# COLLABORATIVE DISASTER MANAGEMENT SYSTEM

AN EXPLORATORY FOR LANDSLIDE IN MALAYSIA

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## ABSTRACT

A disaster management system has active, unpredictable, and complex characteristics due to dynamic conditions with a high level of uncertainty. Non-Government Organizations (NGO) and Government organizations from different jurisdictions and sectors with different responsibilities at regular times create an emergent and complex system in response to disasters. Although being mostly demanded, the collaboration initiatives between government agencies that specifically designed to address risk management before a disaster happens is lacking in effectiveness. In the Malaysian perspective, there are organizations, such as the Public Works Department (**PWD**), Department of Mineral and Geosciences (**DMG**) and Centre of Remote Sensing (**MACRES**) that are involved in mitigation and preparedness of landslides disasters, but results are not encouraging due to the need of effective collaboration among these organizations. It is natural for humans to collaborate while dealing with complex problems. In this regard, we consider this process of effective collaboration in the context of information systems. Investment in the information technologies and systems, and its utilization can play a critical role in creating a complex socio-technical disaster system to coordinate organizations and jurisdictions in dynamic settings. We propose a simple model for collaboration that helps us to realize a successful risk management in disasters. A model of Collaborative Disaster Management System is then rendered based on an extended model of management of information systems



*Keywords:* Disaster; landslide; collaboration; management.


## 1. Introduction

As one of the top ten natural disasters in Malaysia, landslides have great impacts on the environment and on societies, and often cause vast economic losses and casualties. Many methods have been developed for the prediction or forecast of landslides; however, in Malaysian perspective there are many organizations who are predicting or forecasting with the monitoring of landslides but results are not very satisfactory due to lack of collaboration among these organizations(NSMP, 2009). In this paper we are going to propose a simple collaboration between Malaysian Remote Sensing Agency (**ARSM**), formerly known as Malaysian Centre for Remote Sensing (**MACRES**) and Jabatan Kerja Raya Malaysia (**JKR**), known as Public Work Department Malaysia (**PWD**), Jabatan Pengairan dan Saliran **(JPS)**, Jabatan Alam Sekitar **(JAS)** and so on (NSMP, 2009). The resulting method could improve the overlapping of prediction or forecast of landslides from any kind of individual information.

Public Work Department Malaysia (**PWD)** is the main implementing agency to government. PWD was born in 1872. Since then, it has provided infrastructure and conductive environment for living, working, playing, and praying. PWD built roads as a means of communications, and they have been the main catalyst in the socio-economic development of the Malaysia (Wikipedia, 2010). PWD supplied safe water and had contributed in building a healthy and progressive nation. Architecture has been playing a major role in the nation building. They are proud to have contributed significantly in these developments.

**PWD** vision is to become a world-class service provider and centre of excellence in asset management, project management and engineering services for the development of nation's infrastructure through creative and innovative human capital and state-of-the-art technology. Their objective is to deliver projects with quality, on time and within cost.

Malaysian Remote Sensing Agency (**ARSM**) is a department under the Ministry of Science, Technology and Innovation (**MOSTI**). It was established as an R&D centre in remote sensing and related technologies in August 1988. Currently, **ARSM** is equipped with computer system for satellite data image processing, geographic information system and global positioning system, satellite ground receiving station for real time data acquisition, microwave remote sensing laboratory (anechoic chamber, mobile scatter meter), remote sensing digital photographic laboratory and remote sensing data archiving & retrieval centre. Especially they are conducting research on applications of remote sensing, GIS and related technologies in all sectors of agriculture production, natural resources, environment, disaster, security and land development management. They Operate and manage user service centre for remote sensing satellite image and related services provided to clients Operate and manage remote sensing satellite image ground receiving station; and Operate and manage a remote sensing technology information one-stop-centre (**MOSTI, 1990**).

