2013

Mobile Apps in Flood Disasters: What Information do Users Prefer?

Natt Leelawat
Tokyo Institute of Technology, leelawat.n.aa@m.titech.ac.jp

L. G. Pee
Tokyo Institute of Technology, peelg.aa@m.titech.ac.jp

Junichi Iijima
Tokyo Institute of Technology, iijima.j.aa@m.titech.ac.jp

MOBILE APPS IN FLOOD DISASTERS: WHAT INFORMATION DO USERS PREFER?

Leelawat, Natt, Tokyo Institute of Technology, 2-12-1-W9-66 Ookayama, Meguro-ku, Tokyo 152-8552 Japan, leelawat.n.aa@m.titech.ac.jp

Pee, L.G., Tokyo Institute of Technology, 2-12-1-W9-120 Ookayama, Meguro-ku, Tokyo 152-8552 Japan, peelg.aa@m.titech.ac.jp

Iijima, Junichi, Tokyo Institute of Technology, 2-12-1-W9-66 Ookayama, Meguro-ku, Tokyo 152-8552 Japan, iijima.j.aa @m.titech.ac.jp

Abstract

Mobile applications have prompted new interest due to its potential in efficiently supporting information gathering during floods. In order to improve the usage of mobile applications during flood disasters, a guideline for flood mobile applications is needed. Based on a field study of mobile applications used in 2011 Thailand Floods and interviews with developer and users, this study identifies what users prefer to know via mobile applications and investigates their impact on the download number of mobile applications. This is one of the first empirical studies on flood mobile applications and contributes to research by focusing on the information aspect of users' preference and its effect on the success of mobile applications. It also contributes to practice by providing suggestions to mobile application developers with regard to users' preference.

Keywords: Disaster Management, Flood, Information Systems, Mobile Application.

1 Introduction

With the increasing usage of mobile devices worldwide, about 90% of global population is covered by mobile signals (ITU, 2010). A current research also reveals that mobile phone is the first priority that the victims took along while escaping to safe places (Mobile Society Research Institute, 2012). As a result, it is a good time for researchers, government, and practitioners to consider the potential of mobile technology in the context of disaster management and relief.

Gartner (n.d.) defines Mobile Business as "new business models enabled by the extensive deployment of key mobile and wireless technologies and devices." Mobile business has ultimate goal as "to create new experiences of social interaction between individuals, and between individuals and businesses" (Mylonopoulos and Doukidis, 2003). An effective design of disaster mobile applications is important in mobile application business. As same as other mobile applications, by making the application exceeds a large number of downloads or reaches a ranking chart, the mobile application will be known as a success product. Sometimes, it seems difficult to find direct relationship between mobile business and disaster in the aspect of disaster mobile application, because most of the disaster mobile applications are free. However, there are some indirect benefits such as reputation of developer, image of Corporate Social Responsibility (CSR), and in-app advertisement. Success of disaster mobile application is similar to other types of mobile application; development of mobile application should follow the user's preference and requirement.

Flood is "an overabundance of water that engulfs dry land and property that is normally dry" (Haddow et al., 2011, p. 30). Floods are "uncontrollable natural event that causes loss of lives and damage to public property" (Usul and Turan, 2006, p. 227). According to the International Disaster Database (Centre for Research on the Epidemiology of Disaster (CRED), 2013), Thailand Floods in 2011 and China's Yangtze River Floods in 1998 are ranked in the top ten of the world costliest natural disasters. In addition, floods are also shown in various ranks in the world top ten most disruptive natural disasters. Since it can be seen that flood is a disaster that causes a large number of affected people and damages, it motivated us to set the focus on the technological solution for people who encounter this disruptive disaster.

In the information intensive era, mobile phones tend to play a supplementary role in early warning systems, while "prior surveillance, public education and news media are generally the best way to prepare people for disaster" (Coyle and Childs, 2006, p. 3). Mobile technologies have become pervasive. According to the survey of possession of goods that people would take during evacuation process, mobile phone leads to the highest in percentage (79.6%), which is higher than wallets and identification (Mobile Society Research Institute, 2012). Mobile applications also can overcome some limitations of traditional media, such as mobility and coverage area. Aronica et al. (2010) mentioned that using mobile phones could fulfil the lack of information in the unmonitored areas. Since the information technology can provide better and quicker information about disaster that helps people understand clearer and be able to make a better decision quickly, we can find the availability of mobile applications for disaster in many countries. Despite the increasing efforts of worldwide disaster mobile application development (e.g., Australia, Czech Republic, England, France, Hong Kong, Japan, Philippine, Singapore, Taiwan, Thailand, U.S.A.) (DailyNews, 2012; Disaster Information Management Research Center, 2012; Madrigal, 2012; Souza and Kushchu, 2005; Sung, 2011), a limited number of studies have focused on disaster mobile applications (Sung, 2011), especially from the user aspect.

