Improving Disaster Responsiveness using a Mix of Social Media and e-Government

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Abstract: Data sharing is essential for government agencies during disaster management as it requires high collaborative efforts among various organizations. Recently, social media have been increasingly used during the disasters for disseminating and receiving information to and from the public. By using social media for communications, the government can receive real-time data from the public and from organizations. The challenge lies in how to combine social media with government data, which is gathered from multiple sources, in multiple formats using multiple terminologies. This paper focuses on how to manage, integrate, and verify data acquired from multiple sources. The proposed model was designed by using frame-based data collection and ontology-based data integration, combined with the effective use of dynamic data from social media, with the aim of improving the disaster assistance.

1 INTRODUCTION

The recent flood disaster in Thailand, starting in September and continuing until December, 2011 was the country's worst flood disaster in the last fifty years. It became apparent that activities associated with the disaster response needed more effective management. There were too many government agencies responsible for disaster management, which made it difficult for collaboration and coordination. As a result, flood water management was poor, and flood relief goods and services were not distributed equally to affected people. In addition, there was conflicting and contradictory information about the flooding. Many people, including ordinary citizens and businesses, turned to social media for accurate and up-to-date information (Perry, 2011; Russell, 2011).

In order to achieve a higher level of efficiency and accountability in the handling of disaster response activities, accurate and up-to-date data are crucially needed in the support of government decision making. One of the key success factors in managing response activities is access to real time data, which could be provided by the local population living in affected areas via social media.

The challenge lies in how to handle the mixed social media and government data gathered from multiple sources, in multiple formats, using multiple terminologies. This paper focuses on how to manage dynamic data and various sources of government data. Using a flood response scenario as a case study, a design of frame-based metadata for data collection, and ontology-based data integration are proposed.

2 CHALLENGES IN USING A MIX OF SOCIAL MEDIA AND E-GOVERNMENT

Providing assistance during disasters in a timely manner needs e-Government data, as well as real-time data that can be provided by local residents in affected areas via social media. This section gives the overview of the challenges in using mix data from various sources.

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2.1 Disaster Response Management

The challenges of disaster response management are the efficiency and responsiveness of assistance provisions and supply distribution. These challenges are:

- How to determine the location and number of victims requiring assistance.
- How to extract and verify information of assistance requests from social media.
- How to unify assistance efforts among public and private organizations in providing support.
- How to integrate data from back office databases of government agencies with the real time data from social media.
- How to estimate the severity of risk management and determine the level of required assistance.

2.2 Data Interoperability

During any crisis, data integration of related organizations is essential. However, integrating the data of various organizations is not easy. The difficulties arise from the following problems.

2.2.1 Heterogeneous Data

The problems mentioned in the previous section are those that need supporting data coming from various government agencies. These data are heterogeneous in nature. These heterogeneities can be classified as syntactic, schematic and semantic (Bishr, 1998):

- Syntactic heterogeneity is caused by the use of different data models, different file formats, etc.
- Schematic heterogeneity is the result of structural differences, caused by storing the same data in different ways. For example, the same information could be stored in a single table or distributed in multiple tables, etc.
- Semantic heterogeneity is caused when the same data has different meanings, or the same data is interpreted differently under different contexts. A semantic issue can arise when the same term represents two different concepts, or two terms represent the same concept.

Similarly, for spatial data, governmental organizations usually run a variety of spatial information systems. Different organizations usually use different GIS software to handle spatial data in different formats.

Since flood-related data is increasing in volume and diversity, unifying metadata is insufficient to enable valuable data to be accessed or understood. One solution is to develop common metadata standards and a metadata registry.

2.2.2 Data Quality

Although social media contains a lot of valuable information, it is problematic with regard to quality and needs to be carefully evaluated. Some of the problems are: rumors, imprecise information, contradictory information, and non standardized information.

In social media, people write messages in non formal languages without any standard. They may describe flood depth in various ways or refer to a location using the informal name that they are accustomed to. Without standardization, it is difficult to utilize such data effectively.

Because of the problem of having no standard, we need both a knowledge base and a methodology to normalize extracted information. Ontology can be used to map locations reported with different names and granularity to a normalized spatial system (e.g. latitude-longitude, etc.). It also allows for more flexible aggregation and reasoning in terms of spatial information. For flood level, we need to normalize a different measuring system into the same system.

3 PROPOSED SOLUTIONS

During the disaster response phase, information flows are very important in providing disaster assistance (Day et al., 2009). However, there are many issues related to acquiring, integrating and verifying various data supporting operations. This section describes the proposed solutions.

3.1 The Conceptual Framework

Figure 1 shows the conceptual framework, which illustrates how data from different sources can be extracted, integrated, harmonized and verified in order to support disaster assistance management.

