QUALITATIVE DISASTER INFORMATION DELIVERY THROUGH CLOUD TECHNOLOGY

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Abstract

When responding to a disaster, a disaster prevention unit in Taiwan must compile and analyze real-time precipitation and disaster information from different locations immediately to make timely response decisions. These data are mostly presented in reports in PowerPoint format and delivered in hard-copy print-outs. Producing PowerPoint presentations and printing reports consumes a massive amount of time, and therefore it is difficult to update and deliver the latest disaster information. This reduces the speed and accuracy of disaster-related data, thus hampering the efficiency of disaster-response decisions. To solve this lack of real-time data, this study develops a qualitative disaster information delivery system, called Disaster Show, or D-Show for short. We first attempted to digitalize paper documents and develop D-Show (Alpha) through an existing internet photo album application. D-Show was introduced to real disaster-response operations in 2010 and solved the data synchronization problem. After four years of actual disaster-prevention experience, however, we found that D-Show (Alpha) retains issues in the three

aspects of management, presentation, and operation. Thus, we further develop D-Show (Beta) by adopting cloud technology. In management, D-Show (Beta) provides a system with a faster deployment mechanism that largely reduces the time required for initial settings and follow-up updates to the system, and the structuralized data naming principle increases the convenience of managing data. In presentation, D-Show (Beta) can sequence and identify disaster-related data, allowing this data to be presented more intuitively. In operation, D-Show (Beta) allows a user to perform customized disaster-related data marking and exploration for disaster-response decisions, judgment, and analysis. The research team conducted field testing in 2015 to verify D-Show (Beta). In the annual D-Show update, each device takes only 3 minutes to update, which is 70% less time than D-Show (Alpha). During Typhoon Noul in 2015, D-Show (Beta) took only 2 minutes to file 150 briefing reports (in PowerPoint format), saving 98% of the filing time.

Keywords: disaster-response decision making, disaster data/information, delivery system, customization

1. BACKGROUND AND MOTIVATION

Disaster protection and prevention is a clear and present issue for Taiwan, which sits in South East Asia where typhoons are frequent and inevitable. When facing critical water issues, decision makers require systematic and ample relevant information as a reference for making decisions (Finlay, 1989) (National Research Council, 1994). When natural disasters take place, a disaster-prevention unit must closely monitor the precipitation volume, disaster situation, and response status all over Taiwan.

In delivering multilingual disaster information, Hasegawa et al. shows that graphic text is a useful tool (Hasegawa et al., 2005). The information that must be processed includes quantitative data presented in standardized tables (such as precipitation volume, flood levels, etc.) (Sung et al., 2014) (Sunga et al., 2015) and qualitative information that cannot be presented in standardized tables (such as maps showing distribution of precipitation volume, maps of potential routes, etc.). Currently, briefing reports in the PowerPoint format are the chosen way of sorting and presenting both kinds of information (Power, 1997). In order to increase readability on screens. Hasegawa et al. have an experiment to determine the most legible size for characters (Hasegawa et al., 2009) (Hasegawa et al., 2008) on mobile terminals, and Fujikake et al focused on car navigation systems (Fujikake et al., 2007). During a disaster response, the most important challenge is

immediately delivering accurate information to each decision-making unit (Tsai et al., 2013).

Here, we use the disaster-response operations of the Water Resource Agency of the Ministry of Economic Affairs as an example. When the Central Weather Bureau issues a sea warning for a typhoon, the decision-support team must hold a response meeting every six hours and this meeting requires quantitative and qualitative information to study and judge, as well as pre-warning information. In the past, staff members have compiled data and produced briefing reports in PowerPoint and in print-outs, which are submitted to their supervisors to review and approve and are then submitted to decision-making officers after verifying the accuracy of the content. Should there be new information, staff members would need to revise the briefing reports and print-outs and repeat the whole process. However, in practice, weather and disaster statuses cannot be predicted and thus revisions were required repeatedly. Aside from consuming massive amounts of time in revising and repeating briefing reports, delivering the print-outs was also a crucial impediment to efficiency. Print-out delivery not only resulted in inefficiency in delivering data, it was also prone to synchronization problems between versions. Because of these problems, the process of producing a briefing report would take up to four hours to finalize.

