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Theoretical Framework for Stakeholders' Disaster Response Index in the Built Environment

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Abstract

Disasters are becoming increasingly frequent, expensive and devastating globally. They also jeopardize society, performance of economy, built environment, and other socio-economic and physical determinants. While disasters cannot be eliminated, resilient built environment are those where disasters are effectively managed by stakeholders. Therefore, it is important to measure stakeholders' approaches against disasters in the built environment. A widely used measure is to create a composite index. The aim of this paper is to propose a theoretical framework using stakeholder and decision-making theories in the development of stakeholder disaster response index. Stakeholder theory determines power and legitimacy of stakeholders whether they have tendency towards proactive or reactive approaches. Decision-making theory, on the other hand, provides optimized decisions for stakeholders in order to minimize all negative consequences of disasters. Furthermore, stakeholders take rational behaviors in reactive approaches in recovery and post-disaster reconstruction activities. With a sound theoretical framework, the anticipated benefits of the resultant stakeholders' disaster response index include: (1) direct comparison of different stakeholders' approaches against disasters in the built environment; (2) high-level disaster management planning decisions; and (3) development of stakeholder disaster management procedure.

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1. Introduction

The natural hazard becomes a natural disaster as soon as human beings, infrastructure, or other forms of tangible or intangible capital is threatened and/or destroyed by that hazard (Alexander, 1997). However, it is noted that some scholars believe that 'Natural Disaster' is now largely considered to be a misleading concept (Bosher 2008; Mileti 1999; Winser et al. 2004). O'Keefe et al. (1976) suggested that some radical rethinking on the nature of "natural" disasters is necessary. Natural disasters can occur when natural vulnerability and human vulnerability have the same coordinates in space and time (Alcantaraayala 2002; Alexander 1997, 2000; Smit et al. 2000). The crucial point about understanding why disasters occur is

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that it is not only natural events that cause them, but they are also the product of the social, political, and economic environment. In this paper we focus on disaster as a general concept which covers natural, technological, and man-made hazards.

Disasters affect not only communities, but also physical assets and the built environment due to lack of stakeholders' awareness before, during and after natural disasters (Bosher et al. 2009). Although there have been efforts to measure different aspects of natural disaster management including preparedness, resilience, mitigation efforts, social vulnerability, and hazard exposures, there is little work on stakeholder approaches against disasters in the built environment. There are potential benefits from measuring stakeholders' approaches, such as a clearer understanding of their preparedness, and providing a means to encourage stakeholders that are more vulnerable and less prepared to improve their preparedness efforts. Better measurement also may lead to more efficient allocation of scarce resources, and assist in assessing risk more effectively and accurately.

An overview of literature related to preparedness indices in disaster management indicates that previous research efforts have dealt mainly with emergency management theory, and socio-economic conditions (e.g., Haque 2003, Ibarrarán et al. 2007, Kahn et al. 2005). Indeed, there is no solid foundation of emergency management theory to guide the development of disaster response indices (Covington and Simpson 2006). Increasingly, few studies have focused on stakeholders' roles and reaction behaviours against disasters in the built environment (Roberts 2008). The aim of this paper is to propose a theoretical framework using stakeholder and decision-making theories in the development of stakeholder disaster response index. Stakeholder theory determines power and legitimacy of stakeholders whether they have tendency towards proactive or reactive approaches. Decision-making theory, on the other hand, provides optimized decisions for stakeholders with considering expectation, asset integration, and risk aversion. We hypothesise that the ideas of both stakeholder and decision-making theories would pave the way to develop stakeholder disaster response index remarkably. In this, first we review the concept of both theories, and then we borrow ideas from both theories to support the theoretical framework of stakeholder disaster response index.