It is true for some natural disasters such as the Great East Japan Earthquake and Tsunami in 2011 (Mobile Society Research Institute, 2012) that the mobile networks can establish the congestion problems and the base stations might be damaged during the disaster impacts. Nevertheless, flood normally has some special characteristics comparing to other types of natural disaster, which is the time period that is available for nearby area to prepare, and the possibility to still be able to use the mobile services if the base stations are installed in higher areas. According to the report of 2011

Thailand Floods from the World Bank (2012), it is found that the major damage of telecommunication sector stayed in the landline communications, especially in the industrial areas and urban areas, thus the telecommunication sector was dominated by the mobile communications. Moreover, based on our interviews and documents, mobile signal (e.g., 3G, GPRS, EDGE) was functional in most areas even during the flooded situation in Thailand.

When disaster impacts, people normally try to gather information about the current situation and news as much as possible (Mobile Society Research Institute, 2012). However, sometimes the official sources (e.g., public sector's announcement) are not quite up-to-date and not covered what people would like to know (DailyNews, 2011). The ICT alternative ways are what people, especially young generations and metropolitan people, chose to gather the information (DailyNews, 2012). The information gathering via mobile applications does not appear only during disaster situation, but also during normal daily life, even in developing countries (Sung, 2011).

Previous studies on disaster mobile applications were likely to focus more on technical development and rescuer user aspect (Fajardo and Oppus, 2010; Monares et al., 2009; Puras and Iglesias, 1999). Due to the increasing number of smart phone users, it is interesting to study the usage of mobile applications during flood disasters to understand the aspect of people's preference. Since there are various types of the information that developers can choose to deliver to users via their mobile applications, and there is limited study focused on the interests of mobile application users in flood disaster, therefore this research tries to fill this gap and sets a research question as "What kind of information should mobile application provide to the users according to their preferences in flood disaster?"

Through the empirical study using a field study of mobile applications and interviews with developer and users from 2011 Thailand Floods, this study makes contribution in both academic and practice aspects. For academic implication, this paper shows the analysis of mobile application usage in the real flood situation. We point out the necessary information type for flood mobile applications, which can be further study in other aspects. It is also one of the first studies focuses on mobile applications during disaster in Thailand. As for practical implementation, this paper provides suggestion to mobile application developers to understand preference of the user and the idea to develop their mobile applications in the future.

The next section of this paper reviews the literature of flood disaster stages and necessary information in flood disaster. The third section describes the research design, methodology, and data collection. The fourth section explains data analysis and result. Finally, the last section provides discussions and conclusions.

2 Information in Flood Disaster

Based on Wurman et al. (2001), there are five ways to organize information: (1) similarity relatedness, (2) chronological sequence, (3) geographical or spatial references, (4) alphabetical sequence, and (5) magnitude (e.g., higher to lowest, best to worse). Since the nature of communication needs is various at different disaster stages (Coyle and Childs, 2005), this study organizes the information according to the chronological sequence in order to identify the information type by (1) declaring the stages of flood disaster based on previous studies (see section 2.1), (2) reviewing the key information in disasters according to previous studies (see section 2.2), and (3) identifying the assumed necessary information in each stage of flood disaster based on previous researches (see section 2.3).

2.1 Flood/Disaster stage

In order to examine the detail of each stage of flood disaster, we look at the previous frameworks, which have been used to describe the stages of flood or disaster. The literature review of disaster stage is summarized in Table 1. According to these studies, this research classifies the composite stage of disaster into five stages (i.e., pre-event, early-warning, emergency, immediate, and recovery).

Source(s)	Stages
Robert (1994)	(1) "Pre-flood": action can be taken to prevent flood disasters; (2) "Flood": effects of disaster have been felt and action has to be taken in order to recue the people; (3) "Intermediate phase": short-term needs of the people affected must be deal with; (4) "Recovery, Rehousing, Long-term aspects": Continue of previous phase, but items that could not be addressed quickly are attended to this point
Faulkner (2001)	(1) "Pre-event": action that can be taken to prevent or mitigate the effects of potential disaster; (2) "Prodromal": disaster is imminent; (3) "Emergency": effect of disaster is felt and action is needed to protect the people and property; (4) "Intermediate": focusing on restoring the services and the community; (5) "Long-term" (recovery): post-mortem, self-analysis, healing
Alexander (2002), Coppola (2011)	(1) "Mitigation": finding our the way to reduce or eliminate the impact; (2) "Preparedness": preparing people and tools to minimize loss; (3) "Response": action to reduce the occurred disaster; (4) "Recovery": returning to the normal condition
Coyle and Childs (2005)	(1) "Early Warning": 0-2 days before the disaster impact; (2) "Disaster Impact": emergency response is needed to emphasize on lifesaving; (3) "Immediate aftermath": 12 hours to 3 days after disaster impact; (4) "Recovery, Rebuilding, Fundraising": 3 days onwards

Table 1. Literature Review for Flood/Disaster Stages

2.2 Necessary information in flood disaster

In order to understand the necessary information during the flood situation, the previous researches have been reviewed. According to the previous studies (see Table 2), it can be seen that the necessary information in flood situation consists of plan, warning, monitoring, food-supplies, evacuation, medical/health, relief, and damage information. The detail of each type of information will be discussed in section 2.3.

