thier smart phone is available for effective responses. Then, the staff workload of municapilities can be reduced. This dirill asked the resident to give her information and to update it. The results shows that the inhabitants can use COCOA to share the information with disaster headquater.

d) Visualize the situation in the headquarter for disaster operation

The graphs or charts are visualized obtained by COCOA to monitor the conditions and to make a decision making at headquater (Fig.10 and 11).
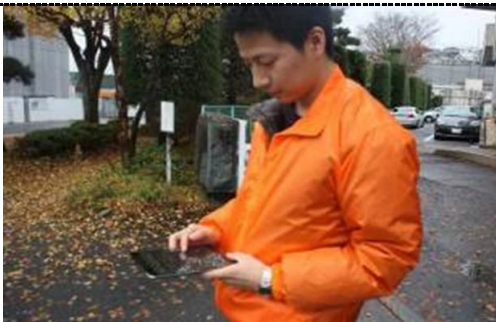

Fig. 8 – Mobile device for input at evacuation location
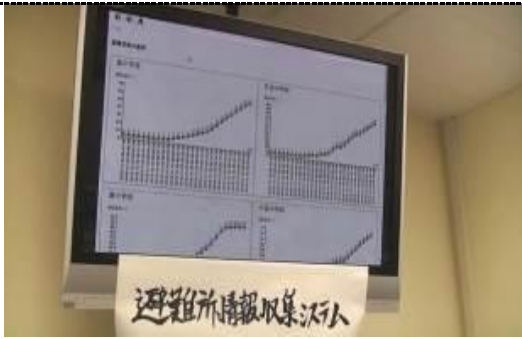

Fig. 9 – Inhabitants evacuate

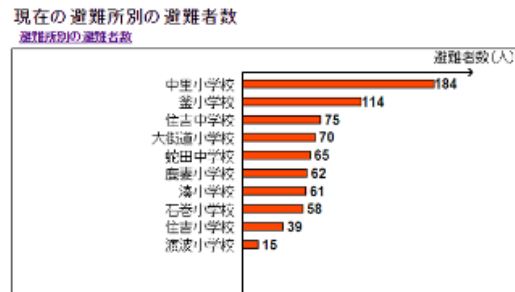Fig.10 – Real-time monitoring with number of evacuee

Fig. 11 – Number of the refugees according to the evacuation facility

(2) Experiment at the fire drill in Institute of Industrial Science of the University of Tokyo

COCOA was used for the fire drill carried out for Institute of Industrial Science, the University of Tokyo on December 9, 2015 (Fig.12 and 13).

Cooperators for the experiment are eight members in total of four students (including one foreign student) of the laboratory and four office workers. Tablet devices are used to use the system. At first, five people were placed at every five research groups. Then, other members were placed at the groups where were late for the registration as for temporary supports. The name lists created before the drill is effective to regist the refgee.

In addition, the Fire and Disaster Management Agency who monitored this system discussed and to exchange opinions with members of operation staffs of COCOA after the drill with the created visualization in a graph and the figure for evacuee trend (Fig.14 and 15).

By this experiment, the following items are discussed.

a) Availability of the system for the fire drills during normal time

Purpose of COCOA is to be used not only the evacuation facility during real disaster but also the fire drill in normal period. COCOA can support to obtain information about prople moving during disaster drills.

b) Efficient regisration of the refugee

For the efficcient registration of refugee, the name list is effective to regist the refugee. To use the name list, it is need to be used before the disaster.