Supervisors normally set the deadline for the briefing report at one hour before the meeting started, so the briefing could not provide instantaneous data for decision making. Thus, in the decision-making meetings decision-making officers often discussed data that was not up-to-date and not coherent, owing to the time-consuming data delivery and unsynchronized versions of reports. However, disaster-response meetings require immediate and correct information.

2. QUALITATIVE DISASTER INFORMATION DELIVERY SYSTEM

This study developed a qualitative disaster information delivery system, called D-Show (short for “Disaster Show”), for use by high-ranking officers in the Water Resource Agency. The D-Show prototype (Alpha) changed the delivery of briefing reports from paper print-outs to digital images, achieving paperless briefing and solving issues of time and accuracy. In order to further enhance briefing image management efficiency, this study adopted a database module and produced D-Show (Beta) in 2014. From 2010 until now, delivery of briefing reports developed through three stages: paper print-outs, digital images, and a database. Table 1 shows an initial comparison of these three stages.

Table 1: Comparison of briefing report delivery methods

Delivery Method	Print-Out	Digital Image	Database
Time for report production and delivery	4 hours	1 hour	1 hour
Difficulty in delivery	Difficult	Easy	Easy
Accuracy	Low (difficult to revise)	More accurate (easier to revise)	More accurate (easier to revise)
Speed	Low (data created 4 hours before meeting)	Fast (data created 1 hour before meeting)	Fast (data created 1 hour before meeting)
Archiving and application of reports history	-	Better (with reports history file folder)	Better (with reports history file folder)

2.1. D-Show (Alpha) Problems

To solve the information-timing problem and the synchronization problem between the latest version and the version the decision makers had on hand, this study first attempted to change paper documents to digital documents by converting the PowerPoint briefing file to a digital image file and sending it to the mobile devices of decision-making officers through an existing Internet photo album application. By doing so, staff members need only a very short time to convert the PowerPoint file into an image file when finished with the briefing report before uploading it to the Internet album space, and decision makers would all receive the latest version of the report at the same time. Should there be any changes in the report, staff members only need to upload the revised file and notify supervisors with a text message, and the supervisors would receive the latest information. By changing paper documents to digital documents, the problems of information timing and version inconsistency were resolved. Compared to the four hours needed for completing briefing print-outs and submitting them to supervisors, the entire process with digital documents could be completed within half an hour.

Although the digital workflow resolved the information timing and synchronization problems, there remained three major issues in the delivery of disaster information. These three issues included management, presentation, and operation.

2.1.1. Management Problems

The original Internet photo album used one Internet account to manage multiple photo albums. This process treated each page of the briefing report as one image and each briefing report as one album. There could only be two layers in the data structural level and thus one single Internet account could only store the same type of briefing reports. In actual disaster-response operations, however, different types

of briefing reports are required and therefore multiple Internet photo album accounts were needed to sort through the various types of briefing reports.

Figure 1 shows the interface of this system. On the left of the figure, there are at least four public file folders and six specific file folders; this means that there are at least ten internet photo album accounts. When there is demand for a public file folder or a customized file folder, new accounts need to be set up. Thus, even though the system satisfies the data sorting requirement, each mobile device would need to connect to the new account manually. Whenever a new account was set up, it was difficult to update all the mobile devices within a short period of time, which caused difficulties in management. This further extended into three management issues: the time for setting up an account was too long, the method of setting up an account was too complicated, and data management was inconvenient.

