ANALYSIS OF THAI GOVERNMENTAL INFORMATION LOGISTICS OF EARLY WARNINGS

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Introduction

An Early Warning System (EWS) is the set of required capacities to generate and disseminate timely and useful warning information for those who are at risks (Kelman and Glantz, 2014). A good structure for an EWS constitutes risk knowledge, monitoring and warning services, dissemination and communication of warnings and response capability (Rogers and Tsirkunov, 2011). While disaster monitoring is extremely important, the significance of dissemination and communication of warnings are often underestimated. The 6.5 magnitude earthquake in Leyte, Phillipines, was an example of several natural disaster incidents struck without warning (Interaksyon, 2017).

Warning information must be simple, clear, recognizable, understandable, reliable, and timely (WMO, 2011). The supporting systems must allow needed information to be delivered effectively, efficiently, in the right format, to the right place and persons and at the right time (Michelberger *et al.*, 2013). Information Logistics (IL) concerns about achieving those goals.

Research in IL involves information flow models, efficiency, and distribution of information based on user demand (Haftor and Kajtazi, 2009). Distribution of needed information in the right format to where and when it is needed is crucial. Information made available by EWS needs to be processed and transformed into the right form of useful and needed information and forward to those at risks in time to prevent disasters and reduce the impacts.

The main concern of IL is efficiently driving information flow from the source to destination. Various parts in information flows can be optimized to increase efficiency of delivery of warning information (Haftor and Kajtazi, 2009). The first part is a warning dissemination process. The second and third parts are information production time and flow time, and user-demand and information-supply chain, respectively.

For the first issue to be achieved, standardized warning dissemination mechanisms should be enforced through government policy. Once the policy is in place, procedures and protocols can be defined at local and national levels. Then, partners and their responsibilities can be identified. Multiple communication channels should be made available. Moreover, information provided on certain channels should be tailored for specific recipients. After an effective warning dissemination process is recognized, production, processing and transportation time of information should be shortened to allow critical information to be delivered as early as possible when every single minute is important to saving lives. However, ineffective information processing can lead to information overflow and lack of needed information. Consequently, not enough of important information can be passed through to the recipients. Warning dissemination, thus, should focus on providing the right content in the right form at the right place and at the right time.

The increasing popularity of the World Wide Web has been influencing private and public organizations all around the world to use websites as their public information outlets (Panopoulou *et al.*, 2008) to reach a large audience. The innovation in information technologies not only allowing different types of information to be presented on websites, they can be customized to allow a variety of presentation styles. Different information presentation style affects the ability of audiences to receive information and how well they do so. In this paper, a further investigation was conducted to evaluate the quality of warning messages given via websites of Thai authorities responsible for early warning. Thereafter, the effectiveness of IL can be determined based on the quality of warning messages.

Warning dissemination

An architecture of EWS contains components such as monitoring, decision supporting and warning dissemination (Wächter *et al.*, 2012). Information flow in EWS starts with acquisition of sensor data and transmitting them to related warning agents. Once information reaches the warning agents, the decision support component analyses and plans for dissemination. Warning information is then customized and disseminated to selected channels. In this study, warning information available on the selected channel, websites, are observed and analysed to evaluate the ability of the warning systems in production and dissemination warnings.

Warning dissemination encompasses transformation of warning information into forms, usually as warning messages and reports, that are understandable and useful to those who needs them. Recipients of warning information include authorities (local and national) and public.

Observation and Analysis

A warning dissemination part of EWS usually deals with a large amount of data that has to be processed in a limited time and notifies affected parties with information they need (Lendholt and Hammitzsch, 2011). To improve warning dissemination, the quality of warning information should be assessed. Then, the results can be analysed to identify problems and their roots.

The study began with an initial investigation of available warning information, in this case, warning messages on the selected websites. This is to survey on characteristics of warning information. Generally, warning messages are tailored for specific needs of recipients and types of hazards. For example, Tsunami related warning messages may include one of the followings: “Tsunami warning” or “All Clear” (Lendholt and Hammitzsch, 2011). If the recipient of those messages is the administrator of the local authority who are trained to recognize to the message and actions associated with it, he should be able to quickly take the appropriate action in response to the message received. On the other hand, if the recipient is a commoner who has never been trained to recognize the meaning of the message, he may not understand the message the way it should be understood. Consequently, the subsequent actions may not be taken.

Specific types of warning messages are formatted to aid in reduction of the time for recognition, interpretation and communication of messages. However, for a particular type of recipients, such as commoners, it is not possible to train all of them to recognize types and meanings of messages. For practical use, typical warning messages on the websites are appeared in natural language. While natural languages are easy to understand and require no additional training, there are limits to how it can be used in communication (Erikksson, 2018). Natural language is ambiguous, hence, may not be consistently understood. On the other hand, language is linear. If the important message is placed later in the page, the delay in receiving and interpreting is greater. Besides, in many cases, it is hard for machine to get a good translation.

