

## Application of Knowledge Management Framework as a Decision-Support System for Disaster Management in Metropolitan Areas – Tehran as the Case Study

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### 1 ABSTRACT

Disaster management and metropolitan planning both involve making decisions and taking actions which has wide-ranging and diverse spatial information requirements. One major challenge in existing disaster management and metropolitan planning – on both fields of knowledge and practice – is the lack of relevant, accurate and available information or in other words an appropriate decision support system (DSS) along with a knowledge management framework (KMF) which not only establishes a DSS but also converts information to knowledge and considers the knowledge of past experiences.

In the context of disaster management worldwide, the crucial problem is that there are apparent gaps in terms of information coordination and knowledge management at different stages of disaster management. The post-disaster stages too require appropriate information as there are little common terminology and definition amongst relief agencies and assistant groups worldwide. Considering the fact that varied and multiple agencies are involved in different stages of disaster management and metropolitan planning, this makes sharing and integration of information between such agencies very intricate. A key problem is that such information is fragmented and is not efficiently organised.

Knowledge management that aims at facilitating the processes of collecting, maintaining, sharing and utilising information and knowledge in disaster management can provide a framework that integrates multiple information in order to subsequently analyse and manage information. Knowledge management initiative has been envisaged as a tool to integrate, store, retrieve, disseminate and manage information and knowledge related to disaster management. The main functions of knowledge management in any disaster management process are to enhance and develop the knowledge of disaster management and to support decision making in an emergency situation. Using comprehensive, Integrated, accurate and reliable information and knowledge may enhance the process of disaster management, and reduce the negative impacts of disaster in the communities at risk.

Tehran, as the case study of this paper, lies on a seismic zone with a high risk of earthquake which can have severe impact upon the life of its residents. This has been one of the most important challenges of the country in general and also in decision-making and planning for this city. One important aspect of planning and managing change in this city is to have due regards to disaster management. This requires not only an integrated method of planning and management but also an appropriate information and knowledge base. Information required for operating disaster management in Tehran currently is fragmented (i.e., owned by different organizations) and not capable to be converted to an appropriate DSS and KMF.

The dual aim of this paper is first to delineate the situation of Tehran in terms of its disaster management related information and knowledge base and second to propose an appropriate and integrated knowledge management framework. The proposed framework is intended to facilitate integrating, sharing and reusing knowledge in order to support decision making in both disaster management and metropolitan planning. The proposed knowledge management framework can help achieving an efficient and effective disaster management process which can be integrated in a metropolitan planning process, reducing the future risks and improving the resilience of vulnerable communities in case of a crisis in Tehran. The proposed framework – as a comprehensive, consistent and dependable knowledge base which will facilitate knowledge sharing – will help identify the information needs, will present an awareness of a disaster situation for the society at large and for decision-makers and can provide practical recommendations based on past experiences. This framework can also be applied to other parallel decision-making environments, such as crisis management.

## **2 INTRODUCTION: PROBLEM UNDER STUDY, PURPOSE AND AIM**

Urban planning that makes and implements spatial decisions and policies about different aspects of urban structure and urban life, including decisions and policies relevant to disaster management, has wide-ranging, diverse and all-embracing spatial information requirements. Not only the availability, continuity and quality of data are essential components of an information system, as part of a knowledge base, it must also be considered that the dependency of such systems upon many sources of production is a key impediment to the establishment of such systems.

It is common that in different societies a specific planning approach is practiced (either traditional, rational comprehensive or some form of a mixed approach). Each approach requires its specific information or knowledge base. Important point about the adoption of any planning approach in any society is not only the planning process with its different stages and the information requirements of each stage, but what is vital is the adaptation of the process to local circumstances and also the type and the availability of information at the local level of planning and decision-making. While there are many information sources in any metropolitan area, there are many information gaps. Thus it must be considered that the official procedures do not usually enable and facilitate the sharing and integrating process of the available information to support decisions when planning and managing an urban environment.

It is important to note that an effective disaster management process is an important component of a successful spatial urban planning. Within the disaster management framework and the different stages of its process, the crucial and worldwide problem is that there are apparent gaps in terms of information, information coordination and knowledge management. Such information is fragmented and is not efficiently organised. The post-disaster stages as well as pre-disaster stages of such a process too require an appropriate information system (especially that there are little common terminology and definition amongst relief agencies and assistant groups worldwide). Considering the fact that there is varied and multiple agencies involved in different stages of either metropolitan planning or disaster management, the sharing and integration of information between such agencies turns out to be very intricate. Information required for operating either disaster management or any sort of metropolitan planning in Tehran is currently fragmented (i. e., owned by different organisations) and not capable to be converted to an appropriate decision support system (DSS) or a knowledge management framework (KMF). These information systems can help improving the efficiency of urban planning management activities including disaster management in general and in the case studied in this paper.