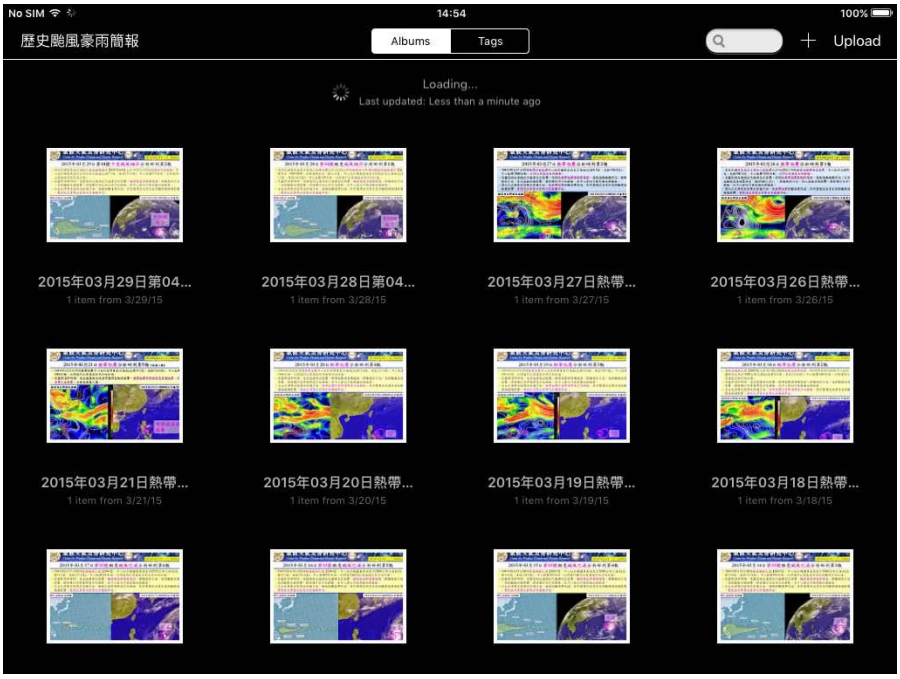
Figure 1: Prototype interface of the D-Show qualitative disaster information delivery system

2.1.2. Presentation Problems

In the original Internet photo album, there were only two layers in the structure, the album and the photos. A sequence of data could only be sorted by the time of upload and the thumbnail only showed the first photo of the album. With these features, the original Internet photo album had three problems in presentation: the

quantity in the file folder layer was too small, file folder sequencing was insufficient, and identification of file folders was poor (as shown in Figure 2).

Figure 2: Report presentation interface of the D-Show prototype.



2.1.3. Operation Problems

Users of the original Internet photo album were only authorized to examine the data and were not allowed to make notes or request for the files to be categorized based on actual needs. In addition, each and every Internet photo album account could not be updated all at once. The above issues caused three operation problems: no personalized preference function, no ability to mark errors in the data, and difficulty in updating the data.

2.2. Research and Development of D-Show (Beta)

Since it was launched in 2010, D-Show (Alpha) has gone through four years of actual application in disaster prevention and demonstrated its usefulness in delivering qualitative disaster information. Although D-Show (Alpha) possesses the advantages of providing instant and consistent information, the current system still has three major problems to be resolved: management, presentation, and operation. In order to make information easier to share and manage throughout this system, this study decided to adopt Cloud Space as the foundation for development of the new system. We compared three current cloud services that

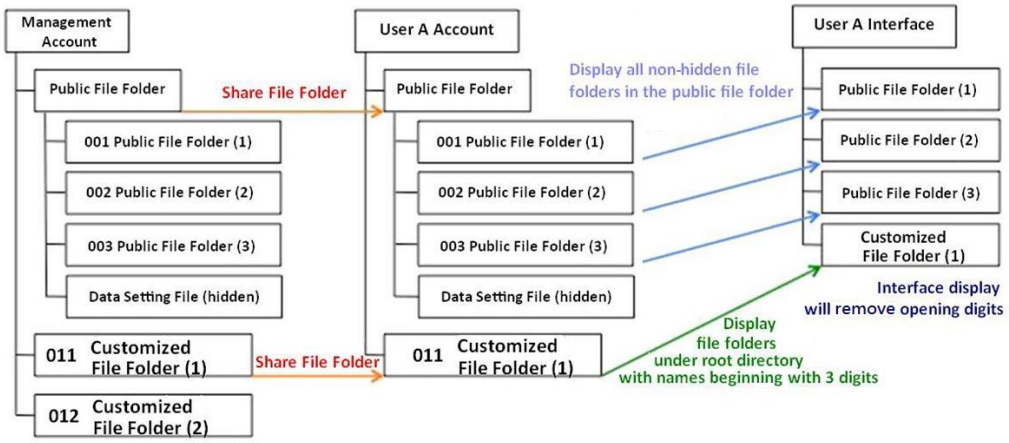
were more common on the market: Picasa, Google Drive, and Dropbox. Table 2 compares these three cloud services, including the available space, convenience in data connection, convenience in file management, and expanded capacity. After assessing these factors, we finally chose Dropbox, which best suited the new system's requirements, as the development base.