3.2 Social Media Information Acquisition and Extraction

Despite the impurity or erroneous aspects of its nature, social media still holds high potential to be a useful data source for monitoring, prioritizing

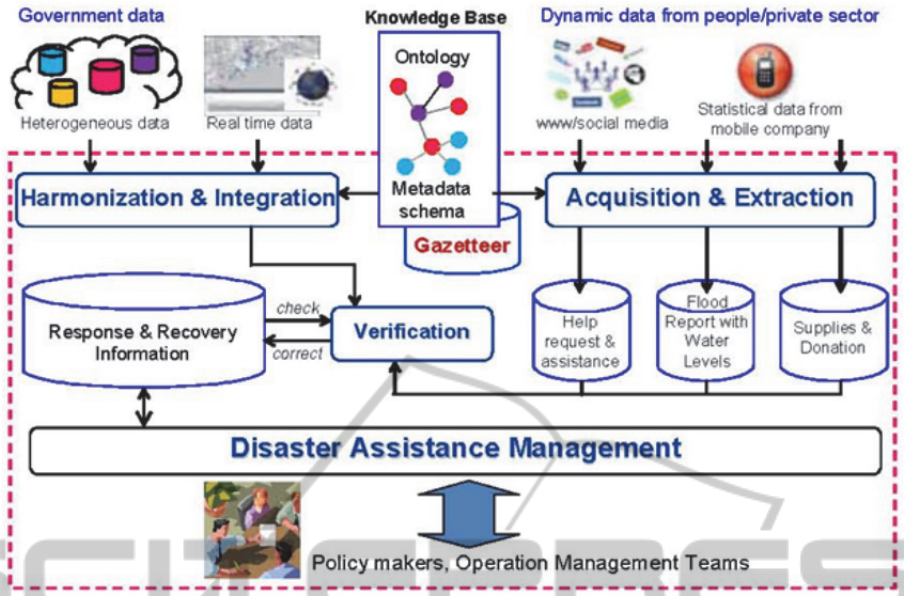

Figure 1: Analysis framework for the role of social media in disaster assistance management.

disaster severity, and managing resources for disaster response and recovery. We can extract the needed information from social media using NLP techniques, as explained briefly below.

- Information Retrieval

This task could be performed by utilizing a social media application interface (API), such as a Twitter API, a Facebook graph API, as well as a Facebook query language

- Information Filtering and Classification

Some of the retrieved messages may not be related to a help request or flood report. We need a means to filter irrelevant information and also automatically classify messages into help requests and reports. This can be done by using text classification method (Sriram, et al., 2010).

- Information Extraction

Information extraction techniques can be used to automatically extract predefined information and structuralizing it in XML or database format.

3.3 Data Verification

Before using help demand data received from various sources, e.g., social media and telephones, we need to assess the level of data quality (McGilvray, 2008) as follows:

- Data completeness

Data can be accessed from the completeness of required data either in a single field or a combination of required fields. If incomplete, then additional sources of information are needed.

- Data accuracy

Data accuracy can be assessed by verifying with reference sources. For example, the number of people in a specific area can be verified with the summary of the people registered in the system for that area, or with mobile usage statistics from mobile network operators.

- Data Reliability

Data source reliability is important for eliminating malicious requests; it can be assessed by given prioritization rules. For instance, if a source of data is from an official, then the data sent can be regarded as having a high level of reliability.

3.4 Harmonization and Integration

The syntactic issue raised due to multiple data formats can be resolved by transforming them into a single standard format, such as XML.

3.4.1 Data Harmonization

For semantic differences, data standards can be used for harmonizing data. As recommended in our previous study (Kawtrakul, et al., 2011), Thailand has not established data standards at the national level as yet. To prepare for and respond to disasters that might occur in the future, the following processes need to be prepared:

- Establishing universal core data standards.

- Forming a collaborative group which consists of the representatives from all agencies that are involved in providing help to disaster victims. This group should create disaster responsive common or domain specific data standards.

3.4.2 Ontology based Data Integration

An ontology is an explicit specification of a conceptualization. Ontology can be used to support semantic data sharing and data integration among these organizations (Blomqvist and Öhgren, 2008). Hence, the concept of ontology is recommended to support data sharing and integration.

Semantic data integration based on ontology uses a conceptual representation of the data and their relationships to solve heterogeneities problems. A Simple Knowledge Organization System (Miles and Bechhofer, 2009), provides a common data model for sharing and linking knowledge organization systems. In SKOS, ontology can be represented in such a way that concepts can be shared among organizations which are involved in data sharing and integration.

3.4.3 Gazetteer based Spatial Data Integration

Water level estimates cannot be monitored by satellite remote sensing. Flood depths are collected by social network and integrated with spatial data such as DEM (Digital Elevation Model), flood extent maps, etc. Flood depth is point information that is provided in meters with latitude and longitude. This point data from social networks usually identifies the location by geographical names, such as city name, village name, landmark, etc. Gazetteer is utilized to convert geographical names to latitude and longitude (Nagai and Ono, 2008). Geographical point data is analyzed and interpolated to grid data which will then be overlaid and integrated with spatial data so as to support flood level estimates.

4 CONCLUSIONS AND FUTURE WORK

When a disaster occurs, the critical performance of disaster relief operations is timely responsiveness. Since social media has been proven to be a major means of disseminating and receiving information during a crisis, social media mixed with e-Government creates a new level of data integration for responding to help requests. Data required during a crisis are from various sources in different formats. Hence, it is essential for government to prepare the technology for integrating and harmonizing information systems for disaster management. To handle disaster situations, the government should also consider the following issues:

- Establishment of a national standards body that is accountable for supporting data interoperability and data standardization.
- Creation of a disaster collaborative group that consists of all government agencies, the military, and private organizations that need to collaborate in exchanging data during a crisis.

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