Lesson Learned Center for Disaster Prevention and Management

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Abstract The aim of this work is to develop a Lesson Learned Center (LLC) to help the government agency preserve the valuable first-hand experiences gained from each disaster. This system can provide critical and timely information during or just before a disaster to those who need the information, such as decision-makers, engineers and local leaders in potential disaster areas. The LLC can also provide ideal teaching material to train students or young engineers. To achieve this aim, three major tasks were included in the development of the LLC: (1) data collection, (2) data organization, and (3) system implementation. We focused on the serious disasters in Taiwan over the past 15 years, which includes 25 floods, 3 droughts and 8 other events. For each disaster, we collected weather information, causes of the disaster, details of the disaster response, newss reports, and other critical information related to the disasters. We also interviewed the officers, engineers and residents affected by the disaster to study the impact of the disasters from varied observation angles. We then organized the information using templates developed in this research. The templates help to ensure the completeness of reports and also help to organize the information well. The final step was the implementation of the LLC system. To maximize the portability of the system, we adopted the HTML5 standard, a standard protocol commonly used throughout the Internet. We modularized the contents and develop a flexible layout. For each disaster, we provide a default layout, which helps users obtain an overall picture of the disaster. They can change the layout interactively and can easily browse through the detailed content. The LLC system is nearly complete. We plan to test the system in the Water Resources Agency of Taiwan to verify its us1ability.

Keywords. Disaster Prevention Decision, Experiential Learning, Usability

1. Introduction

Taiwan, affected by the natural force and human factors, is evaluated one of the most dangerous places hit by natural disasters. Recently, the aquatic environment is influenced by the global climate shift, which has changed the rainfall patterns and enlarges the gap between rain season and dry season. Under this situation, natural disasters are harder to predict nowadays (National Research Council, 1994). Besides, preventing and rescuing for disasters have no standards to follow. In this research, we apply the "Lesson Learned" mechanism, a method for people to learn from past experience rather than any fixed rules (Smith, 2001). We keep collecting related data and turn it into valuable knowledge for handling the coming disasters. We study events with their valuable reference and operating approaches in order to facilitate the efficiency of rescuing and the judgment how operating staffs made immediate decisions in that time. The meaning of "Lesson Learned" is not only for operating the relief efforts today, but also for affecting the attitude toward what might occur in the future. "Lesson Learned" is the main force for progress and innovation continuously.

It is essential for the Water Resource Agent (WRA), the organization that guides the water resource of Taiwan, to reference the past experience by analyzing and reflecting previous events, further more, to adopt related law and to develop the working procedure for reducing any possible damages in the future.

2. Background

In the last few decades, there has been a dramatic increase in the number of publications on decision support system, which provided suitable information for decision makers (Alter, 1980; Sprague and Carlson, 1982; Silver, 1991; Finlay, 1994; Turban, 1995; Power, 1997; Marakas, 1999; Power, 2002; Gachet, 2004). The use of decision support system in disaster prevention has increasingly been the object of study in recent years (Abebe and Price, 2005). One of the most import information for disaster prevention in decision support system is the experiential data. In this research, we focus on build the experiential data as a Lesson Learned Center with suitable interface.

Recently, advanced countries have put amount of efforts in setting the Lesson Learned Center (LLC) to make previous experience recordable, sharable and analyzable for related organizations to set the rules. Take the Wild-land Fire Lessons Learned Center (http://wildfirelessons.net/Home.aspx) in the U.S.A. for example. The web-based WFLLC presents plentiful multimedia resource and up-to-date information about related conference and seminar (Fig. 1).

Fig. 1 Wildfire Lesson Learned Center

In Taiwan, we already have an LLC system for natural disasters, which focus on collecting separated data and classifying them into reasonable categories. In general, each event belongs to Flood, Drought or Water Resource Related event, and under each category, there are seven items describing the specific details about an event. Based on the resourceful data of the old LLC website, our research puts more energy on learning efficiency for people to gain related information. To build up a suitable learning environment for users, we focus on designing an easy-to-learn interface, and try to solve the following problems:

a) Unfriendly user interface.
b) The information transmitting is not direct enough.
c) Lack of conclusive key points.
d) Lack of mechanism to compare among different events.