Table 2: Comparison of cloud services

Cloud Space	Picasa	Google Drive	Dropbox
Size of Space	Insufficient (2 GB)	Sufficient	Sufficient
Data Connection Difficulty	Medium	Medium	Easier (Complete API)
File Management Difficulty	Difficult (difficult in adding and deleting data)	Easier	Easier (regular file operation method)
Expanded Capacity	Lower (for images only)	Better	Better (includes regular file formats)
General Rating	General	Good	Excellent

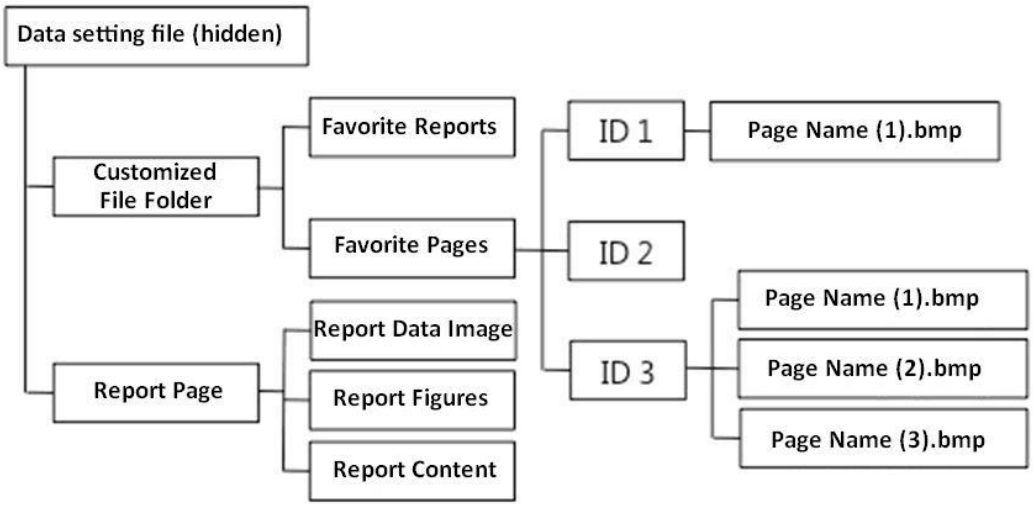
To reduce development costs, all data were stored in the Dropbox cloud space and the public file folder was used to manage users' authorizations. File folders are divided by "public file folder" and "customized file folder". Information in the public file folder is available to and shared by all users. Inside the public file folder is a hidden folder that stores setting information, including bookmarked favorite pages and briefings and reports. The customized file folder is managed by the management account and is shared only with authorized users. The user interface shows all the file folders within the "public file folder" (except for the hidden folder with setting information), and file folders under the root directory with names beginning with three digits; the three digits will be taken out when the folders are displayed. The file folder structure of D-Show (Beta) is shown in Figure 4.

Figure 3: D-Show (Beta) file folder structure.



The setting file folder stores favorite briefing report files and pages as selected by users and report pages and other information. When a briefing report file is selected, the system will set up a blank BMP file with the file name under the briefing report (page) for storing the system information. Figure 4 shows the structure of the D-Show (Beta) customized folder and report page.

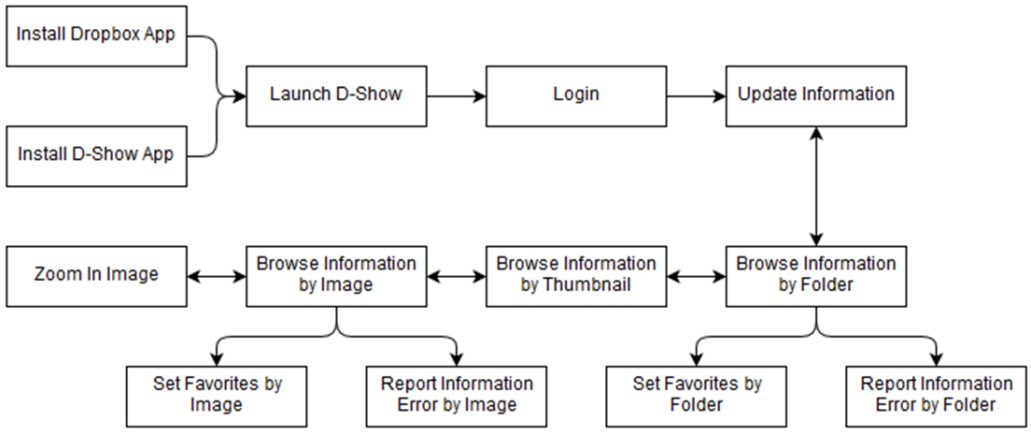
Figure 4: D-Show (Beta) file folder structure