## 2. Literature review

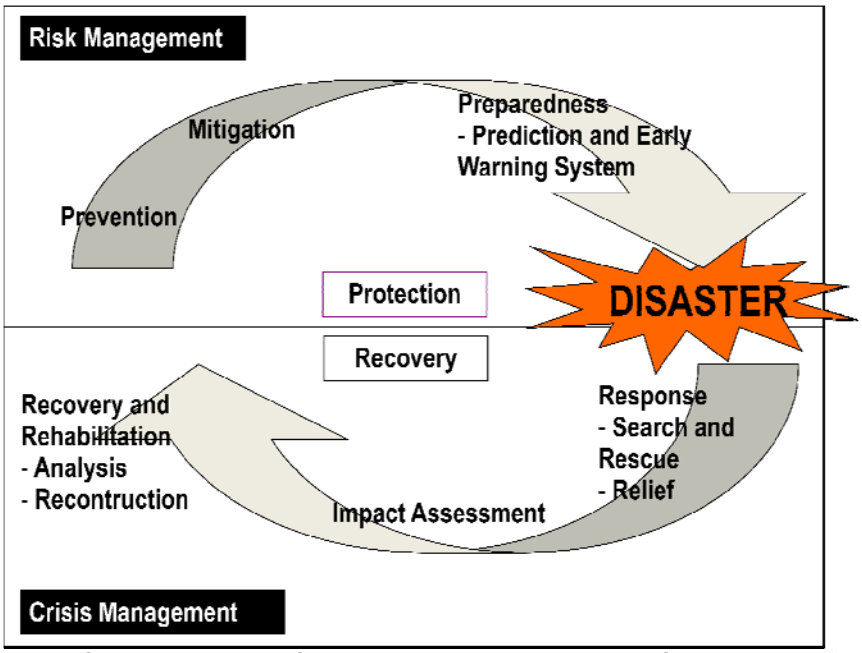
Collaboration is the act of people working together to reach a common goal. It involves getting the right information to the right people at the right time to make the right decision. Such well-informed and speedy decisions in turn help organizations get work done. But collaboration is much more than communication. It is the way that all the people in an enterprise function together. Better collaboration means better business operations. By improving these capabilities with improved collaboration, organizations can increase the scale and capacity of their processes and develop new ways of doing business **(Cisco, 2000).** Good collaborative information sharing and decision making lead to better business results by reducing manufacturing costs, stimulating innovation, speeding time-to-market, improving product and service quality, and opening new business opportunities.

Portal is a web system that provides the functions and features to authenticate and identify the users and provide them with an easy, intuitive, personalized and user-customizable web-interface for facilitating access to information and services that are of primary relevance and interests to the users. To the organization that sets up the portal, it is a system that provides versatile functions for the organization to collaborate or organize collections of different and

multiple sources of information and service resources for dissemination to many users according to their specific privileges, needs and interest. Hence, the main purpose of setting up a portal is to bring the vast information and service resources available from many sources to many users in an effective manner (**Marlon. E. P., et. Al., 2003**).

Nowadays, many organizations are making extensive use of the web to disseminate information and provide services to their users, say their staff members, customers, etc. To cope with the various needs of different users, the numerous types of information and services that can be available to all kinds of users would be grouped together and presented on the web according to the nature of the operational functions. In general, this means that the information and services are grouped based on the division of the service-providing departments, and the users must have some idea about what kind of information or services could be provided by which department in order to gain access to the required information or service without much difficulty (**Rezayat. M., 2000).**

### 2.1 Phases of Disaster Management




Source: Che Moin Umar, Crisis and Disaster Management Directorate, National Security Division (NSD),Prime Minister's Department MALAYSIA 21 March 2007

#### 2.1.1 Prevention

Government and private organizations can create vulnerability assessments using GIS to accurately locate and identify hazards and threats that could result in catastrophic events. GIS is used to analyze potential events or attacks to determine threats and potential consequences. Geographic representation makes hazard risks, such as chemical storage, nuclear plants, flood

zones, earthquake faults, wildfire-prone areas, and hazardous waste sites, obvious. Map layers that overlay hazard data with critical infrastructure, population densities, areas of commerce, natural resources, and so forth, illustrate risk and areas that require mitigation and protection strategies.GIS is critical for analyzing complex protection problems and developing adequate protection solutions. It can help create buffers around high-risk or essential values, monitor environmental health indicators, design early public warning systems, plan evacuation routes, locate shelter facilities, and relocate certain critical facilities exposed to natural or technological hazards.

### 2.1.2 Preparedness

Preparedness is a continuous cycle of planning, organizing, training, equipping, exercising, evaluation and improvement activities to ensure effective coordination and the enhancement of capabilities to prevent, protect against, respond to, recover from, and mitigate the effects of natural disasters.