3. Methodology

3.1 Improving the interface by enhancing the usability

Under the promotion of usability (Jakob, 2003) in several fields, the user interface has become an important part in software design. User interface (UI), as the part of a system on the front line to face users, needs to transfer information efficiently and to bring wonderful experience for users. In order to strengthen the influence of UI, our research targets to improve the following five points of usability:

a) Learnability: How easy is it for users to accomplish basic tasks the first time encounter the design?
b) Memorability: When users return to the design after a period of not using it, how easily can they reestablish proficiency?
c) Efficiency: Once users have learned the design, how quickly can they perform the task?
d) Error: How many errors do users make, how severe are these errors, and how easily can they recover from the errors?
e) Satisfaction: How pleasant is it to use the design?

To increase the Learnability and Efficiency, first, we made LLC's layout easy-to-read by using bright colors to guide users the hierarchy of information. For example, the left side of the LLC

system is for search, thus, its color must be different from the right side, an area for displaying information (Fig. 2).

Secondly, each event has its own webpage with seven items, so users will know the outline he needs to learn in the beginning. After gaining a general view, users will keep his/her own exploring blueprint in mind, and then look at the details presented in each item.

Fig. 2 Basic layout of LLC system

Besides, the dynamic layout enhances the Memorability in remembering the skill to use and to remember the content in LLC, since users are able to modify the layout by changing the relative location of each item. According to the theory in psychology, short-term memory can become long-term memory when there are meaningful associations between them (Najjar, 1998), the flexibility our layout system provided allows users to explore the relationship of each items, and then remember them as they move and review the items in common together. Furthermore, users can mark each item with red and yellow as a reminder for them to recall information (Edward, 2004).

Figure 3. Steps to move an item (From left to right)

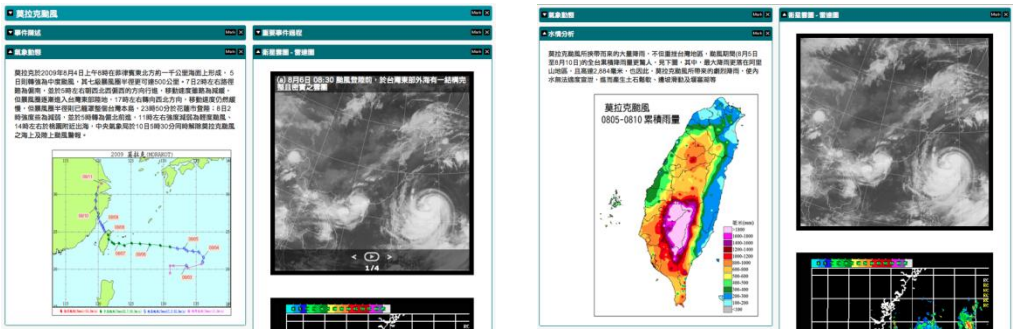

Fig. 4 Typhoon's path and map of clouds (Left); accumulated rainfall and map of clouds (Right)

To reduce the possibility of making mistakes, our LLC system simplifies the UI for users from being confused. Starting from searching the LLC website, there is a search bar up on the left column, supported by the Google Customer Search Engine, users are allowed to type in any keywords they want to search. Under the Google search bar, there are several indexes that contain the same set of events. Users might search the event by the type of disaster, or by the year it

occurred and so on. After an event is chosen, the hierarchy of its data is no deeper than two levels, event if users explore to the second level, there is a clear guide to go back to the first level.

