INTEGRATED FRAMEWORK FOR ENHANCING EARTHQUAKE RISK MITIGATION DECISIONS

Temitope Egbelakin, Massey University, New Zealand
Suzanne Wilkinson, The University of Auckland, New Zealand
Jason Ingham, The University of Auckland, New Zealand

ABSTRACT

The increasing scale of losses from earthquake disasters has reinforced the need for property owners to become proactive in seismic risk reduction programs. However, despite advancement in seismic design methods and legislative frameworks, building owners are found unwilling or lack motivation to adopt adequate mitigation measures that will reduce their vulnerability to earthquake disasters. Various theories and empirical findings have been used to explain the adoption of protective behaviours including seismic mitigation decisions, but their application has been inadequate to enhance building owners' protective decisions. A holistic framework that incorporates the motivational orientations of decision-making, coupled with the social, cultural, economic, regulatory, institutional and political realms of earthquake risk mitigation to enhance building owners' decisions to voluntarily implement adequate mitigation measures, is proposed. This framework attempts to address any multi-disciplinary barriers that exist in earthquake disaster management, by ensuring that stakeholders involved in seismic mitigation decisions work together to foster seismic rehabilitation of EPBs, as well as illuminate strategies that will initiate, promote and sustain the adoption of long-term earthquake mitigation.

KEYWORDS: Earthquake, Decision-making, Motivation, Seismic risk mitigation.

INTRODUCTION

Earthquake disasters pose a serious threat to many seismically active communities. Buildings having insufficient seismic capacity contribute to the built environment's susceptibility to earthquake hazard and are the key contributors to earthquake losses (Egbelakin, 2013a). These buildings are constructed, owned and inhabited by owners who make a range of decisions and choices that shape their level of vulnerability to disaster impacts. Some owners make the decision to minimise their exposure to risks by adopting mitigation measures, some choose to ignore the risks, while others accept the risk without undertaking any protective measures (Burton, Huq, Lim, Pilifosova & Schipper, 2012).

Losses from earthquake disaster can be minimised by implementing appropriate risk mitigation decisions (Bostrom, Turaga, & Ponomariov, 2006), specifically decisions on seismic retrofitting of earthquake-prone buildings (EPBs) (Dowrick, 2003). An EPB is considered as a building that will have its ultimate structural performance capacity exceeded in a moderate earthquake, and would likely collapse causing injury or death to people in the building, or those in a nearby property, or damage to adjoining structures (Department of Building and Housing, 2004). The term EPB is the standard language used in New Zealand, and similar terms may be used in other countries. Seismic risk mitigation decisions refer to the choices made by property owners regarding whether or not to adopt pre-disaster mitigation measures (Egbelakin, 2013b).

The earthquake disaster risk mitigation sector is generally characterised by a series of challenges relating to the adoption and implementation of several risk mitigation mechanisms such as high retrofit cost, lack of motivation, lack of trust and belief in technical solutions (Egbelakin & Wilkinson, 2010; Egbelakin *et al*., 2014). Moreover, EPB owners are often found unwilling to adopt earthquake mitigation measures, due to several challenges associated with the decision-making process (Egbelakin *et al*., 2011b; Egbelakin *et al*., 2014). For example, the complexity of the decision-making process often discourages building owners from implementing adequate mitigation measures in their EPBs. The context in which each decision is made is a major determinant, and many trade-offs such as mechanical upgrade and maintenance, and other risks related to the property including fire and flood, are considered during the process. The final decision becomes complex because the factors affecting earthquake risk decisions are inter-related and difficult to analyse individually. According to Arlikatti, Lindell, Prater and Johnston (2007), any earthquake risk mitigation plan that fails to recognise the impacts of the inter-relationships among these factors' mitigation decisions may be deficient, leading to a sub-optimal outcome. Consequently, environmental hazard managers, researchers and policy-makers have attempted several approaches to investigate the building owners' unwillingness to adopt adequate mitigation measures. Yet, the rate of property owners' adoption of mitigation measures lags behind advances in the scientific and engineering understanding of earthquakes (Egbelakin, 2013a), which is evident in the recent earthquakes in Christchurch, New Zealand in 2011 and in others areas around the globe.