### 2.1.3 Recovery

The aim of the recovery phase is to restore the affected area to its previous state. It differs from the response phase in its focus; recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. Recovery efforts are primarily concerned with actions that involve rebuilding destroyed property, re-employment, and the repair of other essential infrastructure

### 2.1.4 Response

First responders use GIS to understand the scope of the damage, develop priorities for rescue, and contain the spread or proliferation of the emergency. They can also determine how to reduce the probability of secondary damage such as where to shut off contaminated water supply sources, cordon off affected areas to prevent further injury, and prevent looting. GIS is essential to understanding the scope, complexity, and severity of the emergency as well as which assets are and are not available. The wide range of GIS capabilities can be used for assigning rescue personnel and equipment, organizing medical support, monitoring environmental problems (toxic plumes, etc.) and evacuation routes, providing logistical support, and hundreds of other tasks. The information and data collected in the initial risk assessment will provide more efficient and effective response.

## 2.2 National Disaster Strategy

National Disaster Management Strategy (NDMS) of Malaysia is the backbone strategy to advance effective coordination and integrated approach in the building of a culture of prevention,

Protection/public safety in the community. Its vision is to create a safe environment for the community through disaster management and sustainable development in the 21st century.
ADRC country reports that one of NDMS' main components is Community Awareness. This component outlines the aim to develop a national approach to fostering and enhancing the community's awareness of risks, and encourage involvement in prevention /mitigation, preparedness, response and recovery strategy (NIMS Community, 2008).

In Malaysia, (Chanuka Wattegama,2007), one of the challenges faced by state crisis management agencies is lack of fund for training to conduct disaster preparedness and readiness for the local community. While fund and budget allocation is not within the organization's control, the effort to continuously offer preparedness programs should not take a back seat.
Chanuka Wattegama, in his report entitled ICT for Disaster Management produced by United Nations' APCICT (2007), emphasized the important role played by ICT in managing crisis. He stated that information and communications technology (ICT) can potentially play a pivotal role in disaster prevention, mitigation and management. Remote sensing for early warning is made possible by various available technologies, including telecommunication satellites, radar, telemetry and meteorology.

### 2.3 The Road Map for Disaster Risk Management

According to United Nations DP, (2008) the areas proposed by the disaster risk management framework cover:

1. Policy, Institutional Mandates and Institutional Development: Including the preparation of a national disaster management plan, a national policy for disaster management, a national emergency response plan, reviewing, formalizing mandates and identifying capacity development needs of agencies to perform their disaster management functions as well as steps to implement policies already in place.
2. Hazard, Vulnerability and Risk Assessment.
3. Multi-hazard Early Warning System: Incorporating elements to generate advance warnings for floods, cyclones, abnormal rainfall, droughts, landslides and tsunamis, thus enabling decision-makers to take necessary measures well before the occurrence of a disaster.
4. Preparedness and Response Plans: To minimize the adverse impacts of a hazard through effective precautionary actions and timely, adequate responses.
5. Mitigation and Integration of disaster risk reduction into Development Planning.
6. Community-based Disaster Risk Management: Involving activities that recognize the fact that communities, even when affected, are still the first line of defense against disasters if they are well prepared.
7. Public Awareness, Education and Training: Focusing on empowering the public with ways and means to reduce disaster losses, and includes a national awareness campaign, designating a 'National Disaster Safety Day', promoting disaster awareness among professionals through integration into university curricula and training, and among children through school curriculum and school awareness programmes.

### 2.4 Priorities for action

According to ( World Conference on Disaster Reduction, 2005, Hyogo Framework for Action 2005-2015 ) drawing on the conclusions of the review of the Yokohama Strategy, and on the basis of deliberations at the World Conference on Disaster Reduction and especially the agreed expected outcome and strategic goals, the Conference has adopted the following five priorities for action:

1. Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation.
2. Identify, assess and monitor disaster risks and enhance early warning.
3. Use knowledge, innovation and education to build a culture of safety and resilience at all levels.
4. Reduce the underlying risk factors.
5. Strengthen disaster preparedness for effective response at all levels.

## 3. Objective:

The main objective of this project is to collaborate between two organizations by developing a central portal to contribute towards the development on Geographic Information System (GIS) based on Information Technology (IT). This collaboration will optimize the use of remote sensing and related technologies for sustainable development of the country. It will also provide total solution in remote sensing and related technologies applications, and centrally acquire and distribute information for the requirement of the country without any overlapping.

## 4. Benefits:

There are more than 30 organizations that are predicting or forecasting with the monitoring of landslides in Malaysia (NSMP, 2009).. Most of these companies are involved with remote sensing. But every organization is doing their job individually without any collaboration. As a consequence, information is overlapping with each other due to lacking of collaboration. Since there is no centralize portal, same project or same task has been done by many companies. Once a portal will be created as centralized then overlapping will be eliminated.

