

The Success Factors for Government Information Sharing (GIS) in Natural Disaster Management and Risk Reduction

Abdul Rahman Ahmad Dahlan¹, Hayati Mohd Dahan², and Md Yazid Mohd Saman³

¹ Faculty of ICT, International Islamic University Malaysia (IIUM)

² Faculty of Business Management, University Technology Mara (UiTM)

³ Faculty of Science & Technology, University Malaysia Terengganu (UMT)

Abstract— The frequency of natural disasters has been increasing for the last 30 years in the world, having caused great damages/losses. Among those damages/losses, about 90 % are concentrated in the Asian region where natural disasters are one of the serious issues not only for humanitarian but also for economic and industrial point of view. These bring about the loss of lives, property, employment and damage to the physical infrastructure and the environment. Disaster management (DM) including risk reduction efforts aim to minimize or avoid the potential losses from hazards, assure prompt and appropriate assistance to victims of disaster, and achieve rapid and effective recovery. While information, knowledge and resources sharing can enhance the process of DM, there is a perceived gap in government collaboration and coordination within the context of natural DM. Identifying potential success factors will be an enabler in managing disasters. The objective of this paper is to present the literature findings on success factors that ensure government information sharing quality in supporting effectively DM. Accordingly the identified factors were classified into major categories, namely political leadership support, inter-agency collaboration, individual agency capacity including ICT, and agency benefits.

I. INTRODUCTION

Billions of people across more than 100 countries are periodically exposed to at least one natural disaster [1], where around 30 natural disasters world-wide have been identified [2]. There is evidence that the frequency and extent of natural disasters are increasing on a global scale [3]. In the decade 1900-1909, natural disasters occurred 73 times, but in the period 2000-2005 the number of occurrences rose to 2,788 [4].

Natural disasters claim many human lives, damage a great deal of property, have devastating impacts on economy and environment [5]. For example, on December 2004, a massive earthquake of magnitude 9.0 struck the coastal area of northern Sumatra in Indonesia and this triggered the tsunami that affected Indonesia, Thailand, Sri Lanka, India, Maldives, Bangladesh, Malaysia, Myanmar and Somalia [6] [7]. It is identified as one of the deadliest and costliest disasters in history [8] [9] which caused an estimated US \$ 9.9 billion worth of damages [10]. The death toll is estimated to be between 200,000 and 300,000 [11]. Haiti earthquake and Pakistan floods in 2010 record the latest deadliest

disasters. The total cost of natural disasters in 2008 was US\$ 181 billion [12].

Malaysia has also experienced some devastating natural disasters. In 2007 alone, 29 people had been killed and more than 166,000 people had been affected by floods, with economic damage amounting to USD 968 million [13]. From December 2010 to February 2011, the northern and southern states of Malaysia experienced devastating floods, where flood is the most significant natural hazard in Malaysia [13]. In terms of landslides in Malaysia, based on the National Slope Master Plan 2009-2023[14], about 440 landslide cases were reported from 1960 to 2007. Of these, 25 cases were considered as major landslides in which sizeable number of fatalities, serious injuries and substantial property damage had been reported. The total economic loss associated with landslides from 1960 to 2007 was about RM 3.0 billion [14]. In the December 2008 Bukit Antarabangsa landslide tragedy, four residents were killed with many injured. The recent 21 May 2011 Ulu Langat and 7 August 2011 Cameron Highlands landslide tragedies where 16 dead/ 9 injured and 7 dead/3 injured respectively had been reported. This is despite of the fact that Guidelines for Slopes has been widely applied to minimize risks in slope failure disasters, based on the “*National progress report on the implementation of the Hyogo Framework for Action (2009-2011)*” [13].

Therefore the need to reduce disaster risks [1] and develop a resilient community is of increasing concern in many countries [15]. This demand for a comprehensive disaster management (DM) including risk reduction program covering a wide range of disciplines, sectors and organizations, calling for diverse and expanded forms of partnerships [16]. The achievements from networking and collaboration can be far more powerful than individual or specialist contributions. According to the theory of organizational learning, inter-organizational information and knowledge sharing is important, because no single organization can have all the resources necessary to run its activities without inputs from other organizations [17]. Thus, inter-organizational information sharing and collaboration have been termed “the core” of DM [18]. In the context of disaster reduction in Malaysia, for an example the prediction of landslides occurrences as well as for adequate mitigation/preparedness planning and decision-making, the Public Work Department requires multiple climatic and non-climatic data from other government agencies such as Department of Irrigation and Drainage, Meteorological

Department, Agency of Remote Sensing, Town Planning Department, local councils, agriculture department and forestry department [14]. Furthermore, with the advent of ICT and information systems, sharing information through creating networks between government agencies, the public, the private sector and professional bodies is technically feasible.

However, an important challenge is to develop sustainable mechanisms and policies to link these DM-related-organizations. These networks and collaboration can only be successful if these wide ranges of participants display the same commitment to share their information, knowledge, experiences and expertise [16]. It is observed that a perceived gap in information and knowledge sharing between government agencies exists within the context of DM [19] [20]. In addressing challenges of inter-government collaboration, government agencies tend to behave as separate organizations, rather than operate under the whole-of-government concept [21] and the lack of commitment on behalf of government officials [22].

Hence, this research aims to identify what are the success factors which best promote sustainable and effective government information sharing (GIS) and collaboration in DM. With regard to this study, this paper presents the literature findings on success factors which support successful GIS and collaboration in natural DM. Future studies shall involve the formulation of a research framework and research instrument, and as well as interviews with experts who are responsible in Malaysian DM.