For browsing of the disaster briefing file to be smoother and more convenient, our team interviewed professional disaster-prevention personnel to compile relevant demands on management, presentation, and operation, based on their experience

in browsing with D-Show (Alpha). We found that the existing official Dropbox application function could not satisfy their demands in disaster prevention. Thus, this study adopted Dropbox API, using Xcode to develop D-Show (Beta), which was iOS7 compatible. Since D-Show had already accumulated over 2000 briefing reports, our team undertook research into the insufficiency of D-Show (Alpha) in order to develop D-Show (Beta) to be more fit for the needs of users. For example, we corrected the problem of it being unable to show the full-length file name when the file name was too long; provided a larger preview thumbnail; adjusted file-access authorization based on the user account; expedited the transmission speed; simplified the file-management interface; adopted a single login account; and increased the file layers, etc. The user operation flow for D-Show (Beta) is displayed in Figure 5.

Figure 5: D-Show (Beta) user operation flow



This study developed D-Show (Beta) in 2014. On the management side, D-Show (Beta) largely reduced the operation time as it allowed the addition of a briefing report classification from the remote end; it also simplified the operation procedure by integrating multiple accounts into one single account. On the presentation side, D-Show (Beta) extends the dual-layer data structure concept of the photo album and allows file name lengths of up to 25 full-width characters, thus enhancing file classification and shortening search time. For operation, D-Show (Beta) allows users to choose their frequently used files and store files in the file folders they create. When users have a question regarding file information, they can report on file content directly in the interface as information feedback. In addition, D-Show (Beta) uses a single account to manage different mobile devices, saving a massive amount of labor in installation and maintenance. The following is a summary of the D-Show (Beta) system's effects on management, presentation, and operation.

2.2.1. Management

(i) Reduced account set-up time: the initial set-up requires connecting an account to Dropbox on the spot; later settings then can be done on the cloud. When briefing classification needs to be increased, the management account only needs to to share a file folder to the user account. There is no need for a user to be on the spot and the time required is also largely reduced.

(ii) Increased information management efficiency: there is no need to login to multiple accounts when uploading data. A user only needs to upload the data file to the management account by classification. This shortens the upload time on the management end.

(iii) Structuralized data management: this study set up a hidden numerical classification mode to classify different file folders and establish different user authorizations. Through this feature, a manager will be able to understand the connections between different users and their demand for a customized service. To prevent a situation in which information is mistakenly deleted, file deletion is limited to the management end only.

2.2.2. Presentation

(i) Effective classification and layering: by extending the dual-layer data structure concept of the photo album, the Dropbox file folder layer can be widely extended, which enhances briefing classification and shortens search time, which allows data that requires structuralizing (such as typhoon history briefing reports) to have a more suitable classification.

(ii) Personalized data sequencing: files can be sorted by file name, allowing a manager to control the sequencing and choose whether to sort by ascending or descending order to match with application needs.

(iii) Enhanced data identification: A user can choose either the file name or a thumbnail for the presentation. The interface shows a file name of up to 25 full-width characters (Figure 6, left side). Thumbnails are presented in three images per line to enable the user to understand the general content of the briefing report swiftly (Figure 6, right side).

Figure 6: D-Show (Beta) report presentation interface

2.2.3. Operation

(i) Customized briefing report file folder: the D-Show (Beta) system allows a user to select frequently used files based on demand and store files in the file folder he/she creates. The user is able to find the desired briefing report without repeatedly searching through file folders, which reduces time spent in searching.

(ii) Provides data marking feedback: when a user has doubts on the data provided, he/she can report or mark the data directly on the interface. The briefing report manager can then adjust or update the report based on the feedback.

(iii) Synchronized data updating: when qualitative disaster-prevention information is updated and uploaded from the management end, a user can update all the file folder contents on his/her mobile device without needing to update individual file folders. This makes data update and delivery more efficient.