Source	Necessary Information in Flood/Disaster Management	Keyword(s)
Caribbean Disaster Emergency Response Agency (2004)	The media should provide flood warning system, flood information, and preparation instructions to public before the flood situation. During the flood, they should provide geographic area information, water-covered roads and bridges, and livestock protection. After the flood, they should provide re-enter building caution, fire and electrocution hazards alert, damaged utility lines report instruction, etc.	Plan Warning Monitoring
Hagemeier-Klose and Wagner (2009)	"Well designed and associated maps (e.g., using blue colours for water depths) which can be compared with past local flood events and which can create empathy in viewers, can help to raise awareness, to heighten the activity and knowledge level or can lead to further information seeking. A linkage between general flood information like flood extents of different scenarios and corresponding water depths and real time information like gauge levels is important demand by users" (p. 563).	Monitoring
Mobile Society Research Institute (2012)	On disaster impact day and a few days later, people need information related to safety confirmation and communication with friends and relatives, disaster, utility recovery, food-supply, traffic, shelter or hospital, weather, and fuel.	Food-supply Monitoring Evacuation Medical/ Health
Morss, Wilhelmi, Downton, and Gruntfest (2005)	The information used to make a flood-risk decision consists of "climate variability", "scientific uncertainty", and "hydro-meteorological information" (p. 1594).	Monitoring
Shklovski et al. (2008)	ICT can be used for information seeking in crisis events such as evacuation information, relief, warning communication, etc.	Evacuation Warning Relief
The Assessment	The information needs of decision makers are (1) "pre-disaster	Plan

Capacities Project (2011)	information": baseline data; country background information (e.g., area specific information, cultural habits); information on risks (e.g., hazard profile, epidemiological profile); in-country capacities (including contingency plans); pre-existing vulnerabilities; previous disaster trends; risks; and (2) "disaster specific information" (p. 2).	Monitoring Damage
Usul and Turan (2006)	"The flood maps can show the extent of the possible inundated areas for future floods in the region. To know how many and which parcels will be flooded, together with their total area, and also the possible water depth in case of a certain magnitude future flood, is important for the purpose of informing people" (p. 224).	Monitoring
Zhang et al. (2002)	Before sending rescue team, the decision makers need to know "the severity of the disaster, the number of people dead or injured, the urgent demands in the damaged area, and so on" (p. 381).	Damage
Zipf and Leiner (2004)	The projects and systems within the area of flood protection consist of automated collection and transmission of environment data environmental data bases, geographic information systems, systems for disaster/danger simulation, management systems, and communication platforms.	Monitoring

Table 2. Literature Review for Necessary Information in Flood/Disaster.

2.3 Necessary information in each flood disaster stage

2.3.1 Pre-event

During pre-event stage, the suitable action is to create a plan preparing for floods. It is the stage that the relevant government and non-government organizations should develop disaster management strategy to improve the ability of them and their people (Haddow et al., 2011). The plans or guidelines should be documented and provided to people (Coppola, 2011; Haddow et al., 2011). *Plan information* should include "decision making and management", "planning", "public communication and preparedness", "evacuation of people with special needs", "operations", "shelter considerations", and "mass evacuation training and exercises" (Haddow et al., 2011, p. 104). Basic plan is defined as "main body of the document that describes emergency operations within the community or country" (Coppola, 2011, p. 253).

2.3.2 Early-warning

Since disaster is expected shortly, mass media should provide warning information (Faulkner, 2001). It is also the time that the disaster command center should be established. During this stage the warning information is necessary for people in the expected areas. *Warning information* should be broadcasted as much as possible when flood is expected (Coyle and Childs, 2005). The information should contain the type of warning, type of disaster, location, date, and time (Jagtman, 2012).