II. NATURAL DISASTER MANAGEMENT (DM)

A. *Natural Disaster*

A disaster is defined by the International Strategy for Disaster Reduction [23] as: “A serious disruption of the functioning of society, causing widespread human, material or environmental losses which exceed the ability of affected society to cope using only its own resources”. Disaster types and definitions have been discussed by Turner et al. [24], the World Health Organization [25] and the Federal Emergency Management Agency[26]. The types of disaster have been reviewed, and it was found that natural, man-made and hybrid disasters cover all types of disastrous events. Natural disasters are catastrophic events resulting from natural hazards. Natural disasters result from internal (beneath the Earth’s surface), external (topographical), weather-related (meteorological/ hydrological) and biological phenomena. Natural disasters are beyond human control. Natural disasters are often termed an “Act of God”. Federal Emergency Management Agency, USA has classified natural disasters into earthquakes; extreme heat; floods and flash floods; hurricanes; landslides and mud flows; thunderstorms and lightning; tornadoes; tsunamis; volcanoes; and wild fires. The Malaysian National Security Council Directive 20 [27] classified natural disasters into floods, storms, drought, shore erosion, landslides or any other disaster due to strong winds and heavy rain.

On the other hand, man-made disasters are those catastrophic events that result from human decisions and

actions. Man-made disasters can be sudden or long-term disasters. Sudden man-made disasters are known as socio-technical disasters. It is also highlighted that socio-technical disasters occur in at least four types of organizational situations. These are plant and factory failures (major accidents); transport failures; stadia or other “public place” failures; and production failures. The Center for Research on the Epidemiology of Disasters (CRED) has established criteria for defining disasters qualified to be entered into its disaster databases, i.e. at least one of the following criteria has to be fulfilled, either ten or more people has been reported killed, or 100 people has been reported affected or a call for international assistance has been made; or a state of emergency has been declared [28]. This paper focuses on natural disasters.

B. *DM and Disaster Risks Reduction*

It is generally agreeable that there is no way of eliminating all adverse impacts and consequences resulted from natural disasters. However, plans and actions can be made in order to minimize their adverse impacts. In this regard, effective DM including risks reduction is a key element in good governance [29]. DM efforts aim to reduce or avoid the potential losses from hazards, promote prompt and appropriate assistance to victims of disasters, and seek to achieve rapid and effective recovery. DM involves plans, structures, and arrangements established to engage the normal endeavors of governments, voluntary and private agencies in a comprehensive and coordinated way to respond to the whole spectrum of DM cycle. One of the important activities is carried out in an urgent manner when there is an onset of disaster occurrence. All DM activities are centered at governmental departments and agencies. DM has two (2) main components, namely Risk Management (before a disaster strikes) and Crisis Management (after a disaster strikes). Risk management includes two (2) generic phases, namely Prevention & Mitigation, and Preparedness – Prediction & Early Warning System. While Crisis Management includes two (2) phases, namely Emergency Response – Search, Rescue & Relief, and Impact Assessment, Recovery, Rehabilitation & Reconstruction [27].

Despite the growing understanding in the importance and acceptance of disaster risk reduction and the increased disaster response capacities, DM including reduction of risk continue to pose a global challenge. Sustainable development, poverty reduction, good governance and disaster risk reduction are mutually supportive objectives, and in order to meet the challenges ahead, accelerated efforts must be made to build the necessary capacities at the community and national levels in managing and reducing risks. Such an approach is to be recognized as an important element for the achievement of national and internationally agreed development goals. There is now on-going international agreement that efforts to reduce disaster risks must be systematically integrated into national policies, plans and programs for sustainable development and poverty reduction, and supported through bilateral, regional and

international cooperation, including partnerships. The importance of DM and disaster risk reduction efforts on the international, regional, national and local levels has been recognized in the past few years in a key multilateral frameworks and declarations [30].

The World Conference on Disaster Reduction, held from 18 to 22 January 2005 in Kobe, Hyogo, Japan, has adopted the present Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters (referred to as the “Hyogo Framework for Action” or HFA). The Conference provided a unique opportunity to promote a strategic and systematic approach to reducing vulnerabilities and risks to hazards and disasters. It highlighted the criticality and need for, and identified ways of, building the resilience of nations and communities to disasters. The HFA is a recognized global guide for facilitating the effective implementation of disaster risk reduction at the international, regional, national and local levels to substantially reduce losses of life and of the social, economic and environmental assets of communities and countries [31].

The HFA proposes five priorities for action: (1) ensure that disaster risk reduction is a national and 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; and (5) strengthen disaster preparedness for effective response at all levels. The implementation of the Hyogo Framework entails fostering national political commitment to integrate disaster risk reduction into national development planning; evaluating existing legal and institutional mechanisms and policies and strengthening the clear distribution of tasks and the allocation of responsibilities; engaging in dialogue with all relevant national actors in DM to set up a multi-disciplinary and multi-stakeholder national coordination mechanism for disaster risk reduction; and institutionalizing disaster risk reduction and establishing mainstreaming mechanisms [31].