2. Impact of natural disasters on the built environment

The built environment, defined by the facilities and civil infrastructure systems that people use, is the fundamental foundation upon which a society exists, develops, and survives. Built environment is at risk from the impacts of natural disasters associated with climate changes. Natural disasters affect built environment not only in developing countries but also in developed countries. The estimated damages from flooding in UK is around £270 million and around 80,000 urban properties in UK are presently at risk from flooding (Wilby 2007). According to the Department of Climate Change and Energy Efficiency 2011, between 187,000 and 274,000 residential buildings in Australia are exposed to the combined impact of inundation and shoreline recession associated with sea level rise. Furthermore, between 27,200 and 34,500km of transportation infrastructure is potentially at risk from floods associated with sea level rise and climate changes. The average value of exposed residential buildings and transportation infrastructure is $65 and $60 billion, respectively. In

2009, natural disaster costs US$ 41.5 billion, which the costliest disaster was winter storm Klaus, which caused damages totalling US$ 5.1 billion in France and Spain (Bureau of Transport Economics (2001). The database has also recorded that Hurricane Katrina solely caused damages amounting to almost US$ 137 billion in United States in 2005. The issue of climate change and natural disasters are remarkably crucial in the built environment. The climate risks most frequently addressed in existing studies are associated with sea-level rise, and water resources (Nicholls 2004). Anticipated consequences of climate change for cities include fewer periods of extreme winter cold; increased frequency of air and water pollution episodes; rising sea levels and increased risk of storm surge; and changes in the timing, frequency and severity of urban flooding (Wilby 2007). These events and changes will, in turn, have both direct and indirect impacts on the built environment (Wilby 2007). A review on literature by Hunt and Watkiss (2010) suggests that there has been little study pertinent to impacts of disasters on energy sectors and transport infrastructure. Roberts (2008) argue that the principle vulnerability of the built environment and infrastructures to climate changes is derived from extreme events; including floods and storms and to a lesser extend heat-waves and drought. New buildings will have to be designed to cope with the effects of disasters associated with climate change. Stakeholder approaches towards natural disasters in order to mitigate the consequences of disasters are firmly recommended in the built environment (Moe and Pathranarakul 2006, Bosher et al. 2009).

3. Stakeholder approaches to managing disasters in the built environment

Stakeholders' approaches toward natural disaster management can be classified into pro-active and reactive approaches. Moe and Pathranarakul (2006) described that pro-active approach refers to those activities such as mitigation and preparedness that are planned and conducted before the natural disasters by stakeholders in order to tranquilize the adverse impacts of natural disasters effectively. In contrast, responses and recovery activities which are conducted by stakeholders during and after natural disasters is called reactive approach.

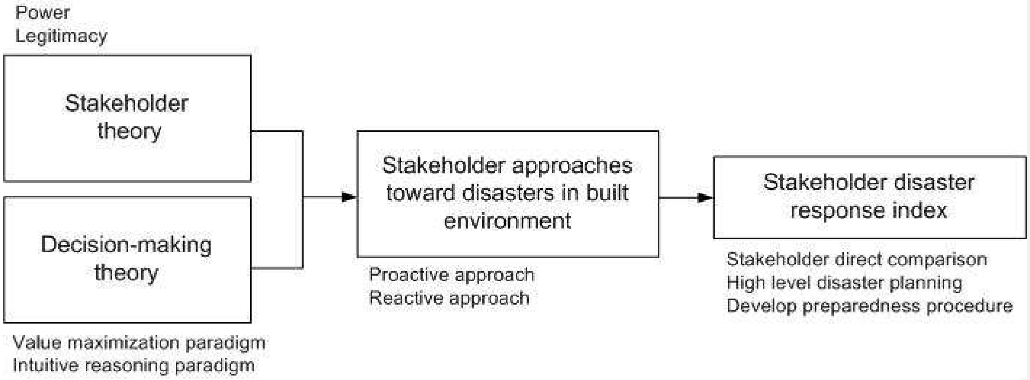
Although there are two approaches to tackle the natural disasters; reactive and proactive approaches, most studies have claimed that the stakeholders often resolve the predicaments arisen in natural disasters by reactive approaches (Bosher et al. 2009, Brilly and Polic 2005, Loosemore and Hughes 1998). It is also noted that few studies exist on stakeholders' approaches toward natural disaster management in the built environment. Loosemore (1998) investigated reactive crisis management in construction projects. Brilly and Polic (2005) studied a case in Slovenia to provide an integrated flood mitigation decision making process with considering stakeholders' approaches. Moe et al. (2007) proposed a balanced scorecard technique with considering pro-active and reactive approaches to provide a continuous assessment of performance in each life-cycle phase in natural disaster management project. Bosher et al. (2009) claimed that there is a need to proactively address strategic weaknesses in maintaining the built environment from a range of disasters. They also emphasized that there is still insufficient evidence that key construction stakeholders are playing an active role in mitigating flood risk. The pre-construction phase of building's life cycle has been identified as the most critical stages in their study when key stakeholders such as architects/designer, structural and civil engineers, urban planners, specialist contractors and emergency/risk managers need to adopt natural disaster mitigation strategies. Their survey on the integration of disaster risk management in UK's built environment indicated that knowledge and awareness of integrated disaster risk management is poor, they also concluded by some key recommendations as: (i) built environment stakeholders need to become more immersed in group decision making; (ii) professional training for stakeholders such as architect, planners, engineers, developers, etc pertinent to risk and hazard awareness should be systematically organized; and (iii) performance-based contracting, and product or service oriented procurement decision should be taken in order to make designers and contractors think about long-term implications and performance of buildings and structures they design and construct. Development of indices is highly required in the built environment to measure stakeholders' responses against disasters. For this, we need to shape theoretical framework to justify the feasibility and reliability of disaster response index in the built environment.