This paper has a dual aim of first to delineate the situation of Tehran in terms of its disaster management related information and knowledge base and second to propose an appropriate and integrated knowledge management framework that is intended eventually to improve urban resilience in Tehran. To achieve this aim, this paper – both in general and in Tehran – examines the the role of urban planning in disaster management and also the current links and gaps between urban planning and disaster management and also between the information and knowledge base of the two distinct, though highly connected, realms. In addition, this paper explores possible and appropriate courses and approaches to manage and plan urban systems in order to reduce risk in urban communities: advocating that a new way of thinking and a more collaborative and interdisciplinary approach is required. The development of knowledge management framework as a decision-support system for disaster management has possible consequences for all levels and forms of decision-making, including urban planning and disaster management in general and in the case studied in this paper.

## **3 CONCEPTUAL FRAMEWORK**

Information plays a central role in urban spatial planning as well as in disaster management. Information requirements of urban spatial planning include the collection, manipulation and analysis of spatial structure.

Disaster management and urban planning both involve making decisions and taking actions which has wide-ranging and diverse spatial information requirements. One major challenge in existing disaster management and urban planning – on both fields of knowledge and practice – is the lack of relevant, accurate and available information or in other words an appropriate decision support system (DSS) along with a knowledge management framework (KMF) which not only establishes a DSS but also converts information to knowledge and considers the knowledge of past experiences.

### 3.1 Disaster management

Occurance of natural disasters is inevent in many cases worldwide. Disasters increasingly threaten human beings and bring tremendous social, economic, and environmental impacts.

Within the field of Disaster Management, disaster has been defined as a progressive or sudden, widespread or localised, natural or human-caused occurrences which can cause death, injury or disease, damage to properties, infrastructure or the overall environment that exceeds the ability of those affected by the disaster to cope with its effects using only their own resources (Disaster Management Policy 2002).

Disaster management refers to a continuous and integrated multi-sectoral and multi-disciplinary process of planning and implementation of specific measures aimed at reducing or avoiding the potential losses from disaster, promoting appropriate assistance to victims of disaster and seeking to achieve rapid and effective recovery(Seneviratne, Baldry, and Pathirage 2010).

Disaster management process includes the two main phases of (a) pre-disaster risk reduction and (b) post-disaster recovery.

The pre-disaster risk reduction phase involves three stages as follows(Seneviratne, Baldry, and Pathirage 2010):

- Stage one: Risk and vulnerability assessment, this stage involves identifying the nature and magnitude of risks (current and future) from diasters to people, infrastructure and buildings.
- Stage two: Mitigation or risk reduction activities, this stage include structural and non-structural measures undertaken to limit the adverse impact or consequences of diasters.
- Stage Three: Preparedness, this stage deals with the activities and measures taken to ensure effective response to the impact of diasters.
- Post-disaster recovery phase involves three stages as follows (Seneviratne, Baldry, and Pathirage 2010):
- Stage one: Relief, this stage refers to the provision of assistance – or intervention by the relevant authorities – during or after a disaster to meet the life preservation and basic subsistence needs of the people affected by disaster.
- Stage two: Transition, this stage involves the relevant transitional related activities, including community surveys, needs assessment, land survey and acquisition and provision of transitional shelter.
- Stage Three: Reconstruction, this stage refers to the rebuilding of damaged living conditions with considering the aim of long term sustainability.

### 3.2 Knowledge management

For holistic understanding of knowledge management, it is necessary to identify knowledge. There are wide-ranging definitions of knowledge. A comprehensive definition has defined knowledge as “a fluid mix of framed experience, contextual information, values and expert insight that provides a framework for evaluating and incorporating new experiences and information” (Otim 2006). In addition, knowledge is defind from a dual perspective of practical and general, as follows(Dongsong et al. 2002):

- Specific and practical definition of knowledge defines knowledge as applied information that actively guides task execution, problem-solving, and decision making.
- General definition of knowledge, defines knowledge as any fact, event, rule, hypothesis, or model that increases understanding or performance in a domain or discipline.