C. Fundamental Roles of Information Systems in DM

ICT, information systems and inter-agency information sharing play fundamental roles in supporting the Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters. This is the main outcome of the World Conference on Disaster Reduction, held in Kobe, Japan, in January 2005 [31]. Information system is essential for building quality information and knowledge based on risk and disaster risk management; establishing a hazard monitoring programme that includes effective, timely and reliable early warning and alert systems at the national and local levels; integrating remote sensing and Geographical Information System databases for disaster risk management; enhancing inter-agencies information sharing and access to information and knowledge base; and an understanding of risk and risk management; involving the media community in risk assessment and risk communication; and organizing and coordinating emergency

operations, disaster response and recovery capability [31]. DM is information intensive, where access to quality information is crucial before, during and after disaster strikes [31].

UN-ISDR [30] says that effective DM depends on the informed participation of all stakeholders. The exchange and sharing of quality information with easily accessible communication practices play key roles. Data, information and knowledge sharing is crucial for ongoing research, national planning, monitoring hazards and assessing risks. The widespread and consistent availability of current and accurate data is fundamental to all aspects of DM activities. Information describes working conditions, provides reference material and allows access to resources. It also shapes many productive relationships. Advances in ICT especially mobile data communications and network infrastructure, help to capture and disseminate experience, convey professional knowledge and contribute to well-informed decision-making processes. Integrating new developments in information management with established and more traditional methods can help to create a much better understanding about hazards and risk at all levels of responsibility. This information and knowledge can be disseminated through public awareness and education programmes. Information sharing is also instrumental in achieving more comprehensive early warning systems and effective mitigation efforts.

III. GOVERNMENT INFORMATION SHARING (GIS) IN THE CONTEXT OF DM

GIS is defined as the capability of government agencies to access, obtain, possess and apply information and knowledge in common with other organizations [32] [33] [34] [35] [36]. GIS is a key capability required for one-stop and networked government or “Whole-of-Government” approach, responding to a variety of intra-organizational, inter-organizational or cross-national needs like sharing service-related information between parties involved in the delivery of seamless services, sharing information on available resources to enable “Whole-of-Government” response to disasters and emergencies, etc [35]. GIS offers a real opportunity to share databases and information, thus enabling well-informed decision-making process [37] [38] [36]. GIS initiatives attempt to “unlock” data on fragmented databases or isolated information systems spanning multiple government agencies, making it readily discoverable and accessible to authorized users for direct consumption or further analysis and processing. Contexts for information sharing range from intra-organizational - for instance sharing citizen data among functional units within a single government agency; through inter-organizational - for instance the delivery of seamless services involving cross government agencies processes; to inter-governmental - for instance the exchange of health or security surveillance or climatic data among neighboring countries or among different states in a federal government system [35] [36].

In the context of DM and disaster risk reduction initiative, multiple climatic and non-climatic data are

required to access, analyze and predict the impacts of and vulnerability to climate change and to work out adaptation needs. The availability of and timely access to information and reliable climatic data on rainfall, tropical storms, temperature, sea surface temperature, sea level rise, and frequency and intensity of events, among other things, and non-climatic observational monitoring data on water resources, agriculture, environment and ecosystems, for example, from different organizations are critical for adequate planning and decision-making in the medium and long term [31]. Hence, GIS is both critical for governments to effectively discharge their responsibilities and at the same time poses challenges for them to achieve. Despite its importance, the GIS capability is not common for governments due to various technical, organizational, cultural and other barriers which are generally difficult to address by individual agencies [35]. Developing such GIS capabilities is a challenging task which requires government-wide coordination, explicit policies and strategies, and concrete implementation frameworks [35] as well as political commitment to integrate disaster management and risk reduction into national agenda [31]. Lack of commitment on behalf of government officials has also been identified as a hurdle in developing policy that enables a culture of communities' resilience [22].

"The rise of intricate inter-organizational service networks has not only vastly complicated the top-down job of government management. With programs increasingly interrelated, government organizations not only face the job of managing their own programs but also connecting seamlessly with closely related programs. Focusing narrowly on an organization's own programs can undermine effective government because the more that government tries to address complex problems and the more it uses a broad network to do so, the more any organization's success depends on its ability to work with others." [39]. The weaknesses of program-specific information and knowledge sharing, implemented in silos or independently, lacks an overarching framework have been highlighted extensively, with evidence, particularly in the context of counter-terrorism efforts [40]. Landsbergen and Wolken [41] also point out that interoperability across government agencies actually represents GIS. They claim that, GIS, more holistic and effective actions can be planned and applied to solve complex problems, and as an outcome, effectiveness can be achieved. GIS can stimulate and enhance the capabilities of integrating strategic data into a standard format to increase the use of information from different data sources, and further provide the participating organizations the capability to have more integrated, diversified, and efficient services to the public and target customers [37] [17] [42] [52]. In addition, GIS can lead to significant cost savings and reduce resource utilization [57] [37] [52] [17]. For digital data, it is easier to duplicate, reformat, merge and consolidate with other databases for enquiry, reporting, analysis and well-informed decision-making. Hence, cost can be optimized and efficiency is accomplished. Organizations can act more quickly to identify problems in a more holistic manner and

subsequently provide solutions that are holistic, relevant and timely [41]. Relationships among the involved organizations can be improved and intensified, and further cooperation will be enhanced to share more resources [17]. It is not only possible to share information and knowledge but also to share IT infrastructure such as hardware and software which is another significant way in optimizing IT costs and to synergize the use of available resources across government organizations [37] [41] [42]. More and more researchers have recognized the importance of GIS, especially in the e-Government research area [37] [52] [17]. While most of the inter-organizational information-sharing in private sector literature focuses on supply chain management [21], this study focuses on public sector literature to discuss success factors that enhance the quality of information sharing among government agencies in DM.