4. Theoretical framework

Disaster response indices play an important role to measure stakeholders' disaster preparedness, resilience, mitigation efforts, social vulnerability, and hazard exposure. Davidson and Lambert (2001) explained that natural disaster indices are appealing because they summarize a substantial amount of technical information in a way that people can easily understand. Indeed, indices have become more widely applied in social capital and capacities, and measure quality of life, human development, social vulnerability, emergency preparedness (Davidson 1997, Davidson and Lambert 2001, Simpson and Katirai 2006). Disaster response indices have remarkable benefits as following (Cutter et al. 2003, Davidson and Lambert 2001, Simpson and Katirai 2006): (1) providing a more dynamic picture of disaster; (2) comparison of vulnerability between different communities; (3) efficient allocation of scarce resources; (4) assessing disaster risk more effectively and accurately; (5) understanding community preparedness. They also support disaster resource allocation, high level planning decisions, public education efforts and disaster risk assessment (Davidson and Lambert 2001).

Apart from the benefits of disaster response indices, there have been numerous issues pertinent to the theoretical aspects in developing disaster response index (Covington and Simpson 2006). Few scholars have applied theories and paradigms in measuring disaster preparedness. These theories include: practice-based theory and a theory-based practice (Gillespie and Streeter, 1987) and planning perspective (Perry and Lindell, 2003) and It is noted that the most frequently used is the emergency management theory (e.g., Dynes 1994, McEntire 2001, McEntire 2002). However, emergency management theory doesn't seem to provide a solid foundation to guide the development of disaster preparedness indices, emergency management theory has three fundamental problems for developing disaster response indices as follows: (1) we are really interested in disasters, not emergencies; (2) the focus on emergency makes the field reactive and limits its applicability to first responders; (3) emergency management may imply that we have total control in our ability to deal with the adverse occurrences we call disasters. Hence, emergency management is both a misnomer and an oxymoron. But a suitable replacement has not been found, and one may never be accepted due to the increasing professional recognition of the name emergency management (Covington and Simpson 2006). In this paper, we combine stakeholder and decision-making theories to support the proposed theoretical framework for developing stakeholder disaster response index.

Figure 1 shows the proposed theoretical framework to develop stakeholder disaster response index by considering decision-making and stakeholder theories in the built environment. An important matter for the disaster management team is to identify and analyse those stakeholders who can have an influence over disaster management phases. This paves the way for managing a process that maximizes stakeholder positive input and minimizes any adverse or negative consequences. Furthermore, disaster management is a decision-making process. In a decision making process we are supposed to choose one or



some choices over different alternatives with considering deficiency of knowledge and uncertainty about the future. The built environment decision making process requires a profound integrated understanding of how to avoid and mitigate the effects of risks and disasters (Bosher et al. 2009).