- Collaboration will conduct research on applications of remote sensing, GIS and related technologies in all sectors of agriculture production, natural resources, environment, disaster, security and land development management from the central portal.
- The central portal will operate and manage as a user service centre for remote sensing satellite image and related services provided to clients.
- Operate and manage a remote sensing technology information one-stop-centre.

# 5. Landslides overview

## 5.1 **Definitions**

There are a number of definitions of landslides. Sharpe (1938) defines landslides as “the perceptible downward sliding or falling of a relatively dry mass of earth, rock or mixture of two”. (J.Suhaimi (2006): Sharpe:1938) It was explain further by Terzahi(1950) ; “ landslides is rapid displacement of rock, residual soil or sediments adjoining a slope and center of gravity of moving the mass advances in a downward and out ward direction”. While, Varnes(1958) defines landslides as “downward and outward movement of slope-forming materials composed of natural rock, soils, artificial fills or combinations of these materials” . Hutchinson(1995) explain landslides as “relatives rapid down slopes movement of soils and rock, which take place characteristically on or more, discrete bounding slip surfaces which define the moving mass”. However “The movement of rocks, debris or earth flowing down a slope” by Cruden (1991) is the most widely used (J.Suhaimi, 2006: Fell, 2000).

## 5.2 Causes of landslides

According to Griffiths (1999) landslide casual factors can be classified into two groups: (1) preparatory factors and (2) triggering factors. The former make the slope susceptible to movement without actually initiating it, while the latter initiate movement. The trigger is an external stimulus that produces an immediate change in the stress-strain relationships in the slope, resulting in movement. The typical triggers are heavy rainfall or snow melt, earthquake shaking, volcanic eruption, erosion, or human factors. As the main factors that control l land sliding , there are (1) geological conditions, (2) groundwater conditions, (3) geo-morphological conditions, (4) climatic factors, (5) seismic activity, (6) weathering, and (7) man-made factors.

## 5.3 Types of landslides

Landslides can be classified according to variety of factors such as material composition, and type and velocity of movement. The material involved in sliding includes soil, rock, and/or artificial fill. Common types of movement are e.g. creep, sliding, flow and fall (Nemcok 1982) or fall, topple slides (rotational and translational), lateral spreading and flow (Dikau et al., 1996). In a broad sense according to depth of the shear plane, landslides can be distinguished between shallow landslides (<2 m) and deep-seated landslides (>10 m).

# 6. LANDSLIDES IN MALAYSIA

According to Zainon, (2009), Hillside development in the urban areas (Kuala Lumpur, Penang, etc.) is a topic of major concern in Malaysia, especially after a recent disaster involving the collapse of a condominium block Highlands Towers in Kuala Lumpur on 11 December 1993, killing 48 peoples. The collapse was attributed partly to a series of retrogressiveslides of a cut-slope located behind the condominium (Tan, 1996). Others chronology of landslides disasters

which have been occur in Malaysia are the natural landslides tragedies at Pos Dipang, Kampar, Perak on 29 August 1996, killing 39 peoples. On January 1998, one killed, after a concrete wall collapse at Km 308.8 of North-South Highway near Gua Tempurung, Kampar, Perak, 8 February 1999, 17 pupils killed at Kampong Gelam, Sandakan, Sabah, when half of the hill collapse.Next tragedies were on January 2000, where 70 hectares farms have destroy by the landslides at Kampong Baru Ringlet, Cameron Highlands. On 27 December 2001, 5 was killed by the mudslides at Kampong Seri Gunung Pulai, Johor has occur on 20 November 2002, where 8 people has killed when landslides destroy one of the bungalow near Hillview Garden (Wan Abdul Aziz, Othman and Halim, 2005) and latest event happened on 6 December 2008, at Bukit Antarabangsa, Kuala Lumpur, four people killed, one unaccounted, 17 injured and 14 bungalows buried (UtusanMalaysia, 2008) - See Figure 1.

**Figure 1**: Examples of landslide events in Malaysia

Most of the tragedies are largely triggered by incidences of heavy rain either a single heavy rainstorm event or successive days of moderate rain during the rainy season. The real time rainfall values in the hilly terrain could serve as a useful indicator of the risk level of landslides. Therefore, monitoring of the landslides and solving of their mechanism are very important to prevent and to reduce their negative effects (Kalkan, Baykal, Alkan, Yanalak, and Erden, 2002).