3. VERIFICATION

To verify the feasibility of D-Show (Beta), this study conducted a comparison of update times between old and new D-Show versions during the annual D-Show update in the Water Resource Agency in 2015. On each mobile device, D-Show (Alpha) took 10 minutes to update as it needed to connect at least four accounts. D-Show (Beta) only needed to connect to one single account and thus the update took only around 3 minutes. The Water Resource Agency needs to update at least fifteen mobile devices each year, so the analysis showed that D-Show (Beta) could save over 105 minutes in maintenance time.

In addition, in order to learn the D-Show (Beta) application during actual disaster response, this study team was stationed in the Water Resource Agency between May 10th and 11th in 2015 during Typhoon Noul to conduct actual testing while

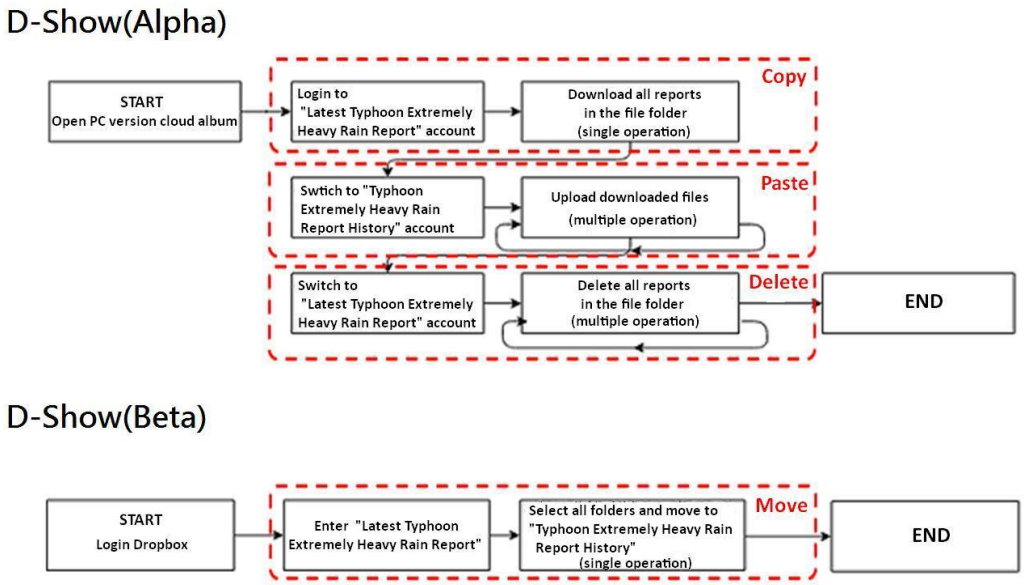
assisting in duties. In assisting the response duty, D-Show was mainly used to categorize “file reports” and “upload reports”; descriptions of this are as follows:

3.1. File Reports

When stationed in the Water Resource Agency, the “file reports” operation was to file old briefing reports into the “Typhoon Extremely Heavy Rain Briefing Reports History” file folder to ensure that officers read from D-Show only the reports related to the current event. There were over 150 reports to be filed during Typhoon Noul; D-Show (Alpha) took 2 hours and 45 minutes to finish filing whereas D-Show (Beta) only took 2 minutes, saving 98% of filing time.

Since D-Show (Beta) uses Dropbox as the platform and integrates all file folders into one single account, the manager is able to upload and update information in all file folders in one session and classifies reports to one individual file folder to reduce operation time. The filing procedures of the old and new versions of D-Show are shown in Figure 7. D-Show (Alpha)’s filing procedures are mainly the download stage (copy), upload stage (paste), and delete stage (delete). D-Show (Beta)’s filing procedure is simplified to the move stage (move). The “Move” function is the same as “copy, paste, delete”, but is much more simplified and therefore D-Show (Beta) greatly enhances filing efficiency. Take filing “Latest Typhoon Extremely Heavy Rain Report” to “Typhoon Extremely Heavy Rain Report History” for example; when a manager enters “Latest Typhoon Extremely Heavy Rain Report” and selects all briefing reports, he/she can use the “move” command to transfer all reports to “Typhoon Extremely Heavy Rain Report History” directly, and the whole procedure takes no more than 5 minutes. As the new version of D-Show does not need to download, upload, and delete reports, the operation time is not affected by the number of reports and thus the time needed to file the briefing reports is largely reduced. If the manager accidently deletes a report during operation, then Dropbox has a restore mechanism to recover the deleted report, making data safety even more complete.