Figure 1: Theoretical framework for developing stakeholder disaster response index

5. Stakeholder definition and theory

Any kind of entity can be a stakeholder in managing disasters. Local people, groups, organizations, institutions, societies, and even the natural environment are generally thought to qualify as actual or potential stakeholders. First definition of stakeholder is attributed to Freeman (1984). He borrowed the notion of memo from Stanford Research Institute in 1963. The memo defined that stakeholder is an entity without whose support the institution would not survive. He also described that the purpose of stakeholder management was to devise methods to manage the myriad groups and relationships that resulted in a strategic fashion. Harrison et al. (2010) claimed that stakeholder theory should be considered the decision makers' roles, their decisions and who takes advantages of the outcomes of those decision. Stakeholders have an interest in the actions of an organization and they have ability to influence it or they can be affected by the achievement of the organization's objectives (Freeman 1984, Savage et al. 1991). Stakeholders experience or anticipate experiencing the harm and benefits of an organization (Donaldson and Preston 1995). Although there have been a few other stakeholder definitions, the latest describes stakeholder who has input in decision making as well as who benefits from the results of decision makings (Phillips 2003). Stakeholder theory is a theory of organizational management and business ethics that addresses morals and values in managing an organization. This theory was originally detailed by Freeman (1984), and it has been a popular heuristic for describing the management environment for years. Stakeholder theory argues that institute's welfare is optimized by meeting the needs of the institute's key stakeholders in an appropriate way. Increasingly, stakeholder theory offers power and legitimacy attributes which are not found in other theories of the organization (Mitchell et al., 1997).

It is important to categorize stakeholders into different groups. Mitchell et al. (1997) classified stakeholders into seven main groups as; (1) dormant stakeholders; (2) discretionary stakeholders; (3) demanding stakeholders; (4) dominant stakeholders; (5) dangerous stakeholders; (6) dependent stakeholders; and (7) definitive stakeholders. Although dormant stakeholders have little or no interaction with the firm the main criteria in dormant stakeholder is to possess power to impose their will on an organization. Discretionary stakeholders hold the attribute of legitimacy, but they have no enough power to affect a firm's decisions. Demanding stakeholders possess urgent claims but having neither power nor legitimacy. Dominant stakeholders have enough power and legitimacy to direct a firm's decision making process. Coercive behaviours making stakeholders dangerous to the firm (Mitchell et al., 1997). The identification of stakeholders who are involved in disaster management depends on the type of the built environment. Furthermore, the number of stakeholders increases when disasters affect the built environment. A generic set of stakeholders in managing disasters in the built environment would include local government, prime (general contractor), subcontractors, suppliers, architects/designers, structural and civil engineers, urban planners, emergency relief organizations, financial institutions, insurance companies and affected local community (Bosher et al. 2009; Moe and Pathranarakul 2006).

In Freeman's (1984) stakeholder theory, power and legitimacy are two distinctive stakeholder's attributes. The power of stakeholder allows them to mobilize social and political forces and to withdraw resources from the organization (Post et al. 2002, Olander 2007). Legitimacy gives opportunity to stakeholder to abide some sort of beneficial or harmful risk pertinent to organization (Mitchell et al. 1997, Olander 2007). These suggest that power and legitimacy provide them to take proactive or reactive approaches in decision making process. Therefore, stakeholder theory could be a pivotal pillar for supporting the theoretical framework in the development of disaster response index in examining their proactive or reactive approaches against disasters. Power and legitimacy help stakeholders to bring about the outcomes they desire; hence, these attributes are very crucial for stakeholders to take proactive approaches against disasters in the built environment. In other words, combination of power and legitimacy can create authority for stakeholder's firm to take proactive responses independently. However, decision making process definitely influence stakeholders to migrate from proactive approach to reactive response, or vice versa. In the next section we explain how decision making theory can affect the stakeholders' approaches toward disasters in the built environment.