In the applied perspective “knowledge is to know when, why and which information is needed, how information could be obtained and processed, and where information can be found to achieve a desired objective” (Dongsong et al. 2002).

There is no general agreement on the definition of knowledge management, though some of its relevant definitions are listed below:

- knowledge management is “a discipline that promotes an integrated approach to identifying, managing, sharing, and reusing all of information assets by using advanced technology” (Dongsong et al. 2002).
- Knowledge management is the creation and subsequent management of an environment which encourages knowledge to be created, shared, learnt, enhanced, organised and utilised ( Sujit et al. 2011).
- Knowledge management is “the practice of selectively applying knowledge from previous experiences of decision making to current and future decision making activities with the express purpose of improving the organisation’s effectiveness”(Otim 2006).
- Knowledge management is “the creation, organisation, sharing and use of knowledge for development results”(UNDP 2007).
- Knowledge management is “about facilitating the process by which knowledge is created, shared and utilised”(Seneviratne, Baldry, and Pathirage 2010).
- The process of knowledge management or what is known as the Knowledge Management Cycle (KMC) has three main essentials as follows ( Sujit et al. 2011):
- Management: This focuses on capturing, organising and facilitating knowledge.
- Application: This focuses on effective retrieval of relevant content through advanced searches and mining headed for (a) conducting knowledge-related work and tasks and (b) using the results for discovery.
- Organizations: This focus on learning, sharing and collaborating: the education component of the cycle.
- Main processes of knowledge management are (Otim 2006):
- The process of knowledge creation: This can be done by (a) acquiring external knowledge, or (b) by means of creating knowledge in the process of learning.
- The process of retention of knowledge: To keep knowledge available, some kind of memory is needed. Retention of knowledge refers to the process of storing knowledge and making its retrieval possible.
- The process of knowledge sharing: Its aim is to make sure that (existing) knowledge is obtained and shared – or in other words knowledge disseminates or transferred – at the right place.
- The process of application or use of knowledge: The other three knowledge processes (mentioned above) are supplementary to this process, i.e., the application of knowledge.

#### 4 URBAN PLANNING, INFORMATION AND KNOWLEDGE

During the post Second World War period, in many European countries, urban planning was essentially an exercise dealing with "the physical planning and design of land-use and built form". The "general and fundamental criticisms" of the prevailed approach to urban planning led to radical changes and the introduction of adapted concepts of planning. Primarily it was the rational process view of planning. Considering the debate about the necessity and implication of this view of planning, an alternative approach which claimed to be more relevant to the real world of planning and policy-making, i.e. the incremental or piecemeal approach, was later introduced. The mixed-scanning approach as was also introduced, involved distinguishing more fundamental or strategic decisions from more detailed decisions. In fact it is the mixed-scanning approach – as a hybrid model of both the rationalist and incrementalist approaches – which involves imposing patterns on information received, formulating a program within this framework and going back to changing that framework (Daneshpour 2007). The major point about the adoption of any of these approaches, in any country or urban/metropolitan area, is that of their process, the different stages of the adopted process and the alteration of the process to the local circumstances as well as the information requirements of each of the stages. Almost all of these stages not only require spatial information but also require considerable information processing and analysis. Part of the information requirements of the planning process, especially problem formulation and evaluation of the existing conditions, require the

collection, manipulation and analysis of spatial features with the aim of being able in the subsequent stages of the planning process to produce plans, whether with strategic or operational nature. Not only problem definition but also problem formulation and the evaluation of circumstances require the collection; manipulation and analysis of spatial information (Daneshpour 2007).

The act of management too requires agencies to use more detailed information for routine operations. These different requirements concerning information can "explain the existence of various specialised ad hoc systems in urban planning, such as management information system (MIS), land information system (LIS), and urban GIS". One important point about using the methods devised in the more developed countries of the world is that general principles and analytical tools that have been developed there is not feasible in the less developed countries of the world without considerable modifications and adaptations. So there is a need to develop new approaches to launch an appropriate decision support system (DSS) along with a knowledge management framework (KMF), appropriate to the varying conditions (Daneshpour 2007).

While there are many formal and informal sources of information in any urban/metropolitan area, the official procedures are usually incapable of sharing and integrating necessary information to support decisions when planning and managing an urban/metropolitan area. Besides information deficiency in cities, there are many concealed and unused information potentialities that not included in or part of an established and effective Dss and KMF system. Decision-making activity involves merging a variety of information in order to analyse the different elements of the applicable spatial structure and their interaction. Integration of incoherent, incomplete and dispersed information that have diverse information sources can reduce information gaps and strengthen the decisions to solve problems in an urban area.