However, sharing of information and knowledge can involve complex interactions between organizations [17]. As Gil-Garcia et al. [52] point out, an inter-organizational cooperation to build a capacity of information sharing and integration is understood to be more complex than an intra-organizational or enterprise-wide initiative focusing on a specific problem. In the government sector, information-sharing projects may cause conflicts in turf, budget and autonomy between agencies and encounter resistance from agencies and departments [43]. According to researches, there are multi-faceted factors which influence cross-boundary information sharing in government agencies [37] [53] [44] [17] [42]. They point out that it is a challenge to integrate information systems of different organizations. In addition, other critical factors such as relationships between involved organizations, management issues, privacy concern, human behaviors, resources in the environment, and government policy all bring significant weights to influence inter-organizational information sharing in the public sector.

Collaboration with other organizations, agencies or authorities is inevitable [45]. Government agencies, normally as the first and major responders in a disaster [46], when facing large scale disaster and acting as a single agency can become ineffective due to insufficient resources and expertise [47] or limited responsibilities. The U.S. General Accounting Office [48] recognized this need of government information and knowledge sharing after September 11, 2001, as well as the U.S. Department of Health and Human Services building an emergency registration system for personnel resource collaboration [49].

IV. PROBLEM STATEMENT

Identification of key success factors for government information sharing (GIS) within the DM and risk reduction perspective is therefore critically required. This paper is based on a comprehensive literature survey and review carried out, to identify the success factors that ensure the quality of information and knowledge sharing amongst DM-related government agencies. As a result of this detailed literature synthesis, a list of success factors within DM perspective is identified and provided in succeeding section. Future studies shall involve the formulation of a research

framework, establishing a research instrument, and conducting interviews with DM experts who are responsible in Malaysian.

V. SUCCESS FACTORS IN DM GOVERNMENT INFORMATION SHARING (GIS)

Success factors are truly important matters that must be considered for the performance of an operation. In the context of DM, success factors can be defined as; circumstances, facts, or influences that can directly affect the quality of disaster management information and knowledge sharing amongst government agencies. It is currently underway and this section provides the literature findings on success factors that need to be verified in ensuring the quality of GIS in DM. Identified success factors are classified into several broad categories as (a) Political Leadership Support - Legislation, Directives & Policy and Project-wide Champion, (b) Inter-agency Collaboration – Trust, Relationship, Compatibility, (c) individual Agency Capacity - Agency Top-management Support, IT Capability, Costs, and Process Security, and (d) Agency Benefits – Benefits and Risks.

A. *Political Leadership Support*

Political leadership or project-wide champion refers to the existence of an organization that is committed to implement and oversee GIS initiative at the higher or national level. Landsbergen & Wolken [41] stated that interoperability projects among government agencies were more easily implemented when there was a common executive leadership. In the context of DM initiative in Malaysia, the project-wide champion can be the National Security Division under the Prime Minister Department that is committed to implement and oversee information and knowledge is shared by the government agencies such as Public Works Department, Department of Irrigation & Drainage, Meteorological Department, Agency of Remote Sensing, Town & Urban Planning Department, and Minerals & Geosciences Department.

Legislation and policy have strong influence on the quality of information and knowledge sharing across organizations, especially for organizations in the public sector [37] [53] [52] [41] [42]. According to Wilson [50], in a complex political environment, government agencies are influenced and supervised by president and legislatives such as congress. In addition, government agencies also need to cope with pressures from citizens and courts, and lobbying from interest groups [51]. Researchers point out that legal and policy regulations can facilitate relationship building, risk reducing, and trust developing in inter-organizational information sharing projects when specific guidance such as how to utilize information is proposed [53] [52] [54] [55] [56]. They also claim that the lack of legislative support to assure the privacy and confidentiality of shared information can impede inter-organizational information sharing in the public sector. A suitable policy to protect information privacy is critical. The approach will also alleviate the concerns of general public by increasing their trust in the

interoperability of government projects [41] [42]. In addition, Bajaj and Ram [57] suggest that multiple players should be involved when determining what information to share in the public sector. The multiple players are privacy advocacy groups, involving government agencies, and legislatives [57]. Lastly, without support from legislatives and policy, GIS can lose its priority and lack necessary funding and resources to make the project sustainable [37] [58].

B. *Inter-agency Collaboration*

The formulation, establishing and sustainability of inter-organizational relationship rely heavily on trust building between involved organizations [37] [41] [59] [60] [17]. In addition to incentive and authority, trust is an alternative approach to achieve inter-organizational information sharing and collaboration [60]. However, trust in information sharing and collaboration decreases due to concerns of losing autonomy and information misusing by other organizations to incur liabilities [61]. Some organizations are also anxious that information and knowledge sharing to other organizations can cause losing of valuable assets and competitive advantages [17]. The lack of trust between organizations is common in the private sector and in the public sector where political conflicts exist [17]. Researches also propose that the clarity of role and responsibility, the respect for autonomy, and the appropriate exercise of authority can help to build trust between participating organizations in government information sharing [62]. Furthermore, a technology mechanism to build a secured information sharing environment also helps to increase the trust among government agencies to share information [63].