2.3.3 Emergency

Emergency is a stage that floods have already started. Everyone needs to understand the current situation. Fast-and-accuracy information is necessary to be provided, thus monitoring information, medical-and-health information, and evacuation information are necessary for people. *Monitoring information* displays water level in each specific place. As for the geographical aspect, the specific place can be set as the important location for living, transportation, or water reservation. So, area of city, canal, road, or dam should be monitored. There are various methods to show this information (e.g., graphical way, line graph, bar graph) depends on the purpose of visualization. *Medical-and-health information* is also necessary in terms of letting people know the available hospitals during the disaster. Indian police has launched an Android application for emergency, which provides hospital location, telephone number, and list of the nearest hospitals from the current position (Jalote, 2013). *Evacuation information* is necessary for people whose residence have already flooded or is going to be

flooded (Coyle and Childs, 2005). It should provide the available place to evacuate to. They can be schools, universities, public halls, or others, which are assigned to be the temporary shelters. The information should include names, addresses, maps, and contact numbers of evacuation shelters.

2.3.4 Intermediate

While emergency stage focuses more on lifesaving, intermediate stage tends to focus on how to let people survive during flood. It is time to start addressing people's needs. All those severe cases of affected areas should be rescued. Government should provide the strategies to help these people. Monitoring information (as same as emergency stage), damage information, and food-supplies information are necessary in this stage. *Damage information* shows the information of the affected people, animals, properties, and assets. By understanding the current available and unavailable resources, it can help the person-in-charge deciding a plan to create strategy and to set priority (Coppola, 2011). *Food-supplies information* is another necessary information since it can let people know where they can purchase food, beverage, and other necessary things.

2.3.5 Recovery

In this stage, all the affected people should be helped. The activities of recovery, rebuilding and fundraising are included in this period. *Relief information* is necessary in this stage. It should contain donation information, update news of disaster area, information of charity group, and volunteer recruitment (Madrigal, 2012; Sung, 2011).

Disaster Stage	Information Category	Source(s)	Description/Contents
Pre-event	Plan	Coppola (2011), Haddow et al. (2011)	Plan that describes planning, communication and preparedness, evacuation process, emergency operations, sheltering considerations, and evacuation training is necessary
Early-warning	Warning	Coyle and Childs (2005), Jagtman (2012)	Type of warning, type of disaster, location, date, time
Emergency	Medical/ health	Jalote (2013), Mobile Society Research Institute (2012)	Nearest hospital list (name, telephone number, and address)
	Evacuation	Mobile Society Research Institute (2012), Pelman and Robinson (2011)	Nearest temporary evacuation shelter list (name, address, route, availability)
	Monitoring*	Mobile Society Research Institute (2012), Sung (2011)	Current location and graphic hazard map
Intermediate			
	Damage	Zhang et al. (2002)	"The severity of the disaster, the number of people dead or injured, the urgent demands in the damaged area, and so on" (p. 381)
	Food-supplies	Mobile Society Research Institute (2012)	Food-and-drink distributor/seller
Recovery	Relief	Coyle and Childs (2005), Sung (2011)	Donation information, update news of disaster area, information of charity group, support request
Note. * Monitoring information is necessary in both emergency stage and intermediate stage.			

Table 3. Necessary Information in Each Flood Disaster Stage.

Since it is important for the emergency management of flood disaster to cover all stages (Yang and Zhang, 2007), we conducted the research on the information of all disaster stages. The necessary information in each stage is summarized in Table 3.

3 Research Design and Methodology

3.1 Methodology

In this study, we decided to start by examining the existing mobile applications. A field study was used as the primary vehicle in this study. The mobile applications involving with 2011 Thailand Floods were the target of this study. We reviewed their user interfaces, functions and features, number of downloads, and user's reviews from the information available on their mobile application store and from the applications themselves. The targets were not limited to any mobile platform(s) or developer(s). The IBM SPSS version 19 was used as a tool to analyse the difference between group of flood mobile application that provided and did not provide each type of information. Next, the follow-up semi-structured interview techniques (Whiteley et al., 1998) were used as the secondary vehicle in order to understand more perspectives of developer and user, and find out the reasons behind their preference.

3.2 Number of downloads

Number of downloads can be interpreted as a feedback from users. Since the number of downloads can reflect an interest of the user to use the application, we decided to use this data as the dependent variable in this study. Number of downloads is a statistical data counted from number of the users who downloaded each mobile application. According to Garg and Telang (2013), it is possible and validated to calculate highly accurate estimates on downloads if the ranking data is available for a given iOS mobile application via the Pareto distribution, $d = 52{,}511 * r_p^{-0.944}$ while d is the number of downloads and r_p is the ranking number. The value of scale parameter, '52,511', and the value of shape parameter, '0.944', are calculated from their data analysis of iOS applications. We have considered using this formula in our analysis for iOS applications.