The activity of existing landslides can be investigated by using two surveying methodologies: **point based** (Total Station, GPS) and area based techniques (Photogrammetry, **Laser Scanning and Remote Sensing**).

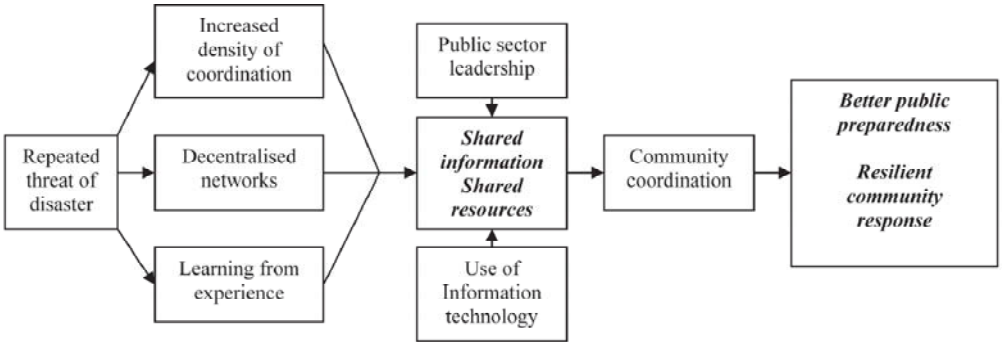
## 7. Malaysian experience in landslide assessment

The Malaysian government departments involved in landslide mitigation are the Public Works Department (PWD), Department of Mineral and Geosciences (DMG) and Centre of Remote Sensing (MACRES). PWD is the main technical department in Malaysia and is largely involved in slope remedial works (active action) as well as the development of slope assessment and management (passive action). The main contribution of the DMG and

MACRES is to inform the government of areas prone to land sliding. They have produced slope or terrain hazard zonation maps and these are widely used by the government agencies as a guideline in the development of hilly and mountainous areas (**S. Jamaludin and A.Nadzri ,2006**).The Drainage and Irrigation Department (DID) has installed rain gauges nationwide for monitoring and prediction of flood. the Malaysian Meteorological Department MMD will work closely with DID for the sharing of rainfall data to improve the data coverage and to strengthen MMD's warning capabilities on weather related hazards.

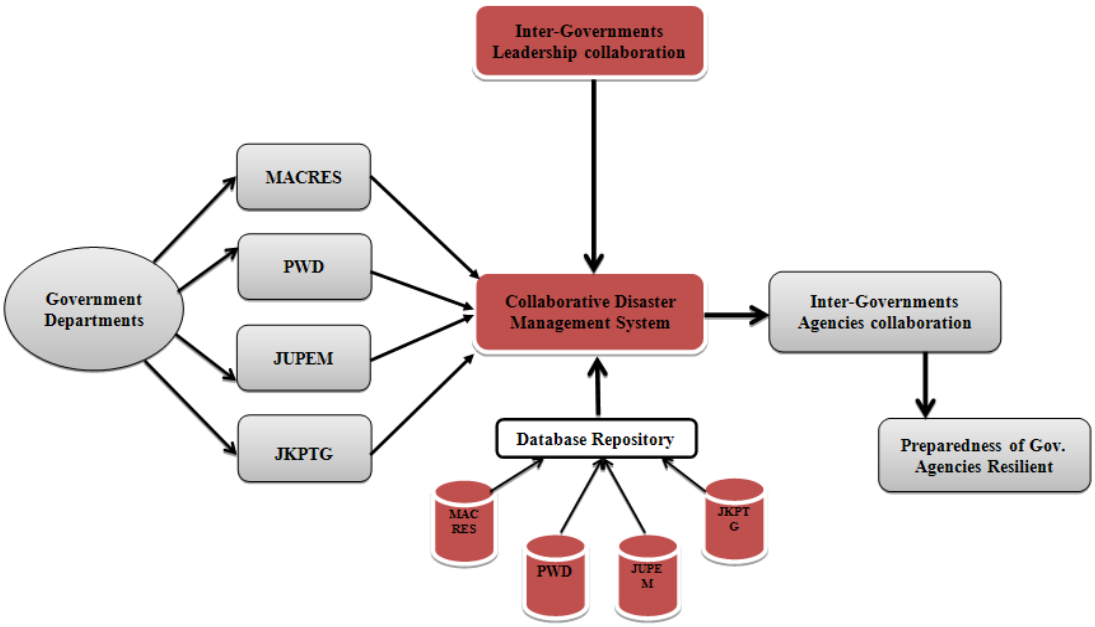
## 8. Proposed model for Collaborative Disaster Management System