Inter-agency relationship or social networks refers an agency has formed or has been forming close social relationships with other agencies. Social network researchers have examined the role of weak versus strong ties in the acquisition of novel information. Weak ties are more likely than strong ties to be bridges to socially distant regions of a network and, therefore, new information. Successful participation by key DM-related organizations in pre-disaster, consensus-building emergency planning processes can lead to strengthening inter-agency relationships that improve information sharing and the effectiveness of DM activities [64]. Such inter-agency preparedness can play a role in the response stage for early warning, evacuation plans and strategies, and detailed situation reports on ongoing disasters [65] [66].

Compatibility refers to the degree to which participation in government information sharing with other agencies is perceived as being consistent with existing information systems, tasks, and the current needs and objectives of the local agency [67]. Caudle [68] found that the integration of data processing, office automation technologies and telecommunication networks is required to prevent the incompatibility of technologies. Researches indicate that information and knowledge sharing may involve complex interactions between involving organizations [69] [53] [54] [17] [60]. They claim that organizations can have different

missions, visions, values, and cultures and may spread in different geographic areas to make communication difficult and inefficient. For instance, Drake et al. [69] point out that cultural difference between government agencies is a barrier to cross-boundary information and knowledge sharing. Furthermore, government organizations can have competing interests. It is not an easy job to have several government organizations target on one shared objective when they have diverse organizational values [51] [70]. Researches point out that, if each organization focuses on respective self-interest, it is difficult to align the mission, to achieve the agreement, and to identify the shared goal of inter-organizational collaborations [51] [62]. They believe that negotiation and commitment development are critical to foster the inter-agency compatibility, when conflicts and risks are created during information and knowledge sharing processes.

C. Individual Agency Capacity

Agency top-management can be utilized as an authority force to promote cross-boundary collaboration between organizations [71]. By providing vision, guidance, and resources, top management support can help to initiate and implement cross-boundary information sharing [59]. Gil-Garcia et al. [53] propose how top-management of agency influences inter-organizational information sharing in the public sector. They believe that top-management of government agencies play an important role in dealing with information sharing initiatives to serve and solve public problems. In their proposed model, top-management is exercised and manifested through executive involvement, formal authority, and informal leadership. Executive involvement can help information sharing initiatives through supporting informal leaders, respecting autonomy of participating organizations, encouraging employees to participate, and providing financial resource. Formal authority can help to build agreement among participating organizations, create an environment to develop appropriate and effective strategies, and bring key actors to get continuously committed and involved. Lastly, informal leaders can help to build trust among participants, facilitate interactions of participants of various backgrounds, provide localized solutions to complex problems, and clarify roles and responsibilities of participants in the collaborative process [53].

Zhang and Dawes [58] point out that with the advancement of ICT, the effectiveness and efficiency of inter-organizational information sharing and collaboration can be enhanced. Chau et al. [72] claim that with the growth of the Internet, information among government agencies can be more easily shared than before. Information and knowledge becomes an important exchanged asset in the network of cross-boundary interaction [42]. However, different organizations may have various types of hardware and software in their information systems that can cause challenges in inter-organizational information sharing. It becomes a very challengeable task to integrate heterogeneous information systems of different platforms, data standards, schemas and qualities [72] [37] [51] [53]

[44] [62] [42] [54]. Therefore, methodologies such as XML standard are applied to help integrate heterogeneous databases that have inconsistent data structures and definitions [57].

Furthermore, the lack of resource e.g. budget and staff in government agencies can also hamper inter-agency information sharing initiatives [45]. Because of limited resource, an agency that can be the information provider may focus on other urgent issues within its own organization when the immediate benefits of sharing information cannot be foreseen by the agency [41] [42]. However, although the short-term cost involved in cross-boundary information sharing may be high, one of the long-term advantages is actual cost saving. In addition, Pardo and Tayi [17] point out that organizations tend to compare reward and risk before sharing information and knowledge. They claim that, through the perspective of transaction cost economics theory, incentive plays an important role to cross-boundary information sharing. Agencies spent their resources such as budget, staff, network, and time to collect information and build up knowledge. Therefore, without appropriate compensation, agencies often are not willing to share their information and knowledge with other agencies [72] [17].

In terms of operational processes, the lack of an explicit mechanism of work management (including monitoring, control, communication, checking of work procedures, and sharing and integrating tasks and responsibilities) causes both internal and external collaborative procedural problems [45]. Better understanding of the nature of collaboration across organizations can also produce benefits. It is easy to confuse between responsiveness with collaboration. The lack of a definition of accountability for each individual organization or agency in different levels of jurisdiction of DM, and unclear agreements among them, causes difficulties in establishing effective collaborative operational processes [45]. Disasters will inevitably produce calls for responsiveness in operations, but an effective response is unlikely to happen without prior collaboration and sharing of information [73]. Vigoda [74] helps to clarify this issue when he argued that New Public Management notions of responsiveness have also been accompanied by “a lower willingness to share, participate, elaborate, and partner with citizens.” Responders can be blinded by their own good intentions.

D. Agency Benefits

Kolekofski and Heminger [75] claim that organizational members' beliefs have impact on their attitude and intention to share information. Some organizational members may always question why individuals require the information they possess, while others always keep an open-mind to the requests of their own information [75]. According to Willem and Buelens [71], people are only willing to share their knowledge when they feel that they are protected against opportunistic people. Hence, in information and knowledge sharing, trust between the involved individuals is critical [42]. Trust can enhance better communication to facilitate information sharing [76]. Trust can promote efficient sharing

of information and knowledge among organizational members because of trustworthiness of each other in their interaction and work ([71]. Jarvenpaa and Staples[77] also claim that sharing of information and knowledge relies on trust of the other party without requesting immediate reciprocal return. The lack of trust among organizational members can create barriers to information sharing in an organization [78].