3.3 Data Collection

This study selected mobile applications developed for providing information related to 2011 Thailand Floods disaster. Search was based on the descriptors "Thai Flood" and "Thailand Flood" in either name or description of the application. These keywords were searched in the following application stores: App Store, Google Play (formerly known as Android Market), AppBrain, AndroidZoom, BlackBerry App World, Nokia Store (formerly known as Ovi Store), and Windows Phone Store. The mobile applications that contained the following specifications were targeted: (1) application that is provided on mobile application store; and (2) application that describes its content of description related to 2011 Thailand Floods. We excluded the applications that had a minor relationship with 2011 Thailand Floods such as theme or game applications. We searched for the related mobile applications in May 2012. The search resulted in twenty-three mobile applications in total. The data (e.g., number of downloads, reviews) was collected on June 8th, 2012. They included six iOS applications, fifteen Android applications, and two Windows Phone applications. We used the number of downloads provided on the website for Android applications, the estimated number of downloads according to Garg and Telang (2013) for iOS applications, and the number of downloads reported by the developer for Windows Phone applications. Nevertheless, in the next step, only eighteen mobile applications were found to provide enough data to analyze.

The interviews were conducted in June 2012. We conducted an interview with a Thai developer from EGCO Dev Team, who developed one of the mobile applications we reviewed in this study. As for the users, since our objective is to understand the user's perspective and find out the reason behind their preference of flood mobile application, we selected the persons who experienced using some flood mobile applications during 2011 Thailand Floods. We conducted the interviews with three real users. The interviewees consisted of (1) a financial planner (27, male, M.Sc. in Real Estate Business); (2) a hospital system analyst (26, female, M.Sc. in IT); and (3) a project management officer (27, female,

B.Sc. in IT). The duration of each interview was around 15 minutes. All of the interviewees are Thai people who lived in Bangkok and Nonthaburi during the floods.

4 Data Analysis and Result

We focus on the influence of information type (i.e., plan, warning, medical/health, evacuation, monitoring (flooded-area, canal, road, dam), damage, food-supplies, and relief) on the number of downloads. However, there was no mobile application provided plan information and damage information.

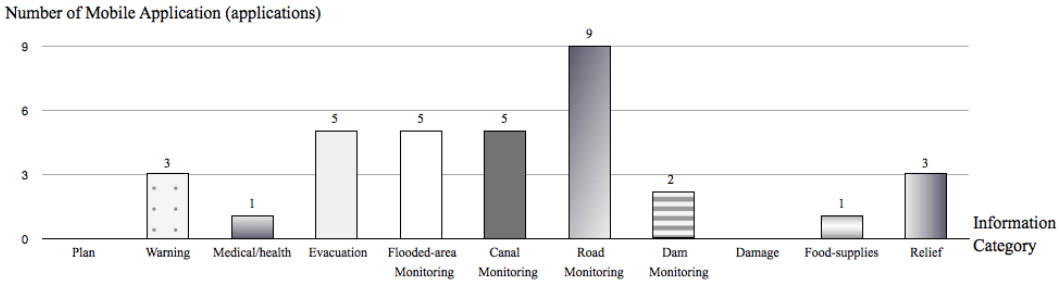

Figure 1. *Number of mobile applications for 2011 Thailand Floods that contain each information type.*

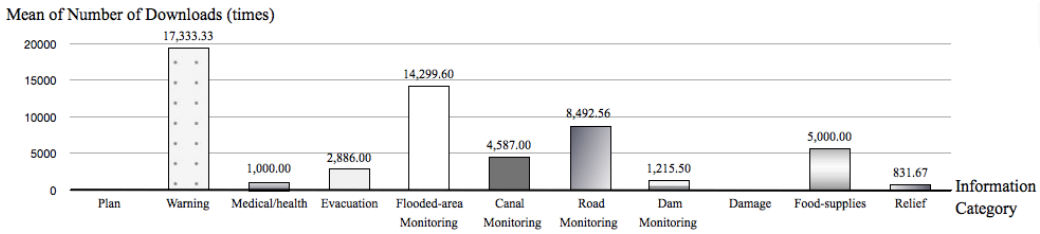

Figure 2. *Mean of number of downloads of mobile applications for 2011 Thailand Floods that contains each information type.*

Information Category	**Group A**		**Group B**		***F***
	N	**Mean of Downloading No.**	***N***	**Mean of Downloading No.**	
Plan	-	-	-	-	-
Warning	15	3,583.80	3	17,333.33	**4.347***
Medical/health	17	6,162.18	1	1,000.00	0.184
Evacuation	13	7,025.15	5	2,886.00	0.460
Monitoring					
Flooded-area	13	2,635.31	5	14,299.60	**4.568****
Canal	13	6,370.92	5	4,587.00	0.084
Road	9	3,258.22	9	8,492.56	0.944
Dam	16	6,457.88	2	1,215.50	0.361
Damage	-	-	-	-	-
Food-Supplies	17	5,926.88	1	5,000.00	0.006
Relief	15	6,884.13	3	831.67	0.691