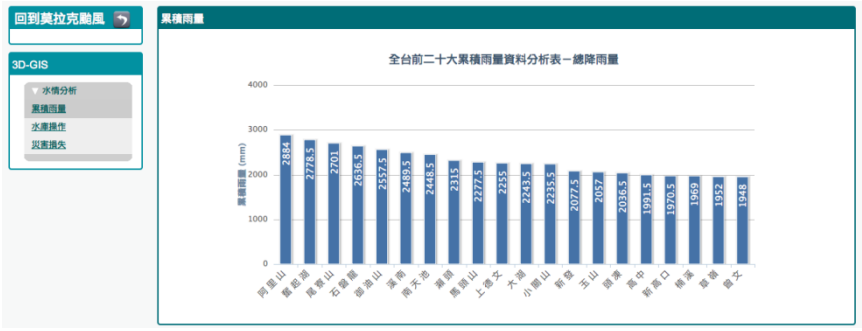

Fig. 5 Data visualization. Rainfall of each rain station

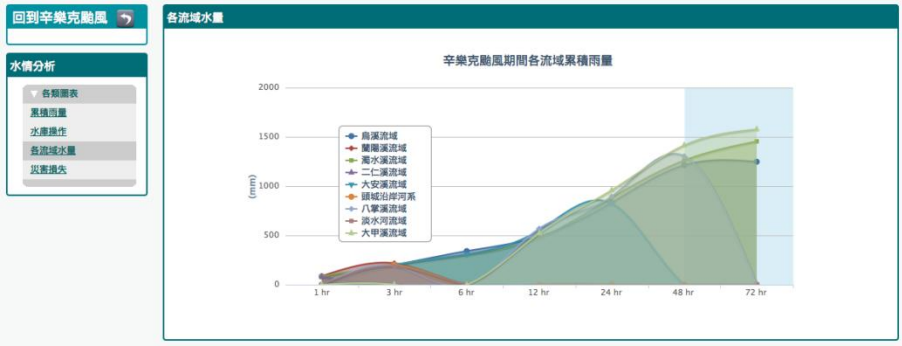

Fig. 6 Data Visualization. Accumulated rainfall in different river basins.

The efforts on keeping the LLC efficient, and the transformation from text to diagram via data visualization deliver a new experience in information receiving. Users are happy to manipulate the dynamic items and gain the impressive feedback from LLC. This interactive communication is different from traditional one-way information transmission, and brings more happiness to satisfy our users.

3.2 Presenting data via multimedia

In our LLC system, each event has its own data set, including the text, pictures, video, dynamic table, and chart diagram. Those media can supplement each other and provides a more lively interaction between users and the LLC system.

Take the accumulated rainfall in river basins for example, in our research, we transfer the quantified data in traditional table into dynamic JavaScript display modules (Fig. 6), users can realize the relationship between each river and can tell the difference in the first glance. Besides, we interviewed the operating staff in some events, and recorded their talk in video and audio format.

3.3 Delivering the "Key Report" for each event

Thanks to previous work in LLC, the data is plentiful to cover most rescuing and operating situations, however, under some urgent conditions, it is not efficient, and that's what motivated us to develop a "Key Report" for each event. Edited by experts in Taiwan Typhoon and Flood Research Institute, the "Key Report" is the most critical part of an event, concentrated in 3 to 5 PowerPoint slide (Fig. 7), users can watch it online in each event's page and also download to their PC for further study and presentation.

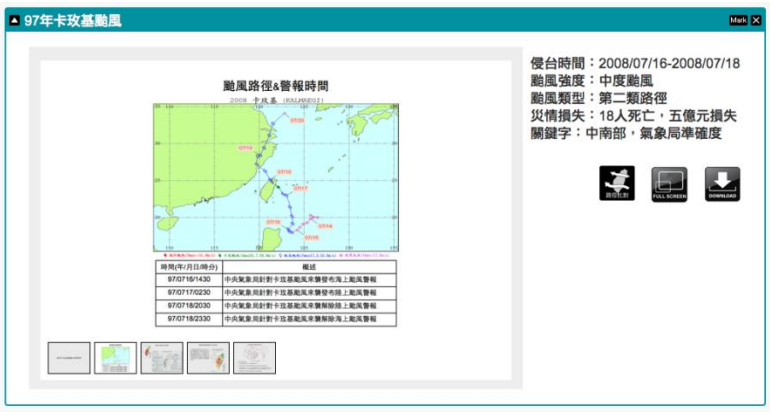

Fig. 7 Key report

3.4 Using dynamic relationship graphics for each typhoon

"Looking for similarity in difference" is useful for categorizing varied events in LLC system. Our research provides dynamic module for users to compare the path of each typhoon (Fig. 8). According to Central Weather Bureau in Taiwan, the path can be classified into 10 types. Two typhoons with the same type of path might have some common attributes like the disaster area, the accumulated rainfalls. Theses data is critical to prevent typhoons and for further study.