According to Kapucu (2008) emergency management consists of four elements: mitigation; preparedness; response; and recovery. In this theoretical framework has been mentioned these four stages. Mitigation refers to those actions that prevent a disaster, reduce the chance of it happening, or lessen its damaging effects. Preparedness refers to those actions taken before impact, including plans. Response refers to actions taken during the initial impact of a disaster, including those to save lives and to prevent further damage to property. Recovery refers to those actions taken after the initial impact, including those aimed at achieving a return to normality (Kapucu, 2008).

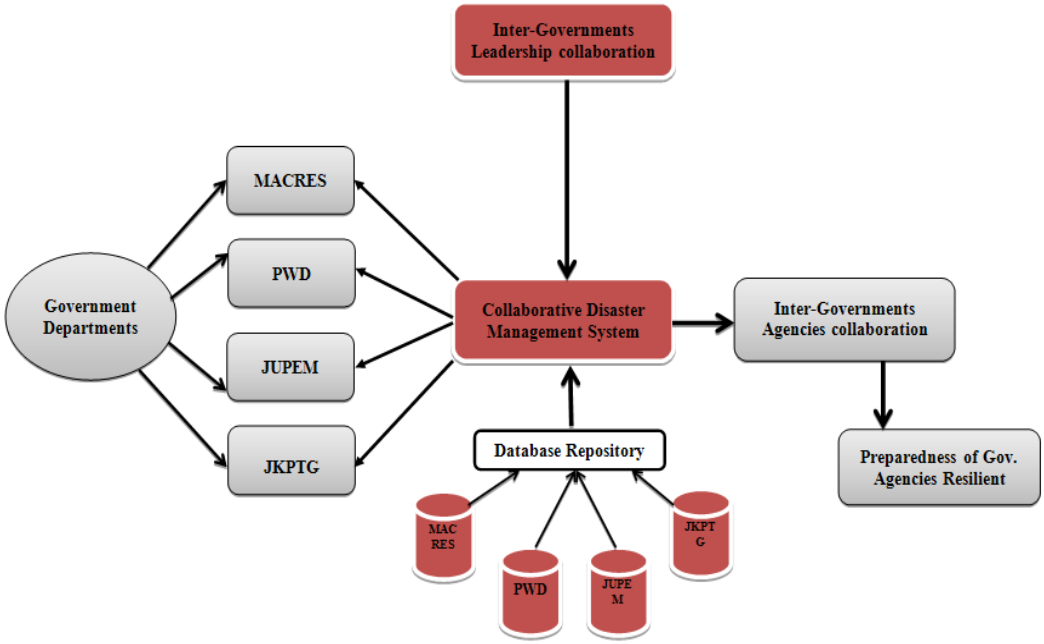



Kapucu's Theoretical Framework

According to kapucu (2008), Disasters have a very low or unknown probability of occurring ('low-probability events'), but if they do happen, they generate enormous losses. In this regard our concern for collaboration with pre-disaster stage, so our propose model is quite different. Particular government agencies or departments are associated with this phase. MACRES, PWD, JUPEM, JKPTG they will collaborate with each other by centrally. Every organization has their own database. Inter-government is responsible for coordinating the Collaboration Disaster Management System. Finally, based on collaborative inter-government agencies report government will go for action.




Our Propose Model




In this diagram, two way directions refers that, once the government agencies will send their information to central, as a same time they are also getting other information which are done by other agencies.

Focusing our attention to information seeking, we present a four layer model centered on information access and organization in Figure 3. On the left side, four layers are labeled, on the

right side, examples are given for these layers and in the middle, and a typical scenario is presented. These four layers are described below in detail.

### 6.1 Layer-1: Information

This layer contains information in various sources and formats (structured, semi-structured, and unstructured). The sources include databases, and Webpage; formats include text, images, and videos.

### 6.2 Layer-2: Tools

This layer consists of tools and techniques a user can use to access the information of layer-1. In addition, since this layer also acts as a mediating layer between information and users, it includes a variety of user interfaces, starting from results as rank-lists to touch panels with mechanisms to visualize results. We can see that a large amount of research in information resources (IR) is focused on the link betweenLayer-1 and layer-2; that is, developing tools and services appropriate for retrieving information of various forms (Shah, 2008) .