Table 4. *Analysis of Necessary Information in Flood Disaster.*
(Note. * *Significance at p <0.10;* ** *Significance at p < 0.05;*
Group A does not provide information; Group B provides information;
N: Number of applications)

In our analysis part, first, we looked at the number of applications that provide each type of information in order to see the aspect from developers. As shown in Figure 1, most of flood mobile application provides road monitoring information, followed by flooded-area monitoring, evacuation information, canal monitoring information, warning information, relief information, dam monitoring information, medical-and-health information and food-supplies information, sequentially. For this aspect, it can be interpreted that from the developer perspective, road monitoring information seems to be the most interesting information to be displayed in their applications.

Figure 2 shows the aspect from users, which is the mean of downloads. It can be seen that flooded-area monitoring is the highest among others, followed by warning information, road monitoring information, evacuation information, canal monitoring information, food-supplies information, relief information, medical-and-health information, and dam monitoring information, sequentially. We can see that, by focusing on the mean of downloads; users seem to be interested in warning information.

According to Table 4, we examined the difference in term of users' willingness to download (via the number of downloads) between the group of providing and not-providing each information type. It can be seen that there is a positive effect for the mobile applications that provide information related to warning, flooded-area monitoring, and road monitoring information. On the other hand, there is a negative effect for the mobile applications that provide information related to medical-and-health, evacuation, food supplies, canal monitoring, dam monitoring, and relief information. Also, the result shows that the group of mobile application providing warning information and flooded-area monitoring information differed significantly (warning information: $F = 4.347$ which is significant at level of 0.10; and flooded-area monitoring information: $F = 4.568$ which is significant at level of 0.05).

5 Discussions and Conclusions

5.1 Discussions

Normally, after life safety, the first thing people consider is gathering information (Mobile Society Research Institute, 2012). Mobile application can provide an important role to alert or warn people from the incoming disaster. In the warning stage, warning information is preferable information that people would like to know, while in the phase of emergency stage, the geographic information is an important asset, as well as one of the interviewees mentioned "*...We need to know when to pack our stuffs*" (i.e., checking the current flood tide to estimate when it would arrive the residence); and others also felt that among all types of the monitoring information, the flooded-area monitoring information is the most preferable with the reason that they need to know the current flooded area in order to avoid that area and prepare themselves. Before anything is coming, notification can let the users realize and prepare to protect themselves and their properties. Practically, people want to monitor their current situations and understand the whole image, however, this kind of information showed difficulty to access at anytime or anywhere with the traditional media such as TV, radio, and newspaper. Therefore, the most preferable information for users during flood situation falls into the category of warning information and flooded-area monitoring information. Moreover, for victims, the mobility is a vital factor for them due to their evacuation away from the flood tide. It is more difficult to carry computer and find Internet connection than to take mobile phone that can access Internet via 3G or GPRS/EDGE.

Nevertheless, it does not interpret that other types of information category are not important for flood mobile applications. Each type of information has its own benefit in some aspects. Plan information is necessary in term of teaching users to prepare (e.g., saving house and property) for flood, which is better to provide through public education or news media (Coyle and Childs, 2005). Medical-and-health information seems not much interesting since many hospitals still opened during the floods in Thailand case. The available hospitals or medical institutes had contacted with the rescue teams in order to transfer the patients to the suitable places. The unavailable medical institutes were mostly located in critical flooded area, where most of the people had already evacuated to other safe places. Evacuation shelter information is quite important as it provides the information of where to evacuate if

their residences are flooded. Nonetheless, it is possible to understand that people could get this type of information from various channels such as TV, newspaper, or evacuation teams, which is more official. Moreover, the leader of community should be informed about evacuation area in advanced for a well preparation. Damage information is possible to be observed via the assessment team. Furthermore, this information was mainly used by the decision makers in the managerial level. They were capable to access this information via their channels. As for food-supplies information, we found from our interviews and data collection that most of Thai metropolitan people who were informed the situation in advanced had prepared and stocked the food and beverage enough to survive. Relief information is necessary in recovery stage. People had more channels at that stage to gather the information of donation and others because many telecommunication systems had been repaired.

5.2 Suggestion for Mobile Application Development

Based on our interview with EGCO Dev Team, MK (2012), and Somprasong (2011), we found that developer has an objective to provide the necessary information to people during the flood disaster. It is difficult to explain the direct benefit to developers because most of flood mobile applications in Thailand are free to download. Nevertheless, what we found in Thailand is that some developers became well known after publishing their useful flood mobile applications (MK, 2012; Somprasong, 2011). It is considered as one great effort in their portfolios. Based on our study, flood mobile application should let users know where the flooded areas are, where the safe place the users can evacuate to, and help the users gather the information to survive during the flood situation. These are the specific information for people to make their decisions. It is the first priority for the developers to consider during the design phase of application development. Some of the mobile applications may not reach the interest of the users due to their complicated or information overload. For mobile application success, developer should pay attentions to the real needs rather than focusing only on programming and designing.