VI. CONCLUSION AND FUTURE WORKS

This study has identified a list of success factors to be considered as key enablers for ensuring the quality of GIS in DM and risk reduction. These factors are classified into: a) Political Leadership Support covering Legislation, Directives & Policy and Project-wide Champion, (b) Inter-agency Collaboration encompassing of Trust, Relationship, and Compatibility, (c) Individual Agency Capacity encompassing Agency Top-management Support, IT Capability, Costs, and Process Security, and (d) Agency Benefits – Benefits and Risks. Future works involve the formulation of a research model, developing a research instrument, and conducting interviews with DM experts, where key enablers can be established in Malaysia. This understanding will assist the government officials in developing alternatives for enhancing their inter-agencies information and knowledge sharing in DM and risk reduction more effectively.

REFERENCES

- [1] Moe, T. L., Gehbauer, F., Sentz, S. and Mueller, M. (2007), *Balanced scorecard for natural disaster management projects*, *Disaster Prevention and Management*, 16(5), 785–806.
- [2] Deshmukh, R., Rodrigues, L. L. R. and Krishnamurthy, G. R. (2008) *Earthquake risk and knowledge management*, *Journal of Knowledge Management Practice*, 9(3). Available at: <http://www.tlinc.com/article162.htm> [accessed 1 June 2012]
- [3] Warren, C. M. J. (2010a) *The facilities manager preparing for climate change*, *Facilities*, 28(11/12), 502–513.
- [4] Kusumasari, B., Alam, Q. and Siddiqui, K. (2010) *Resource capability for local government in managing disasters*, *Disaster Prevention and Management*, 19(4), 438–451.
- [5] Louhisuo, M., Veijonen, T. and Ahola, J. (2007) *A disaster information and monitoring system utilising earth observation*, *Management of Environmental Quality*, 246–262.
- [6] Srinivas, H. and Nakagawa, Y. (2008) *Environmental implications for disaster preparedness: lessons learnt from the Indian Ocean tsunami*, *Journal of Environmental Management*, 89 (1), 4–13.
- [7] Wijetunga, J. J. (2010) *Assessment of potential tsunamigenic seismic hazard to Sri Lanka*, *International Journal of Disaster Resilience in the Built Environment*, 1(2), 207–220.
- [8] Rodriguez, H., Wachtendorf, T., Kendra, J. and Trainer, J. (2006) *A snapshot of the 2004 Indian Ocean tsunami: societal impacts and consequences*, *Disaster Prevention and Management*, 15(1), 163–177.
- [9] Morin, J., Coster, B. D., Paris, R., Flohic, F., Lavigne, D. L. and Lavigne, F. (2008) *Tsunami-resilient communities' development in Indonesia through educative actions lessons from 26 December 2004 Tsunami*, *Disaster Prevention and Management*, 17(3), pp. 430–446.
- [10] Koria, M. (2009) *Managing for innovation in large and complex recovery programmes: tsunami lessons from Sri Lanka*, *International Journal of Project Management*, 27(2), 123–130.
- [11] Poisson, B., Garcin, M. and Pedreros, R. (2009) *The 2004 December 26 Indian Ocean tsunami impact on Sri Lanka: cascade modelling from ocean to city scales*, *Geophysics Journal International*, 177(3), pp. 1080–1090.
- [12] Warren, C. M. J. (2010b) *The role of public sector asset managers in responding to climate change*, *Property Management*, 28(4), 245–256.
- [13] National Security Council (2011) *Malaysia progress report on the implementation of the Hyogo Framework for Action (2009-2011)*, <http://www.preventionweb.net/english/policies/v.php?id=19795&cid=105> [accessed 1 June 2012]
- [14] Public Works Department (2009) *Malaysia National Slope Master Plan 2009-2023*, <http://www.preventionweb.net/english/policies/v.php?id=13116&cid=105> [accessed 15 May 2012]
- [15] Rotimi, J. O., Wilkinson, S., Zuo, K. and Myburgh, D. (2009) *Legislation for effective post-disaster reconstruction*, *International Journal of Strategic Property Management*, 13(2), 143–152.G.
- [16] United Nations International Strategy for Disaster Reduction (2004). *Living with Risk: A global review of disaster reduction initiatives*. 13-14.
- [17] Pardo, T. A., & Tayi, G. K. (2007). *Inter-organizational information integration: A key enabler for digital government*. *Government Information Quarterly*, 24(4), 691-715.
- [18] Drabek, Thomas E. and David A. McEntire. (2002). "Emergent Phenomena and Multi-organizational Coordination in Disasters: Lessons from the Research Literature." *International Journal of Mass Emergencies and Disasters* 20, 197-224.
- [19] Mohanty, S., Panda, B., Karelia, H. and Issar, R. (2006). *Knowledge management in disaster risk reduction: the Indian approach*. National Disaster Management Division, Ministry of Home Affairs, Government of India.
- [20] Otim, S. (2006). *A case-based knowledge management system for disaster management: fundamental concepts*. In: Van de Wale, B. and Turoff, M. (eds.), *Proceedings of the 3rd International ISCRAM Conference*. Newark, USA, May 2006. 598–604.
- [21] Yang, T. M., Pardo, T. A. (2011). *How is Information Shared Across Boundaries?*, *Proceedings of the 44th Hawaii International Conference on System Sciences – 2011*
- [22] Rivera, J. D. and Miller, D. S (2011). *From recovery to resilience: Long lasting social change and disaster mitigation, Community Disaster Recovery and Resiliency*. Taylor & Francis Group. pp 570
- [23] United Nations International Strategy for Disaster Reduction (2009). *2009 ISDR Terminology on Disaster Risks Reduction*.
- [24] Turner, B.A. and Pedgeon, N.F. (1997), *Man-made Disasters*, 2nd ed., Butterworth-Heinemann, Oxford.
- [25] World Health Organization (2003), "Emergency and humanitarian action: natural disaster profile", available at: www.who.int/disasters/ [accessed 30 May 2012]
- [26] FEMA (2003), "Hazards", March, available at: www.fema.gov/hazards/earthquakes/ [accessed 30 May 2012]
- [27] Malaysian National Security Council, MNSC-Directive 20 (2003), "Policy and mechanism of national disaster management and relief".
- [28] Guha-Sapir D, Vos F, Below R, and Ponsere S. (2012). *Annual Disaster Statistical Review 2011: The Numbers and Trends*. Brussels: Center for Research on Epidemiology of Disaster (CRED), available at http://www.cred.be/sites/default/files/ADSR_2011.pdf
- [29] United Nations International Strategy for Disaster Reduction (2012). *How to make cities more resilient: a handbook for local government leaders*.
- [30] United Nations International Strategy for Disaster Reduction (2005). *Hyogo Framework for Action 2005 – 2015: Building the Resilience of Nations and Communities to Disasters*.
- [31] United Nations Economic and Social Council (2010). *Role of information and communications technology in the implementation of the Hyogo Framework for Action*.
- [32] Caffrey, L. (1998). *Information sharing between and within governments*. London: Commonwealth Secretariat.
- [33] J. Ramón Gil-García, Carrie A. Schneider, Theresa A. Pardo and Anthony M. Cresswell (2005). *Interorganizational Information Integration in the Criminal Justice Enterprise: Preliminary Lessons from State and County Initiatives*, *Proceedings of the 38th Hawaii International Conference on System Sciences – 2005*
- [34] Dawes, S. S., Cresswell, A. M., & Pardo, T. A. (2009). *From "need to know" to "need to share": Tangled problems, information boundaries, and the building of public sector knowledge networks*. *Public Administration Review*, 69, 392-402.
- [35] Estevez, E., Fillottrani, P., & Janowski, T. (2010). *Information Sharing in Government - Conceptual Model for Policy Formulation*. 10th European Conference on eGovernment, Limerick, Ireland.