Figure 7: Filing flow chart for new and old versions of D-Show



3.2. Upload Reports

In the response event, “upload reports” is used to upload related briefing reports to the corresponding file folder within the set schedule for a decision-support meeting and a work meeting to review and report. When assisting duty during Typhoon Noul, this study team made seven uploads with a total of 36 briefing reports; among those, twelve reports were uploaded to “Latest Typhoon Extremely Heavy Rain Report” and the remaining 24 reports were uploaded to “Central Emergency Operation Center”.

There is only a slight difference in upload reporting between the new and old versions of D-Show. However, D-Show (Beta) possesses two advantages with “no need to renumber the file name” and “no need to switch album account”.

3.3. Comparison of New and Old D-Show Versions

Based on the analysis made during Typhoon Noul in 2015, when assisting duty at the Water Resource Agency, this study conducted comparisons of management, presentation, and operation between the new and old versions of D-Show. We found D-Show (Beta) to be more time-efficient and convenient in management, providing sufficient and clear display in presentations, and allowing users to provide marking and feedback. Table 3 shows D-Show New and Old Version Comparison.

Table 3: D-Show New and Old Version Comparison

Item		D-Show (Alpha)	D-Show (Beta)
1. Management	1). Time needed for setting up an account	Time consuming (10 minutes for each mobile device)	Time saving (2 minutes for each mobile device)
	2). Method of setting up an account	Complicated (on the spot setting are required for both initial setting and follow-up management)	Simple (initial setting requires to be on the spot; follow-up management can be operated from remote end)
	3). Data management	Inconvenient (internet photo album, single file folder)	Convenient (regular computer files, multiple file folders)
2. Presentation	1). Number of file folder layers	Insufficient (only 2 layers)	Sufficient (more than 10 layers)
	2). File folder sequencing	Default only (only allows sequencing by upload time)	Accept setting (sequencing can be done by file name, date, etc. demands)
	3). File identification	Not clear (shows only the first page thumbnail)	Clear (could choose from text or thumbnail description)
3. Operation	1). Personalize preference marking	No	Yes
	2). Error data marking	No	Yes
	3). Data update	Complicated (each individual file folder requires individual scroll down update)	Simple (synchronize update all file folders with one scroll down update)

4. CONCLUSION

To improve on the problems of printing out and delivery of paper briefing reports and hindrances during disaster response, this study developed a prototype qualitative disaster-information delivery system called D-Show in 2010. In 2014, we developed a new version of the D-Show system to resolve problems in management, presentation, and operation. On the management side, the new version of D-Show is able to add report classifications from the remote end, which

massively reduces operation time. It also integrates multiple accounts into one single account to simplify the operation procedure. In presentation, the new version of D-Show extends the dual-layer data structure concept and allows a flexible file name length of over 25 full-width characters, which enhances report classification and shortens search time. In operation, the new version of D-Show allows users to choose frequently used files and store files in their own file folders. It also provides users with a channel for feedback on the report content for timely updating of data and mutual feedback.

The study conducted practical application testing in 2015 and concluded that the new system saved 70% of update time for each device during the annual D-Show update. In the Typhoon Noul event in 2015, we used the new version of D-Show to file over 150 briefing reports and found that it saved 98% of the filing time. This confirmed that the new version of D-Show allows users to act according to the demands of operation and application of disaster-related information, providing efficiency to the overall disaster-response decision making. Although the new version of D-Show already greatly improves on the problems on the prior version, this study is now in the process of developing cross-platform support, multiple file format support, and data sharing to overcome current restrictions.

5. ACKNOWLEDGEMENTS

This study is grateful for the funding of the Ministry of Science and Technology (project dossier numbers 102-2627-E-002-007 and 103-2627-E-002-007). The authors of this study wish to thank Consultant Wei-Chuan Hsieh and Consultant Chun-Nan Chen of the Meteorological Application and Development Foundation; Yi-Lin Chan and Shih-Wei Chou of the Center for Weather Climate Disaster Research at National Taiwan University; and personnel of the emergency operation team at the Water Resource Agency of the Ministry of Economic Affairs for assisting in user testing, giving the opportunity for practical application and verification for the benefit of this study.

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