5.3 Conclusions

With the dramatically increasing coverage of mobile devices, the usage of mobile technology is gradually extending from phone call and SMS to more diverse fields such as disaster management. Even though mobile application is still smaller than some other nation-wide media in terms of people's interest, but it can serve as an alternative channel to catch the current situation, especially the current flooded-area situation. This study pays attention to the mobile applications during flood disaster focusing on 2011 Thailand Floods. A review of available mobile applications and interviews were conducted. The suggestion is provided for mobile application developers.

The study contributes to research by examining the information aspect of flood mobile application to understand the user's preference. As well as Voigt et al. (2007) found in earthquake disaster information system that showing monitoring information such as area and layer gave a better image and understanding; flood mobile application, one type of disaster information systems, also carries this characteristic of disaster information system. Getting the current situation by seeing the whole image seems to be the users' preference. Our findings offer insight to mobile application developers to understand the preference of the users in order to develop their flood mobile application according to the real interest. It is suggested that warning and flooded-area monitoring should be basic information in flood mobile application in order to make the application success with a high number of downloads.

This research must be interpreted in the view of the study's limitations. First, since we created the scope of mobile application to only applications developed for 2011 Thailand Floods, there may be some geographical, technological, or cultural specifications in this country and the findings may not generalize to others. Second, since we conducted interviews five months after the floods, we are still not quite sure that the interviewees were able to backtrack their mind to the flood situation period. Third, this study does not focus on some other possible factors that may affect the user's preference, such as developer of the application, the origin of source that the application retrieved data from, etc.

Also, we used number of downloads as the dependent variable to interpret the preference of user. It might be influenced by some other factors (e.g., promotion, advertisement).

There are several directions to extend for the future study. The aspect of mobile application developer and the origin of source (e.g., private organization, government agency), and the user interface visualization are necessary to focus in the future study. The future study may also include other variables such as rating or ranking. Moreover, the future study may investigate the scope of social media. In addition, it might be interesting to assess the data in other countries, those countries that encounter floods more and less frequently. Some insights might be found when we compare the preferable information between the high-flood-experienced people and low-flood-experienced people.

Acknowledgements

This research was supported by the Risk Solutions in Engineering Systems 2012 program of Tokyo Institute of Technology. The authors appreciate the useful comments from all reviewers. Also, we would like to thank Mr. Puhn Chaturaphit (EGCO Dev Team), 1st Lt. Yossapong Watcharakue (11th Infantry Regiment, Royal Thai Army), and all interviewees for their support and information.

References

Alexander, D. (2002). Principles of emergency planning and management. Oxford University Press, New York.

Assessment Capacities Project (ACAPS). (2011). Review of information needs after natural disaster – Key findings. Assessment Capacities Project, Geneva.

Aronica, G.T., Maisano, R. and Morey, N. (2010). Integrated WebGIS for flood risk management with mobile and GPS technology within open source system. In Proceedings of the International Symposium on Geo-information for Disaster Management 2010, Gi4DM 2010, Torino.

Caribbean Disaster Emergency Response Agency (CDERA). (2004). Disaster Information Kit for the Caribbean Media. CDERA, Barbados.

Centre for Research on the Epidemiology of Disaster (CRED). (2013). EM-DAT: The International Disaster Database. Retrieved January 2013, from http://www.emdat.net

Coppola, D.P. (2011). Introduction to International Disaster Management. 2nd Edition. Butterworth-Heinemann, Massachusetts.

Coyle, D. and Childs, M.B. (2005). The Role of Mobiles in Disasters and Emergencies. GSM Association, London.

DailyNews. (2012). 2011 Thailand Flood Special Edition (in Thai), SeePraya Publishing, Bangkok.

Disaster Information Management Research Center. (2012). Disaster apps and mobile optimized web pages. Retrieved January 2013, from http://sis.nlm.nih.gov/dimrc/disasterapps.html

Fajardo, J.T.B. and Oppus, C.M. (2010). A mobile disaster management system using the Android technology. WSEAS Transactions on Communications, 9 (6), 343-353.

Faulkner, B. (2001). Towards a framework for tourism disaster management. Tourism Management, 22 (2), 135-147.

Garg, R. and Telang, R. (2013). Inferring app demand from publicly available data. MIS Quarterly, Forthcoming.

