Eliciting User Requirement for Flood Monitoring Application

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Abstract. Flood disaster is the most disastrous hydrological event that can lead to property destruction and loss of lives. One of the efforts to mitigate the impact is by providing an advance technology in monitoring and event alert. The flood monitoring application is developed to provide real-time weather forecast and disaster warnings. To increase disaster management efficiency, we conducted this research to identify the needs and requirements for a flood monitoring application. The study is mainly focusing on user perspective and preferences. The participant of this survey includes the authorities, non-government agency (NGO) and public. The participant is given a set of questionnaires containing thirteen questions, including the combination of open-ended and close-ended questions covering three sub-topics: user background, user experience, and user knowledge. List of important flood monitoring application features based on user requirements analysis and empathy map has been used to visualize user attitudes and behaviours.

1. Introduction
A flood is a catastrophic event, which is given extra concern since it compromises the lives, activity, and citizens' economy. The hydrological events are the one that contributes the most in the losses of life and cost of damage. A significant flood tragedy has caused infrastructure damage over billions, and the property has also lost a few thousand houses.

This study is conducted to identify the needs and requirement of a user for a flood monitoring application. This study aims to include the public in the emergency response which the public is going to be the first responder during the disaster happen and one of the practices that can include the contribution of the communities is by using social media input. This study aims to identify what features are suitable to be placed in a monitoring application and which of social media features are suitable to be used in a flood monitoring application.

The provision of a flood forecasting and warning application is an important, practical and low-cost measure to minimize flood losses. Flood forecasts given early will enable people living in flood-prone areas to be warned so that they can evacuate themselves and their belongings before the arrival of the flood [1]. It can considerably reduce flood loss and damage, and above all, the loss of human lives. A flood alert application supports data collection, analysis, monitor and warning [2]. The current flood monitoring application is built to give alert and warning on the flood event and ease the authorities' early response to the victims to reduce the impact. A different approach has been taken in developing the application include SAR-based monitoring application [3], Moderate-Resolution Imaging Spectroradiometer (MODIS)-based automated flood monitoring application [4], neuro-fuzzy controller-based flood monitoring application [2] many more.
In Malaysia, flood monitoring application is prepared by two government agencies which are from the National Disaster Management Agency (NADMA) and Department of Irrigation and Drainage (DID). These agencies are responsible for giving early warning on water level and heavy rainfall to publics and other authorities [5]. They have installed a telemetric forecasting application in the major river basins and Very High Frequency (VHF) flood forecasting applications in a smaller basin [1]. By 2007, real-time flood forecasting and warning applications in nine river basins have been installed [5][6]. The advance of the flood monitoring application technology in Malaysia has contributed a lot in mitigating the impact of flood disaster. However, it still has some deficiency that can be fixed to increase the efficiency of disaster management.

A sophisticated flood warning and evacuation application (FWESs) are alien to the public accustomed to traditional FWESs [5]. Unlike the UK government that notify the public when a flood is attacked through email or text messaging, Malaysia is still using a traditional media (news and radio broadcast) to disseminate alert and warning to the public. Furthermore, one of the weakness of flood disaster management in every country is their poor communication with local communities [7]. As local communities can be the first responder during the flood event, it is crucial to include them in emergency responses to reduce the impact and losses.

2. Methodology

2.1. Participants

A sampling method recruited various background of the participant with age from 18 – 60 years old. To ensure the results are reliable, the participant involves authorities, non-government organizations (NGOs), and public.

| Category | Percentage |
|----------|------------|
| Publics  | 91.7%      |
| Authorities | 4.2%    |
| NGO      | 4.2%       |

There are a total of 24 participants take part in this survey. As shown in Table 1, 91.7% of the participant is from the local communities, and 4.2% are from the authorities and NGO, respectively. As this study is focused more on the local communities' contribution, it will be enough responses to generate a convincing result. Table 2 shows that the range of participant ages is mostly from 31-60 years old, which is mature enough and aware of the situation of the flood event.

| Age                  | Percentage |
|----------------------|------------|
| 31-60 years old      | 58.3%      |
| 18-30 years old      | 37.5%      |
| 60 years old and above | 4.2%       |

2.2. Procedure

A questionnaire generated consists of thirteen questions covering three subtopics: user basic information, user experience, and user knowledge. It was conducted using the netnography method [8], an online research method to reduce direct interaction during this COVID-19 pandemic attack. This study relied on qualitative analysis to obtain a more in-depth understanding of the user group's needs. For example, a participant is given a different design of an application interface and asked to choose his/her favourite designs and state the reason for their choices. This study of user preferences is focused on designing the application that can be accepted by communities and are easy to interact with. It does
not compliment to design the interface of the hardware. As there was no high-fidelity prototype exist, it might somehow rely on user imagination and experience.

Firstly, the participant is being told and explained the background of the study and the use of the application. The user is being given a situation where the scenario is like when a flood event occurs, and this application will give an alert or warning to the communities through text-messaging and to get more information on the current situation, the user needs to get access to the application. User can get information on the dangerous place, current weather on every region and warning on the heavy rainfall. The application will also be integrated with social media data that enable the user to update situational awareness on that place. This survey requires 10 to 15 minutes for a user to complete.