### 6.3 Layer-3: User

This layer consists of a user, who uses the tools in layer-2 to access the information in layer-1 and accumulate the knowledge in layer-4. We can see that the focus of HCI research has been on the link between layer-2 and layer-3; that is, presenting the information and the information access tools in effective ways to the user. This layer-3 also includes elements relating to a user, such as user profiles, which can be used for personalization(shah, 2008).

### 6.4 Layer-4: Results

The user of layer-3 accumulates the information relevant to him in layer-4. In the most basic sense, this could be a set of WebPages that the user found relevant from his searches on the Web. Extending this further, we can have bookmarks, notes, and other kinds of results, sometimes stored with attributes such as tags, metadata, and comments. At a more conceptual level, this layer consists of the knowledge that the user gained by his information seeking process (Shah, 2008).

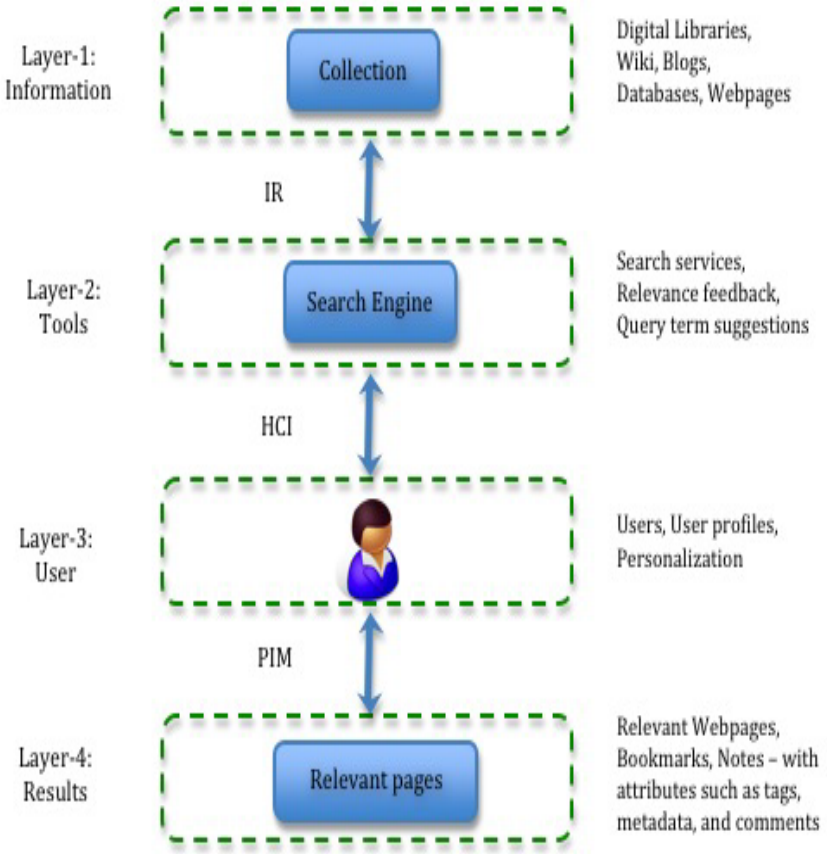



**Figure 3**: Four layer model of information seeking centered on Information access and organization
**Source**: **Chirag Shah (2008)**

We will now extend the general model of information seeking presented in the previous section to incorporate the notion of collaboration that we discussed earlier. To be specific, we will investigate the situations in which a group of users collaborate using traditional or collaborative tools to achieve personal or common information goals. A model with such a configuration is given in Figure 4. This is obtained by extending the original model of information access and organization for respective government agencies. In the case of collaboration, they will have a way to communicate with one another. They may have a common or shared interface. They may also have a shared space where they can store and organize their results. In other words, collaboration between these two users can occur at various levels: (1) while formulating an information request, (2) while obtaining results, and (3) while organizing and using the results (Shah, 2008).