The preliminary findings suggested that available warning information is usually given in forms of textual representation combining with graphics such as image, illustration, chart, map, etc. Interactive media contents are offered with limitations. Remarkably, no contextual Information is provided along with the warning messages. By giving information on current environments (i.e. resources, surroundings and locations), otherwise stated as contextual information (Haseloff, 2005), warning systems can adjust information processing and information representation to deliver information that is useful to the those in needs.

Next, the requirements of warning dissemination were identified from guidelines (Rogers and Tsirkunov, 2011)(WMO, 2011) and generic requirements of IL for EWS (Lendholt and Hammitzsch, 2011). They were used as the base references for assessing the quality of warning messages. Accordingly, the requirements of warning dissemination include (1) independency of hazard types and dissemination channels, (2) increasing reception of warning messages with sufficient information (text, picture, instruction), (3) provision of message type filtering, (4) delivery of context-aware information via appropriate dissemination channels and (5) usability of the system.

1. Hazards types

Warning messages should be independent to hazard types. In other words, warnings must not be limited to specific sets of messages. While there are specific terms to be used for certain types of hazards, the structure of messages should remain the same or similar across different scenarios. This is to increase reception of warning messages across different groups of recipients. If different types of messages are provided for different types of hazards, it could easily lead to confusion and increasing learning curve.

2. Dissemination channels

Warning messages for different channels must be provided by EWS in suitable forms. They should be delivered to a wide range of dissemination channels. The most efficient channels for the specific situation must be chosen for distribution of messages. Messages must be delivered to the dissemination channels which are not just ones that fits for a situation, but they must also be the ones that recipients want to be notified. For example, while websites are perceived to be easily accessible via any devices with web browsers installed, they are not the best choice of receiving warning messages for certain environment, such as in areas with low Internet reception, overcrowded locations or panic situations.

3. Information adequacy

Information comes with a cost. Poor information can lead to a higher cost. Therefore, messages must be adequate in terms of content, forms of content, instruction, context and situations, risk, priority and needed information. Adequacy can be justified by user role, area of interest, spatial reference, situation, direction, granularity and existence of necessary components.

4. Context-awareness

Context can be any piece of information used to describe the situation of an object based on a set of attributes. Each attribute is typed and holds values (Haseloff, 2005). Contexts are important in communication. By providing circumstantial information, meaning can be uniquely shaped and miscommunication can be reduced. Contexts are important in communication among humans as well as humans and computers. Context awareness is a crucial feature of IL (Haseloff, 2005) that allows computers to alter their execution and deliver only needed information.

5. Usability

Adequate information should be formatted in such a way that recipients can easily receive and make informed decisions. Moreover, they should be simple, clear, consistent, recognizable, understandable and authentic. Messages in natural languages are linear. Information appears at the beginning or at the top of the contents is recognized before the later. Important information should, therefore, appear at the site landing. Formatting is another important factor to make message more usable.

Findings and Implications

Five Thai public authorities' websites are used as the main case study in this research (referred as A, B, C, D and E). They were systematically analysed based on the requirements listed above. Table 1 presents the analysis results of warning messages based on the three requirements; hazard/message types dependence, wide range of dissemination channel and context-awareness. Messages from each of the selected website were examined in terms of dissemination channels, dependency to hazard or message types and provision of contextual information.

All of the five surveyed EWS support warning dissemination across a variety of communication channels including Mobile application, Webpage, Online inquiry and Social Media Network. Facebook is used by all cases. Twitter and YouTube are the second most popular Social Media Networks. All of them used E-mail and Online inquiry to provide alternatives for those who would like to contact the system in writing. As Email and Online inquiry are both seen as writing tools that can be used interchangeably, some system omits the use of Email and offers only Online inquiry. Another reason

might be that not everyone uses Email. YouTube and Radio broadcasting are similar tools but yield different coverage. Anyone with smartphone and Internet connection can access YouTube videos. However, not everyone has smartphone. Hence, it is a good idea to provide an alternative to information broadcasting. Radio, although traditional, is in fact a great alternative as it can be efficiently broadcasted to remote locations where Internet connection may not be available. Moreover, the number of people in rural areas who can access radio are far greater than those who can access smartphone. Hotline is another good channel to provide an alternative for spreading warning messages.

Table 1. The analysis of information logistics of five selected Thai authorities based on hazard types, dissemination channel and context-awareness.