## **5 DISASTER MANAGEMENT AND INFORMATION AND KNOWLEDGE**

Information plays a central role in disaster management, while the input of all stages of disaster management process is considered to be information and knowledge. Using integrated, accurate, reliable and timely information has an important role in achieving the aims and objectives of any attempt related to not only disaster management but also towards improving pertinent attempts of decisions-making. Two major challenges in existing disaster management procedure worldwide – on both fields of knowledge and practice – are (a) the lack of relevant, accurate and available information and (b) ineffective management of information despite the importance of management of information in reducing the impacts of disasters.

### **5.1 Information and knowledge requirements of disaster management**

Information in disaster management is an essential resource that is translated into decisions and actions in the two main phases of disaster management process.

The information needs of disaster management can be categorised in two distinct, but closely related, categories as follows (Dongsong et al. 2002):

- Pre-disaster risk reduction: including information about risk assessment, mitigation and preparedness to improve the existing knowledge about disaster.
- Post-disaster recovery: including information about the impact of the disaster and the resources available to combat it to support decision-making.

### **5.2 Challenges related to information and knowledge in disaster management process**

One main barrier of effective disaster management in urban/metropolitan areas worldwide is related to their information system and knowledge base. These barriers can be listed as the following:

- Information and knowledge on disaster management are fragmented (Seneviratne, Baldry, and Pathirage 2010), widely distributed and owned by a great number of organizations/agents (Dongsong et al. 2002).
- Information, experiences, approaches, adopted modalities and generated/created knowledge of disaster management remain in individual or institutional domains and are not usually translated to and transformed into applied knowledge for future experiences for the communities at risk (Seneviratne, Baldry, and Pathirage 2010) & ( Sujit et al. 2011).

- Information and knowledge coordination, sharing and creation on any process of disaster management is usually inadequate and ineffective (Seneviratne, Baldry, and Pathirage 2010).
- The linkages among all agencies working on disaster management is usually weak and inefficient and this fact inhibits an efficient management approach and an integrated and an appropriate coping mechanism (Sujit et al. 2011).

### **5.3 The role and importance of information and knowledge to support decision-making in disaster management as an emergency situation decision-making**

Decision-making is a process of analysing information and using knowledge to resolve problems. During the decision-making process, the problems should be detected, relevant information should be gathered and the right judgment should be made so as to make appropriate decisions (Dongsong et al. 2002). Accordingly, information is the main input of this process, while the main element of a relevant decision-making is accurate, reliable and integrated information. Decision-making during a disaster management process – especially its post-disaster phase – is different from decision-making processes in general. Decision-making in disaster management is by and large faced with a variety of challenge such as (Dongsong et al. 2002):

- Gathering relevant information in a timely and accurate manner;
- Synchronized acquisition and analysis of distributed information;
- Reusing knowledge (or consider past experiences) to facilitate current decision making;
- Organising, sharing and managing the information efficiently; and
- Dynamically changing the situation under study.

## **6 INFORMATION AND KNOWLEDGE MANAGEMENT IN URBAN PLANNING AND DISASTER MANAGEMENT**

Knowledge management that aims at facilitating the processes of collecting, maintaining, sharing and utilising information and knowledge in disaster management can provide a framework that integrates multiple information in order to subsequently analyse and manage information. Knowledge management is envisaged as a tool to integrate, store, retrieve, disseminate and manage information and knowledge related to disaster management in an urban/metropolitan area. As one main function of knowledge management in any disaster management process is to enhance and develop the knowledge of disaster management and to support decision making in an emergency situation, thus using comprehensive, integrated, accurate and reliable information and knowledge may enhance the process of disaster management, and reduce the negative impacts of disaster in the communities at risk in an urban/metropolitan area.