- [36] MAMPU (2011). *The Malaysian Public Sector ICT Strategic Plan – Powering public sector digital transformation 2011-2015*.
- [37] Dawes, S. S. (1996). *Interagency Information Sharing: Expected Benefits, Manageable Risks*. (JSTOR, Ed.) Journal of Policy Analysis and Management, 377-394.
- [38] Laudon, K.C. and Laudon, J. P. (2012). *Management Information Systems – Managing the digital firm*. 12 Edition, Pearson New Jersey
- [39] Kettl, D. F. (2006). *Managing boundaries in American administration: The collaboration imperative*. Public Administration Review (Special Issue, December), 10-19.
- [40] Office of the Director of National Intelligence USA (2011). *Strategic Intent for Information sharing 2011 - 2015*
- [41] Landsbergen, D. J., & Wolken, G. J. (2001). *Realizing the promise: Government information systems and the fourth generation of information technology*. Public Administration Review, 61(2), 206-220.
- [42] Zhang J. and Dawes, S. S. (2006). *Expectation and perceptions of benefits, barriers and success in public sector knowledge network*. Performance and Management Review, 29(4), 433-466
- [43] Lazer, D. & Maria, C. B.-S. (2005). *Information sharing in e-Government project: Managing novelty and cross-agency cooperation: Report for IBM Endowment for the Business of Government*. Arlington.
- [44] Klischewski, R., & Scholl, H. J. (2006). *Information quality as a common ground for key players in e-Government integration and interoperability*. Paper presented at the Hawaii International Conference on System Sciences (HICSS-39), Hawaii.
- [45] Tao, Y. H. & Sun, C. H. (2007). *A Methodology of Establishing Disaster Management Collaboration Network: A Case Study on Flooding Disaster Response in Taipei City*
- [46] Steinberg, T. (2001) *The Secret history of natural disaster*, Environmental Hazards, 3(2001): 31-35.
- [47] Johnson, P., Wistow, G., Schulz, R. and Hardy, B. (2003). *Interagency and interprofessional collaboration in community care: the interdependence of structures and values*, Journal of Inter-professional Care, 17(1): 69-83.
- [48] U.S. General Accounting Office (2003) *Major management challenges and program risks – Department of Homeland Security*, Performance and Accountability Series, - GAO 03-102.
- [49] U.S. Department of Health and Human Services (2005) *Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP) – Legal and Regulatory Issues*.
- [50] Wilson, J. (1989). *Bureaucracy: What government agencies do and why they do it*: Basic Books, Inc.
- [51] Fedorowicz, J., Gogan, J. L., & Williams, C. B. (2007). *A collaborative network for first responders: Lessons from the CapWIN case*. Government Information Quarterly, 24(4), 785-807.
- [52] Gil-Garcia, J. R., & Pardo, T. A. (2005). E-Government success factors: Mapping practical tools to theoretical foundations. *Government Information Quarterly*, 22, 187-216.
- [53] Gil-Garcia, J. R., Pardo, T. A., & Burke, G. B. (2007). *Government leadership in multi-sector IT-enabled networks: Lessons from the response to the West Nile virus outbreak*. Paper presented at the Leading the Future of the Public Sector: The Third Transatlantic Dialogue, University of Delaware, Newark, Delaware, USA.
- [54] Lam, W. (2005). *Barriers to e-government integration*. Journal of Enterprise Information Management, 18(5/6), 511-530.
- [55] Otjacques, B., Hitzelberger, P., & Feltz, F. (2007). *Interoperability of e-Government information systems: Issues of identification and data sharing*. Journal of Management Information Systems, 23(4), 29-51.
- [56] Perri, Bellamy, C., Raab, C., Warren, A., & Heeney, C. (2007). *Institutional shaping of interagency working: Managing tensions between collaborative working and client confidentiality*. Journal of Public Administration Research and Theory, 17(3), 405-434.
- [57] Bajaj, A., & Ram, S. (2003). *IAIS: A methodology to enable inter-agency information sharing in eGovernment*. Journal of Database Management, 14(4), 59-80.