3. Results

3.1. Flood Monitoring Primary Usage
This question designated to identify what the primary usage of flood monitoring application among the community is. It allows us to focus on the main purpose of designing the application.

| What do you primarily use flood monitoring application for? | To get prepared for the flood event | 70.8% | To disseminate warning to the public | 8.3% |
|-----------------------------------------------------------|-----------------------------------|-------|-------------------------------------|------|
| Monitor flood event in your area                           | 16.7%                             |       | All the above                        | 4.2% |

As shown in Table 3, most users choose to use the application as an alert for them to get prepared on any event that might happen. Based on this, we can say that this application is suitable for the preparedness phase, which allows the public to be prepared in terms of evacuation or property protection. It will also enable the authorities and NGOs to give immediate emergency responses and prepare the evacuation centre.

3.2. Importance of Flood Monitoring Application
This question enables us to include the information related to the preferred importance to make the application more informative and reliable.

| In your opinion, what are the importance of flood monitoring application? | Event alert/warning | 62.5% | General information | 0% |
|------------------------------------------------------------------------|---------------------|-------|---------------------|----|
| Situational awareness                                                  | 33.3%               |       | All the above       | 4.2% |

Table 4 shows that most users agree that the flood monitoring application is essential in providing alert or warning. It is another reason that can be considered as evidence which proves that flood monitoring application is suitable to be used in the preparedness phase of the flood disaster management.

3.3. Features of Flood Monitoring Application
This finding allows us to identify which of the features is suitable to be placed in a flood monitoring application. In this question, participant is allowed to choose more than one answer. The list of the features is according to the current flood monitoring application in Malaysia and overseas.

Table 5 shows the three most chosen features are alert/warning, emergency contact information, and current weather. The percentage for alert/warning and emergency contact is the same with 83.3%, which shows that these two features have the same level of importance during the flood event according to the user perspective. As part of this research's objectives, we include social media features in the survey to identify which of their features is suitable to be used in the monitoring application.
Table 5. Features of Flood Monitoring Application

| What features should a flood monitoring application have? | Alert/warning | Maps | Annual flood report |
|---------------------------------------------------------|---------------|------|---------------------|
| Emergency contact information                          | 83.3%         | 41.7%| 50%                 |
| Current weather                                        | 70.8%         | 37.5%|                     |
| Time and Date                                          | 62.5%         | 29.2%|                     |

Table 6. Social Media Features

| If a monitoring application is equipped with information obtained from social media such as Facebook and Twitter, what information should be displayed in the monitoring application? | Location of the post shared | Main topics discuss in social media | Average post shared |
|------------------------------------------------------------------------------------------------|----------------------------|------------------------------------|---------------------|
| Location of the post shared                                                                     | 86.4%                      | 40.9%                              |
| Content of the post                                                                            | 81.8%                      | 18.2%                              |
| Time and Date of the post                                                                     | 59.1%                      |                                    |

The four main features of social media are geo-location (location), network propagation (user), temporal pattern (time) and content [9]. According to Table 6 above, most participants believe that location is the most convenient feature to be placed in the flood monitoring application, followed by content and time stamped. It might be due to the information that it could provide to give information on where the event occurs, what is happening and when it happens.

4. Discussion

Flood disaster is known to be the most devastating event worldwide [10]. A flood monitoring application is said to be one of the efforts in mitigating the impact. However, it still needs an enhancement to provide a reliable medium to help the public and authorities handle the situation. This study was undertaken to understands the user preferences and requirement on accessing a flood monitoring application which leads to insights into a user-friendly applications interface and interaction where it also can be applied to other monitoring application.

Flood disaster management comprises detection, forecasting, and warning components for which various decision-making criteria will be promoted by the interest groups [11]. As the user requires an application that could assist them in preparing themselves to face the flood event, it is compulsory to have a warning or an alert such as heavy rainfall, increasing seawater level or rainstorm in the application to take an immediate action to handle the situation.

The features of an application are something that we should consider as an essential structure in a monitoring application. Event alert/warning is chosen as the main features of a monitoring application, followed by emergency contact and current weather. It is the features that allow the user to give an immediate response to mitigate the effect of the flood disaster. Furthermore, social media is one of the platforms that providing a feature that provides situational awareness. Majority of the user agreed that location is the most important information in disaster management, followed by content and time stamp. The geo-location provided by the social media platform could alert the people nearby to become cautious or prepared and be the first responder to the people asking for help.

An empathy map is a map that used to understand and prioritize user needs [12]. It is widely used throughout agile and design communities to externalizes knowledge about the user. For this research, a multiple-user empathy map is developed to emphasize user needs. From Figure 1 above, we can conclude that safety is the most significant need of the user. Based on the Abraham Maslow’s hierarchy needs [13], the empathy map shows that most users tend to use the application as the safety needs as they believe it could help them prepare themselves before the disaster strikes. They keep comparing several flood monitoring applications which shows that they wanted to find an application that they can use quickly and understand it straight away. In sum, user requirement and preferences are not the primary references for developing an application, but it will be the main guidance to develop an application that is user-friendly and interactive.
The research study has successfully highlighted the requirement and needs for the monitoring application based on user preferences which answer the objective of this research to identify the needs and requirements of a user for a flood monitoring application.

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