Fig. 12 – Line for every flag of each department

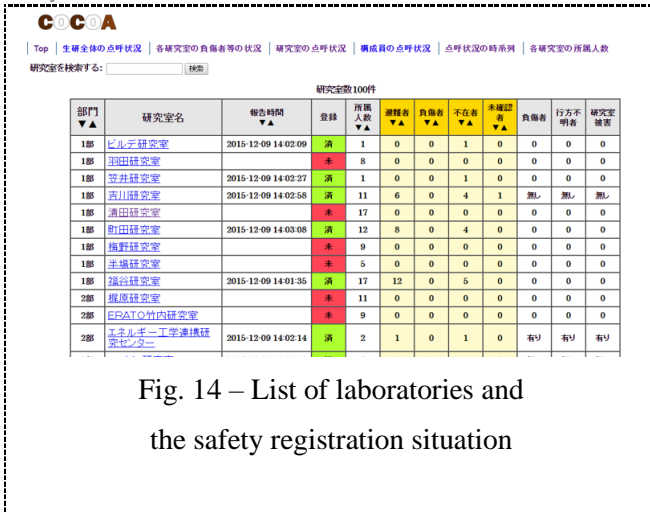Fig. 13 – Colleting information by paper

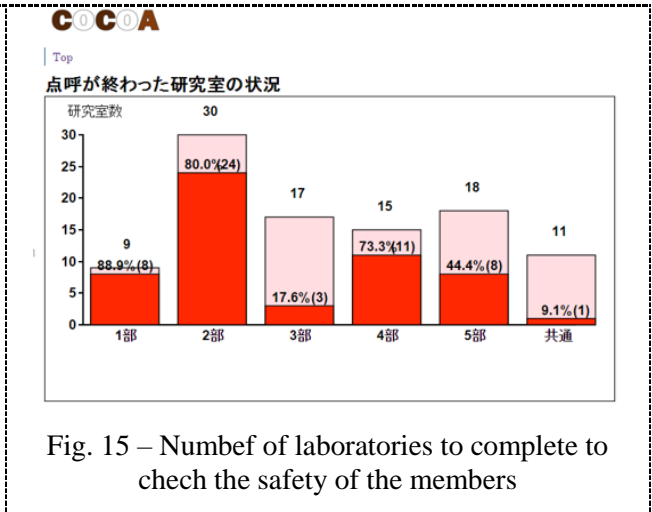Fig. 14 – List of laboratories and the safety registration situation

Fig. 15 – Numbef of laboratories to complete to chech the safety of the members

5. Findings from the drills

This chapter shows the findings from two drills of Ishinomaki city and of Institute of Industrial Science, the University of Tokyo.

(1) Verification for drill in Ishinomaki-city, Miyagi prefecture.

Firstly, findings of each items are summerized.

a) COCOA could input a refugee, an injured person, supplies information in each evacuation facility or could input a refugee, an injured person, supplies information in each evacuation facility and was able to share the information with the headquarters.

b) COCOA could regist a refugee by using personal number, my number for effective registration.

COCOA could register a refugee by using virtual personal number. And, COCOA could share and manage information of the refugee in the headquarters. However, COCOA took time for input more than it is expected due to regist the refguee "one person by one person".

c) COCOA was used to input the information by inhabitants using the smartphone of inhabitants in the evacuation place and was able to input information.

d) Visualization of obtained information by COCOA is effective for the situation in headquarter of disaster operation.

COCOA could make graphs and figures to visualize. The visualizations was able to share refuge information effectively.

Then, questionnaire survey was conducted. The questionnaire is held eight inhabitants (refugees) and the five staffs who really used to regist refugee by COCOA.

About the questionnaire of inhabitants, eight people answered "necessary for COCOA during disasters" for a Q1 "whether the cocoa is necessary?". Eight people answered "COCOA is usable in a real disaster" for a Q2 "whether the cocoa is usable?". In addition, for a Q3 "How do you like about using personal number?", one person answered "there was not resistant". Tow people say "you might always use positively". Four people say "the use only for emergency, it was good". One peole say "there is resistance", but the reason is "I cannot learn a number". For Q4 "How about a function necessary for COCOA?", some comments are proposed. For example, "the restoration situation of the infrastructure", "there should be information dispatch (safety information) to not only the evacuation facility but also the self refuge individually" and "we wanted to know where it should contact when there was an injured person".

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About the questionnaire of staffs, for a Q1 "whether the COCOA is necessary?", three staffs "were necessary", and two staffs "were not necessary". For a Q2 "How about the operability?", there was not the staff who replied "it was easy to use it", three staffs "were hard to use" and two staffs "normal". It is the reason that the registration with personal number was trouble. In addition, For a Q3 "How about how to use?" all five staffs replied "it were simple". For a Q4 "How do you think about COCOA use at the time of the real disaster and use of personal number?", there were many negative opinions. The problems included "it does not have a power supply and internet environment", "I have no time to trouble stolen by input too much" and "The viewpoint that is careful about a way of the administration of the personal number is necessary."

From this experiment, it was revealed that it was shared evacuation facility information effectively and it could be managed by using this system. However, the problems stayed such as the electric wave in the real scene and the impluvement of the effectiveness of the input with personal number. It will be examined various opinions provided by a questionnaire in future.

(2) Experiment in the fire drill in Institute of Industrial Science, the University of Tokyo.

Effective information input was achieved by using personal number comapred with using the paper list of real refugees who registered beforehand. COCOA can calculate the potential number of evacuee by refering the member list from the database. Then, real evacuee and potential evacuee are compared by COCOA.

By the exchanges of ideas with the Fire and Disaster Management Agency, information sharing is critical for emergency situation. During this period, COCOA can support information management.

This system is available for different hazard or all hazard cases.

6. Summary

In this study, the evacuation facility simulation system "COCOA" is developed for efficiennt management of the evacuation facility. COCOA is used for the two drills of Ishinomaki city and of Institute of Industrial Science, the University of Tokyo. The information sharing at the disaster headquarters and each evacuation facility promotes efficiency by COCOA. Conditions and situations can be shared among stakeholders. Effective and smooth operations of the evacuation facilities with sharing the information environments among stakeholders will be achieved by COCOA in accordance with conditions of each evacuation facilities.

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