- [58] Zhang, J., Dawes, S. S., & Sarkis, J. (2005). *Exploring stakeholders' expectations of the benefits and barriers of e-Government knowledge sharing*. The Journal of Enterprise Information Management, 18(5), 548-567.
- [59] Li, S., & Lin, B. (2006). *Assessing information sharing and information quality in supply chain management*. Decision Support Systems, 42(3), 1641-1656.
- [60] Luna-Reyes, L. F., Gil-Garcia, J. R., & Cruz, C. B. (2007). *Collaborative digital government in Mexico: Some lessons from federal Web-based inter-organizational information integration initiatives*. Government Information Quarterly, 24(4), 808-826.
- [61] Faerman, S. R., McCaffrey, D. P., & Van Slyke, D. M. (2001). *Understanding inter-organizational cooperation: Public-private collaboration in regulating financial market innovation*. Organization Science, 12(3), 372-388.
- [62] Pardo, T. A., Gil-Garcia, J. R., & Burke, G. B. (Eds.). (2006). *Building response capacity through cross-boundary information sharing: The critical role of trust* (Vol. 3). Amsterdam: IOS Press.
- [63] Jonas, J., & Swire, P. (2006). *Implementing a trusted information sharing environment: Using immutable audit logs to increase security, trust, and accountability: The Markle Task Force on National Security in the Information Age*.
- [64] Kapucu, N. (2008). *Collaborative emergency management: better community organising, better public preparedness and response*. 239-262
- [65] Kapucu, N. (2005) *'Inter-organizational Coordination in Dynamic Context: Networks in Emergency Response Management'*. Connections, 26(2), 33-48.
- [66] Waugh, W.L., Jr. (2000) *Living with hazards, dealing with disasters: an introduction to emergency management*. M.E. Sharpe, Armonk, NY.
- [67] Moore, G.C. and Benbasat, I. (1991). *Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation*. Information Systems Research, 2(3): 192-222.
- [68] Caudle, S.L., Gorr, W.L., and Newcomer, K.E., (1991). *Key Information Management Issues for the Public Sector*. MIS Quarterly, 14(3): 171-188
- [69] Drake, D. B., Steckler, N. A., & Koch, M. J. (2004). *Information sharing in and across government agencies: The role and influence of scientist, politician, and bureaucrat subcultures*. Social Science Computer Review, 22(1), 67-84.
- [70] Kim, S., & Lee, H. (2006). *The impact of organizational context and information technology on employee knowledge-sharing capabilities*. Public Administration Review, 66(3), 370-385.
- [71] Willem, A., & Buelens, M. (2007). *Knowledge sharing in public sector organizations: The effect of organizational characteristics on interdepartmental knowledge sharing*. Journal of Public Administration Research and Theory, 17(4), 581-606.
- [72] Chau, M., Atabakhsh, H., Zeng, D., & Chen, H. (2001). *Building an infrastructure for law enforcement information sharing and collaboration: Design issues and challenges*. Paper presented at the National Conference on Digital Government, 2001.
- [73] Waugh, W. L. and Streib, G. (2006) *Collaboration and Leadership for Emergency Management*. Public Administration Review, December 2006. Special issue.
- [74] Vigoda, Eran (2002) *From Responsiveness to Collaboration: Governance, Citizens, and the Next Generation of Public Administration*. Public Administration Review 62 (5): 527 – 40 .
- [75] Kolekofski Jr., K. E., & Heminger, A. R. (2003). *Beliefs and attitudes affecting intentions to share information in an organizational setting*. Information & Management, 40, 521-532.
- [76] Barua, A., Ravindran, S., & Whinston, A. (2007). *Enabling information sharing within organizations*. Information Technology and Management, 8(1), 31-45.
- [77] Jarvenpaa, S. L., & Staples, D. S. (2001). *Exploring perceptions of organizational ownership of information and expertise*. Journal of Management Information Systems, 18(1), 151-183.
- [78] Ardichvill, A., Page, V., & Wentling, T. (2003). *Motivation and barriers to participation in virtual knowledge sharing communities or practice*. Journal of Knowledge Management, 7(1), 64-77.