6. Decision making theory and paradigm

Decision making has always been the significant matter for all humans. We need to make decision individually and in groups constantly. In a decision making process we are supposed to choose one or some choices over different alternatives with considering deficiency of knowledge and uncertainty about future (Shih, 2007). There are two distinguished decision making paradigms namely: value maximization paradigm and intuitive reasoning paradigm (Ariely 2008). The first paradigm assumes that humans have great tendency towards to maximize the value of selected alternatives based on their desires. The latter paradigm assumes that humans' decisions are influenced by complicated factors. Therefore, in value maximization paradigm people have rational behavior but in intuitive reasoning paradigm humans might involve irrelevant factors in their decision making process (Levy 1992, Ariely 2008). Based on the concept of expected utility, the value maximization paradigm proposes that a decision maker will choose the alternative that maximizes the weighted factors obtained by utility functions. Von Neumann Morgenstern Theory (VNMT), under the value maximization paradigm, explains that a person or unity is rational if and only if their behavior maximizes the expected value of the set of possible outcomes (Neumann and Morgenstern 1944). Prospect theory introduced by kahneman and Tversky (1979) significantly advanced decision making theory. This theory enrich value maximization paradigm by addressing three principles: (1) expectation, (2) asset integration, and (3) risk aversion. The overall utility of a prospect is the expected utility of its outcomes, and a prospect is acceptable if the utility resulting from integrating the prospect with one's assets exceeds the utility of those assets alone. Moreover, most people will prefer an alternative with expected value X over any riskier alternative with equal expected value X (Senior 2012). In decision making process, alternatives encounter dominance and conflict conditions (Shafir et al. 1993). A condition of dominance emerges when an alternative is perceived as superior to another in all significant features. In contrast, a conflict condition arises when one alternative may be superior to another in only some dimensions.
Altay and Green (2006) conducted a comprehensive review on operation research and decision making in disaster management. They found that most researchers have focused on mitigation, preparedness, and response and recovery phases of natural disasters. For flood disaster, Akter and Simonovic (2005) proposed a flood management decision making methodology to capture the views of multiple stakeholders using fuzzy set theory and fuzzy logic. More important, decision making theory facilitates to select appropriate exposures and pertinent variables in the development of stakeholder disaster response index. The use of decision making techniques can be dated back to four decades. Since then, the theory and applications have been developed significantly (Shih, 2007).

Based on value maximization paradigm, it is hypothesized that stakeholders who are involved in the built environment would try to choose proactive approaches against disasters in order to minimize all negative consequences of disasters. Similarly, stakeholders would take rational behaviors in reactive approaches in recovery and post-disaster reconstruction activities. However, understanding stakeholders' decision making in disaster management can be attributed to intuitive reasoning paradigm. Stakeholders might choose irrelevant factors in their decision making process. For instance, in multi exposure analysis of disasters, one location (e.g., state, city, suburb) would be dominant compared to another location if the former is perceived to be superior to the latter in all significant aspects. Finally, by borrowing the ideas from both the stakeholder and decision making theories, we would be able to justify the development of stakeholder disaster response index that measures stakeholders' response approaches against disasters in the built environment as shown in Figure 1.

7. Conclusion

This paper examined the stakeholder and decision-making theories in the proposed theoretical framework for the development of stakeholder disaster response index. The proposed theoretical framework synthesis the two theories in examining stakeholders' response approaches against disasters in the built environment. Through stakeholder theory, we determine power and legitimacy of stakeholders whether they have tendency towards proactive or reactive approaches. Through decision-making theory, we are able to provide optimized decisions for stakeholders in order to minimize all negative consequences of disasters. Furthermore, stakeholders take rational behaviors in reactive approaches in recovery and post-disaster reconstruction activities with considering expectation, asset integration, and risk aversion.

With a sound theoretical framework for the development of stakeholders disaster response index, the resultant index facilitates: (1) direct comparison of different stakeholders' approaches against disasters; (2) high-level disaster management planning decisions; and (3) development of stakeholder disaster management procedure.

The next stage planned for this study involves validating the proposed theoretical framework with profound quantitative analysis by gathering relevant data from disaster management databases and in-depth interviews with stakeholders who are involved in managing disasters in the built environment.

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