### **6.1 The functions of knowledge management frameworks in urban planning and disaster management**

Though there is no way of neutralising all negative impacts of disasters, efforts can be made to reduce their resource costs and consequences (Seneviratne, Baldry, and Pathirage 2010). Knowledge management can undoubtedly maintain a decision-support system for disaster management in urban/metropolitan areas. This will have possible consequences for all levels, forms and aspects of decision-making, including urban planning and disaster management. In this respect, some functions of knowledge management frameworks can be listed as below:

- Knowledge management frameworks can act as a tool to store, retrieve, disseminate and manage information related to urban planning and disaster management (Sujit et al. 2011).
- Knowledge management frameworks can facilitate the entire process of acquisition, sharing, management, and utilisation of information and knowledge for the support of urban planning and disaster management processes (Dongsong et al. 2002) & (Otim 2006).
- Knowledge management frameworks can avoid repeating past errors of practice, highlight good practice to be replicated and make lesson-learning (UNDP 2007).
- Knowledge management frameworks make it possible to learn from and leverage past experience in the management of current problems (Otim 2006) and to build a culture of learning from previous lessons and the adoption of best practices (Seneviratne, Baldry, and Pathirage 2010).

## **7 CHALLENGES OF PLANNING AND DISASTER MANAGEMENT RELATED INFORMATION AND KNOWLEDGE IN TEHRAN**

Tehran, as the case study of this paper, lies on a seismic zone with a high risk of earthquake which can have severe impact upon the life of its residents. This has been one of the most important challenges of the country generally as well as in planning, decision-making and managing this city, one main aspect of which is to have due regards to disaster management. This requires not only an integrated method of planning and management but also an appropriate information system and knowledge base for the two areas of knowledge and practice. Information required for operating disaster management in Tehran is fragmented and is in the possession of diverse agencies/organisations. This is while this information system and knowledge base is not capable to be converted to an appropriate DSS and KMF.

The lack of reliability, consistency and coordination of urban planning and disaster management related information and knowledge in Tehran has stemmed from factors such as (a) administrative inefficiencies, (b) resource limitations, (c) the shortage of skilled personnel and technical expertise and (d) the lack of funding or political will to support the construction of the an appropriate and integrated DSS and KMF system. These factors, in addition, reflect a disapproval of the policy makers; urban planners and managers for the different aspects of application and importance of information systems and knowledge basis in any urban planning and disaster managing activity especially when continuance and sustainability reveal themselves as important agendas, locally and internationally (Daneshpour 2007).

The main challenges of urban planning and disaster management related information and knowledge in the case of Tehran can be listed as below:

There is a large gap between the two areas of activity, i.e., urban planning and disaster management. In other words, disaster management – as a category of planning activity – has been done without due consideration to urban planning and urban plans as the product of it. Thus the result of risk assessment – as one important stage of a disaster management process – has not been considered in the process of generating urban plans.

- There is varied and multiple agencies/organisations involved in different stages of disaster management which perform the tasks such as research and action. This is relevant to the both fields of urban planning and disaster management. Accordingly it can be deduced that the information and knowledge required for operating disaster management within the broad context of urban planning in Tehran is fragmented.
- There is the lack of information and knowledge coordination at the different stages of urban planning and disaster management in Tehran.
- Agencies involved in urban planning and disaster management in Tehran have their own information sources, while others are not aware of the available information of the other agencies that might aid them and provide a support system for their task of decision-making.
- There is not relevant, accurate and available information system and knowledge base concerning urban planning in general and disaster management in particular in Tehran.

## **8 EXPLANATION OF THE PROPOSED KNOWLEDGE MANAGEMENT FRAMEWORK FOR TEHRAN**

Knowledge management framework in this paper has been envisaged as a tool to share, integrate, store, retrieve, disseminate and manage information and knowledge related to disaster management in Tehran. The main functions of knowledge management framework in disaster management process of Tehran are to enhance and develop the knowledge of disaster management and to support decision making in an emergency situation, while keeping this within the urban/metropolitan planning context of Tehran. Using comprehensive, integrated, accurate and reliable information and knowledge in this city may enhance the process of disaster management, and reduce the negative impacts of disaster in Tehran.

Two essential principles for establishing an appropriate information and knowledge management framework for managing disaster in Tehran are first defining the purpose of the framework, and second investigating the existing information system in Tehran in order to integrate the two (UNDP 2007). In Tehran the main purposes of the proposed knowledge management frameworks are:

- Integrating multiple information and knowledge related to disaster management in order to subsequently analyse, manage information and create knowledge.
- Integrating disaster management with urban planning activity altogether.

Relating to the second base of establishing knowledge management framework for managing disaster in Tehran, there is no complete and integrated pool of information for urban planning and disaster management.

## 9 APPLICATION OF KNOWLEDGE MANAGEMENT FRAMEWORK AS A DECISION-SUPPORT SYSTEM FOR DISASTER MANAGEMENT IN TEHRAN

A comprehensive knowledge management framework is presented here in support of disaster management in metropolitan area of Tehran. The core of the proposed framework is the knowledge base with a set of involved knowledge management processes for knowledge acquisition, organisation, creation, and sharing. This knowledge base must evolve incrementally over the time (figure 1).