Gartner. (n.d.). IT Glossary. M-Business (Mobile Business). Retrieved January 2013, from http://www.gartner.com/it-glossary/m-business-mobile-business/

Haddow, G.D., Bullock, J.A. and Coppola, D.P. (2011). Introduction of emergency management. 4th Edition. Butterworth-Heinemann, Massachusetts.

Hagemeier-Klose, M. and Wagner, K. (2009). Evaluation of flood hazard maps in print and web mapping services as information tools in flood risk communication. Natural Hazards and Earth System Sciences, 9 (2), 563-574.

International Telecommunications Union. (2010). ICT facts and figures: the world in 2010. International Telecommunications Union, Geneva.

Jalote, S. (2013). Indian police launch mobile app for emergencies. FutureGov. Retrieved January 2013, from http://www.futuregov.asia/articles/2013/jan/11/indian-police-launch-mobile-app-emergencies/

Jagtman, H.M. (2012). Design for safety: a new service for alarming and informing the population in case of emergency. In Proceedings of the Third International Engineering Systems Symposium 2012, CESUN 2012, Delft.

Madrigal, J. (2012). ReadyQLD: offering flood victims a mobile solution. Retrieved January 2013, from http://thinkmobile.appcelerator.com/blog/bid/202834/ReadyQLD-Offering-Flood-Victims-A-Mobile-Solution

MK. (2012). Interview EGCO Dev Team (in Thai). Blognone. Retrieved April 2013, from http://www.blognone.com/node/33346

Mobile Society Research Institute. (2012). Lessons from the Great East Japan Earthquake - What Mobile Phones can do in a Time of Disaster?. NTT Docomo, Tokyo.

Monares, Á., Ochoa, S.F., Pino, J.A., Herskovic, V. and Neyem, A. (2009). MobileMap: a collaborative application to support emergency situations in urban areas. In Proceedings of the 13th International Conference on Computer Supported Cooperative Work in Design 2009, pp. 432-437.

Morss, R.E., Wilhelmi, O.V., Downton, M.W. and Gruntfest, E. (2005). Flood risk, uncertainty, and scientific information for decision making: lessons from an interdisciplinary project. American Meteorological Society, 86 (11), 1593-1601.

Mylonopoulos, N.A. and Doukidis G.I. (2003). Introduction to the special issue: mobile business: technological pluralism, social assimilation, and growth. International Journal of Electronic Commerce, 8 (1), 5-22.

Puras, J.C. and Iglesias, C.A. (2009). Disasters2.0. application of Web2.0 technologies in emergency situations. In Proceedings of the 6th International Conference on Information Systems for Crisis Response and Management, ISCRAM 2009, Gothenburg.

Robert, V. (1994). Flood management: bradford paper. Disaster Prevention and Management, 3 (2), 44-60.

Shklovski, I., Palen, L. and Sutton, J. (2008). Finding community through information and communication technology during disaster events. In Proceedings of Computer Supported Cooperative Work 2008, pp. 127-136, San Diego, California.

Somprasong, T. (2011). Special Scoop (in Thai). ThaiWare. Retrieved April 2013, from http://news.thaiware.com/993.html

Souza, F. and Kushchu, I. (2005). Mobile disaster management system applications –current overview and future potential. In proceedings of the First European Mobile Government Conference 2005, pp. 455-466, Brighton.

The World Bank. (2012). Thai Flood 2011 Rapid Assessment for Resilient Recovery and Reconstruction Planning. The World Bank, Bangkok.

Usul, N. and Turan, B. (2006). Flood forecasting and analysis within the Ulus Basin, Turkey, using geographic information systems. Natural Hazards, 39 (2), 213-229.

Voigt, S., Kemper, T., Riedlinger, T., Kiefl, R., Scholte, K., and Mehl, H. (2007). Satellite image analysis for disaster and crisis-management support. IEEE Transactions on Geoscience and Remote Sensing, 45 (6), 1520-1528.

Whiteley, A., McCabe, M., Buoy, L., Howie, F., Klass, D., Latham, J., Bickley, M. and Luckeenarain, L. (1998). Planning the qualitative research interview. Working paper series (No. 15). Curtin University of Technology, Graduate School of Business, Perth.

Wurman, R.S., Leifer, L., Sume, D. and Whitehouse, K. (2001). Information anxiety 2. New Riders Publishers, New York.

Yang, Q. and Zhang, Q. (2007). Study on decision support system of flood disaster based on the overall process emergency management. In Proceedings of the International Conference on Wireless Communications, Networking and Mobile Computing 2007, pp. 6126-6129. Shanghai.

Zipf, A. and Leiner, R. (2004). Mobile Internet GIS based flood warning and information systems. In Proceedings of the Symposium on LBS and TeleCartography, pp. 197-203, Vienna.