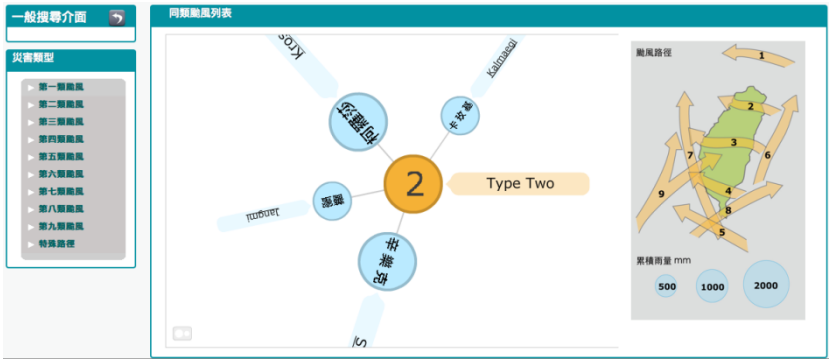

Fig. 8 Typhoon path and their relationship

4. VERIFY

To begin with, our research targets the operating staffs in WRA, who deal with natural disasters on the front line. We have several interviews with them. During the early period of the interview, we discussed more on the functions they need in learning each event, include the multimedia presented information and the relationship between each typhoon. According to their viewpoint, what important is the experience from previous operating workers rather then the event itself, thus, we gathered materials from chiefs to the base crew of disaster preventing units, and we recorded their talk in video and audio format, then delivered those materials with its feedback and comments to the Taiwan Typhoon and Flood Research Institute (TTFRI), an organization that collects and analyzes previous disasters and predicts possible disasters in the future. The TTFRI then edited and cut the video to 3-5 minutes long films for us to upload in our LLC website.

During the late period of the interview, we tried to simplify the presented data and the UI, to achieve this goal, we did (1) reduced the amount of text description in LLC website, since diagram and tables are far more sensible for users, we tried to visualize the text data to increase learning efficiency and minimize the words to keep our user from getting bored by the large amount of words. As for users who want to do further research in each event, we (2) had the raw data, the original reports with 7 items edited by the TTFRI, for users to download. To simplify the UI, we (3) maintained information (except for the 3d GIS (James, 1999) and the dynamic data visualization tables) in the same level in order to provide a clear guide for user to explore our LLC website.

After several discussions, finally, we regarded our website as an open platform to everyone, which means that the public can access to the LLC to know the basic information of each typhoon, and the students can also download the key reports or original data for their research or assignment. To conclude, the interface and the way to present are determined by a serial of discussions, our LLC system is a multidiscipline teamwork with professions in varied fields.

5. CONCLUSION

In this paper, we focus on improving the learning efficiency in the LLC system by designing appropriate user interface for operating staff in WRA. Based on previous research with its plentiful data resource, we try to keep information concise and user-friendly for people to reach. According to the five principles of "Usability", we enhance the Learnability and Efficiency by a clear layout, besides, to increase the Memorability, we apply dynamic layout for users to suit their need. For reducing mistakes, we verify the types of index to search specific events and to keep the hierarchy of our LLC only in 2 levels. All principles mentioned above attribute the Satisfaction of users.

Besides, we apply data visualization to impress our users and to guide them the relationship among different data directly. Also, to highline the relationship among each typhoon, we classify them into 10 types, and provide relation module to compare their similarity and difference. In addition, The Key Report provides a fast and concise approach to know an event.

All in all, there is no fixed principles to handle disasters, thus, we need the LLC system with plentiful related experience to support future acts. To improve the efficiency in learning, our research focuses on designing the user interface to match the 5 principles of Usability.

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