Authority	Dissemination Channel	Hazard / Message types dependence information	Context-awareness
A	- Mobile application Webpage - Online inquiry - Web board - Facebook - Hotline call - Radio broadcast	- Hazard type - Period - Situation, overall - Affected area, Division - Impact / Casualty - Recovery area - Current situation, overall and subdivisions - Relief information	- Location information - No tailored message
B	- Mobile application - Webpage - Web board - Online inquiry - Email (dead link) - Hotline Fax - YouTube - Facebook, Twitter, Instagram	- Period - Message type - Situation - Affected area, Region - Affected area, Division - Instruction / Recommendation	
C	- Mobile application - Webpage - Email - YouTube - Facebook, Twitter, Instagram - Hotline call - Radio broadcast	- Hazard type - Period - Affected area, Region - Situation - Instruction / Recommendation - Affected area, Division	
D	- Mobile application - Webpage - Online inquiry - Email - YouTube - Facebook, Twitter - Hotline call	- Hazard type - Period - Situation - Instruction Recommendation - Affected area, Division - Forecast	
E	- Mobile application - Webpage - Web board - Online inquiry - Email - YouTube - Facebook, Twitter	- Hazard type - Period - Message type - Affected area, Division - Situation - Forecast - Instruction Recommendation	

It is found that all websites that offer warning do provide warning messages of similar structure with slight differences in terms of components in the messages, order of the components and granularity of details. Although, most of them include hazard type, period, affected area and situation information, only some of them specify message type, impact, instruction/recommendation, current situation and forecast. In addition, some website does provide warning messages using only textual information with no other types of information presentation, neither situational picture nor any kind of images. Surprisingly, some of them provide no contextual information in the messages. Consequently, people who read the warning messages need to spend extra time extracting information related to them. All websites appear to provide all available information in bulk without any selective options. Therefore, the information supplied are not likely to match the actual demand. This results in inefficiency of information flow in IL.

Table 2 shows an attempt to classify types of media presenting in the warning messages provided by the five websites studied. Images showing situations are important to reception of warnings. Some images are shown as maps. Geographical and weather maps are useful to represent affected areas and their situations. Yet, layered information posed on top of the map can create confusion due to complexity of information posed. Consistent format of those images provided across different websites containing warning messages could help readers to receive information faster and enable them to response faster as well. Maps are useful for representing geographical related information, but as previously noted that layered information posed on top of the maps could delay information delivery. Remarkably, only one website does provide illustrations to symbolize the situation information in such the way that readers can easily understand and make informed decisions without having to look at the tables full of numbers. This proves that simplification of messages is very important to acceptance of the messages.

Table 2: Types of media used by the five selected Thai authorities

Authority	Text		Graphic					
	Para-graph	Table	Image	Map (Geo-graph-ical)	Map (We-ather)	Map (Inter-active)	Illust-ration	Color code
A	✓	✓	✓		✓	✓		✓
B	✓		✓	✓				✓
C	✓		✓	✓	✓	✓		
D	✓	✓	✓		✓	✓		✓
E	✓	✓	✓	✓	✓		✓	✓

Figure 2. Symbols representing different kinds of disasters shown on the the National Disaster Database provided by Website A.

Figure 1 gives an example of another usability problem found on some of the websites. Indeed, consistency is the key to message delivery and acceptance. However, inconsistency is found from the icons used to represent types of disasters. These icons are not used elsewhere in other public authorities' websites. That means people who use these websites would have to remember different

pictures for the same meaning. This is not a recommended practice for channelling information to the public when time is one of the most important factor in preventing and reducing damage caused by disasters.

Conclusion

The main goal of Information Logistics (IL) is enabling effective and efficient delivery of needed information, in the right format, to the right place and persons and at the right time (Michelberger *et al.*, 2013). In order to meet the goal, EWS or systems supporting early warnings must fulfil the following requirements; (1) delivering warning messages independent of hazard and message types, (2) providing sufficient information in warning messages to increase reception, 3) Disseminating and messages through a wide range of communication channels, 4) filtering information to allow only needed and useful information to get to the recipient, and 5) usability to ensure that everyone can efficiently access and understand the information in a timely manner.

Based on the results of this study, and the recommendation made by other related work, needed information that should be included in warning messages include nature of threats and their impacts, risk information, contextual information, suggestion on how to respond to different types of hazards after an early warning message is received, follow-up actions, provision of simple information on hazards, risks and how to reduce disaster impacts, also information to let the recipients know that the threats have ended. Warning information should also have the following quality attributes to enable high quality IL: Clear, Timely, Reliable, Understandable, Authentic, Recognizable, Simple.

Research Limitations and Future Research

There are other public authorities that can be used in the next study to find similarities or differences. In fact, expanded analysis to regional or international level can also be beneficial. This is due to many other influencing factors such as culture. Nevertheless, the findings can be used to create guidelines for creating useful and effective warning information for all authorities involves in warning dissemination. An experiment to verify this framework can also provide informative feedbacks for further development.

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