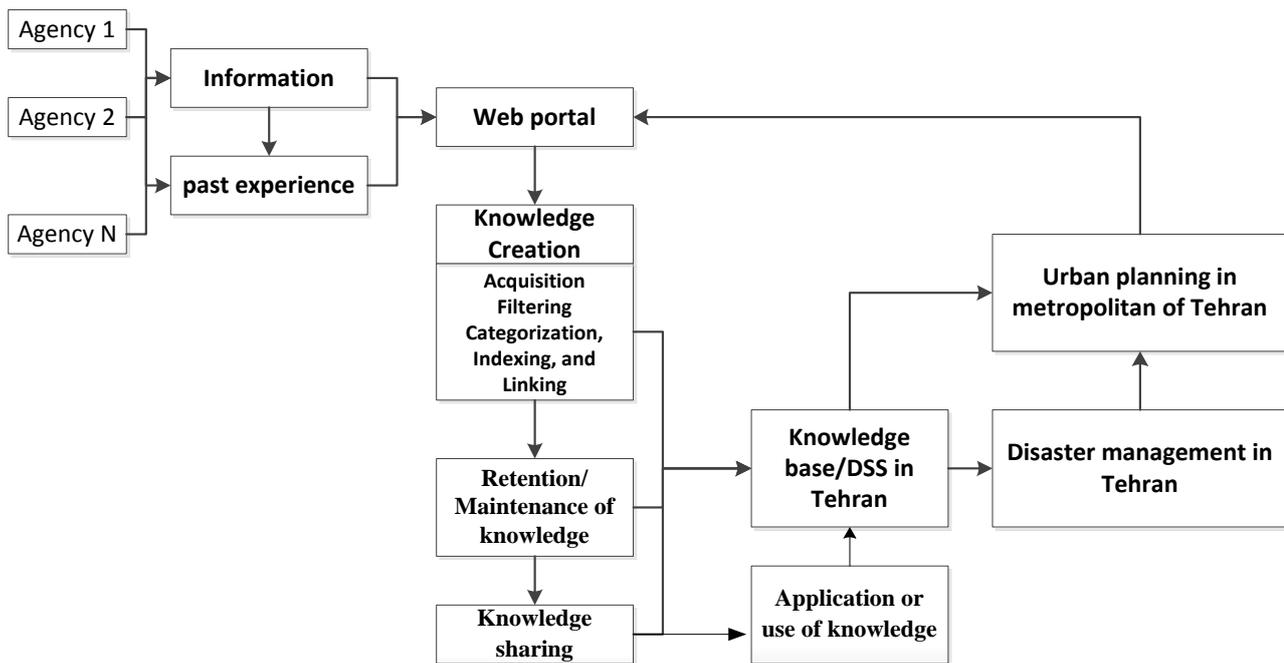


Fig. 1: The proposed knowledge management framework of disaster management within an appropriate metropolitan DSS for Tehran

The proposed framework is intended to facilitate integrating, sharing and reusing knowledge in order to support decision making in both disaster management and metropolitan planning in Tehran. The proposed framework can help achieving an efficient and effective disaster management process which can be integrated in a metropolitan planning process in order to reducing the future risks and improving the resilience of vulnerable communities in case of a disaster in Tehran. The proposed framework – as a comprehensive, consistent and dependable knowledge base which will facilitate knowledge sharing – will also help identify the information needs, an awareness of a disaster situation for the society in general and for decision-makers can provide practical recommendations based on past experiences.

## 10 CONCLUSION

Disaster management requires comprehensive information and knowledge as well as extensive assistance from many relief agencies. The demand for efficient knowledge management to help the agencies make decisions widely recognised. This paper made an attempt to present a comprehensive knowledge management framework in support of decision-making in disaster management process within a broader context of metropolitan planning. It advocates multiple knowledge management processes that create, maintain and share the knowledge, provide consistent support to decision-makers in disaster management operations, and recommend possible solutions based on the knowledge base which includes the past experiences. The proposed knowledge management framework is intended to evolve incrementally while the framework must allow the disaster management agencies/organisations to transcend the existing limitations

and redundancies created by fragmented information and knowledge. This framework can also be applied to other similar decision-making environments, such as crisis management.

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