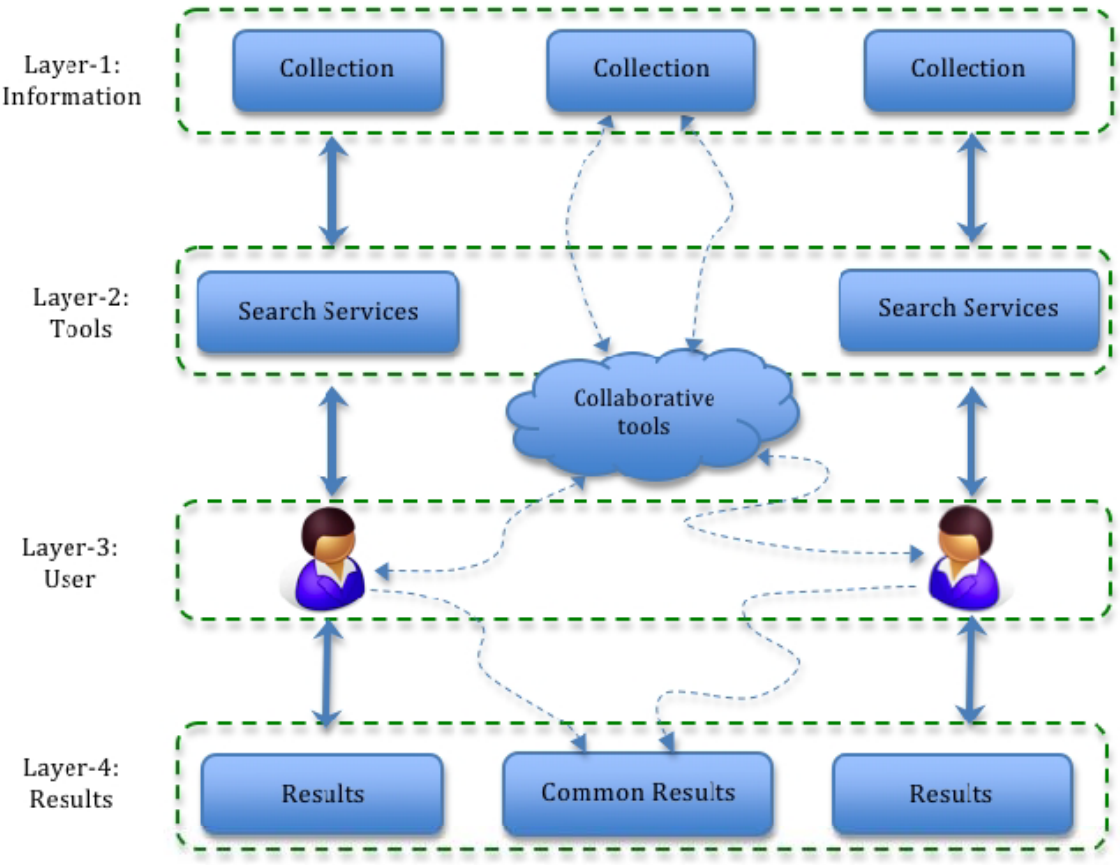



**Figure 4**: A model for collaborative disaster management system
extended from the model in **Figure 3**
**Source**: **Chirag Shah (2008)**

## 9. Conclusion

There is need for more collaboration and continued development of operational and Warning systems among Malaysian Government Agencies such as (MACRES, PWD, JPS, JAS) to provide more effective forecasting regarding the implications and impacts of natural disaster such as landslide.

In this article we attempted to formalize the concept of collaboration and proposed a model of Collaboration Information Seeking Malaysian Collaborative Disaster Management System that put collaboration in perspective. We presented a model of collaboration that incorporated often interchangeably used concepts, such as ‘coordination’, ‘cooperation’, and ‘collaboration’. With this model and related works on collaboration, we came up with requirements and guidelines for having a successful collaboration. This understanding will then be translated into proposing a model for Malaysian Collaborative Disaster Management System. We believe this model can not only help us implement Malaysian Collaborative Disaster Management System environments, but also evaluate existing systems for collaboration. Often “collaborative” systems are designed by mixing various parts or objects of an information seeking process; however, we want to emphasize that a true collaborative system has to be based on a more user-centric design, giving the maximum freedom to the users, than letting the system carry out all sorts of “collaboration” invisibly. Our hope is to see Malaysian Collaborative Disaster Management System realized using a well-grounded model, such as the one proposed here, rather than simply extending a single-user information resource (IR) system for multiple users. Finally, one should also be cautious about the limitations of collaboration. It is important to point out that putting a group of people together does not always result in something that is better than what can be produced by an individual. Another significant aspect to consider is the kind of task. As noted earlier, collaboration may not prove to be effective in certain situations. All of these directions are worth investigating for a better understanding of Malaysian Collaborative Disaster Management System processes and enhancing user experience in collaborative environments.

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