Past studies have demonstrated that seismic mitigation decisions could be influenced by the motivational nature of human decisions and psychosocial factors, most especially when making them under risk and uncertainty (Weber *et al.*, 2002). Such decision choices can be explained by the motivational orientation guiding decision-making (Egbelakin *et al.*, 2011a). The literature on motivation does suggest that a positive motivational atmosphere may enhance building owners' decisions. Little has been done empirically to integrate the motivational orientation of decisions made under uncertainty into the study of earthquake risk and disaster management. This study was initiated by the question of how to reduce the impact of earthquake disasters by motivating individual property owners to adopt adequate seismic mitigation measures, which was considered as a significant approach to successful earthquake risk mitigation (McClean, 2009).

A holistic framework is developed in this study to enhance building owners' decisions to voluntarily adopt seismic mitigation measures. Submissions from this research sought to develop a holistic framework that incorporates the concept and theories of motivation, coupled with the social, cultural, economic, regulatory, institutional and political realms of earthquake risk mitigation. The feasibility of this approach is justifiable because previous research has demonstrated the impacts of motivation on decision-making by establishing their utility in initiating, promoting and sustaining a desired behaviour (Kressler, 2003; Cavalier, 2000).

THEORETICAL PERSPECTIVES OF EARTHQUAKE RISK MITIGATION DECISIONS

Many theories in psychology, sociology, economics and the decision sciences have been advanced to explain the rationale behind the different risk decisions that people make (Lindell

& Perry, 2004). The process by which they choose to undertake protective decisions and actions has been approached mainly from different theoretical perspectives, namely, attitude-behavioural theories and social and cognitive processes theories. Within the tenets of attitude-behavioural theories, the most prevalent theories that have been applied to earthquake risk mitigation are the Theory of Reasoned Action (TRA) and the Theory of Planned Behaviour (TPB) (Ajzen *et al.*, 2009). These theories emphasise the role of behavioural intentions in human decisions and behaviour, by examining the different human characteristics such as beliefs, and personal and sociological factors, which serve as major elements of behavioural predictors (Sheeran *et al.*, 2003). Although, these theories are different from each other and are developed in diverse contexts, they both attempt to explain how perception of risk affects people's decisions and responses to environmental hazards. Paton (2008), however, explained that the interpretive process is influenced by cognitive biases and people's sociological background, limiting the potential of risk perception to predict protective adoption behaviour, consequently exploring other precursors.

The second approach to the study of risk mitigation decision relates to the adaptation of theories in health protective behaviours to reveal social cognitive variables such as problem-focused coping, self-efficacy and a sense of belonging to a community to predict preparedness and resilience to natural hazards. Four of these theories, which include the Protection Motivation Theory (Rogers, 1975), the Person-Relative-to-Event Theory (PrE) (Mulilis & Duval, 2003), the Protective Action Decision Model (PDAM) (Lindell & Perry, 2004) and the Social Cognitive Preparation Model (Paton, 2006), were examined in this study. The pursuit of this line of research is justified by the fact that the precursors of protective behaviour identified in health research have reinforced their potential to influence seismic mitigation decisions in natural hazards research (Paton, 2006, Linley et al., 2004). Collectively, theories incorporating social and cognitive processes have been successfully applied to predicting behavioural intentions and decisions to engage in various behaviours or decisions for earthquake preparedness (Asgary & Willis, 1997). Yet, their application has been inadequate to enhance building owners' protective decisions. For example, the emergence of the Social Cognitive Preparation Model (Douglas & Wildavsky, 1982) recognised the need to understand the "reasoning and judgment that underpin decisions regarding disaster preparedness". The model indicates that variables such as risk perception, self-efficacy, response efficacy and problem-focused coping are predictors of behavioural intention to adopt disaster preparedness measures. However, comparisons of the different adaptations of the model found substantial discontinuity between people's perception of risk and their level of preparation, which suggests that seismic mitigation decisions are influenced by additional interpretative and motivational processes (Paton, 2003). The theories discussed in this section have many useful features and offer some plausible explanations regarding how people respond to earthquake risk mitigation, but their very generality limits their ability to investigate how building owners' earthquake mitigation decisions can be motivated. A motivational perspective in making earthquake risk mitigation decisions would provide a complete understanding of the process of designing effective strategies and mechanisms tailored to the specific needs of different property owners.

ENHANCING EARTHQUAKE MITIGATION DECISIONS - A MOTIVATIONAL APPROACH

The concept of motivation has been adopted in various disciplines relating to decision-making and predicting behavioural patterns (Mitchell & Daniels, 2003). Motivational-related factors such as values, intention, perception and self-efficacy help generate the human desires that engage the mental processes of seeking opportunities to take actions that will reduce the level of risk exposure (Paton, 2003; Clark, 2006). For instance, when a need arises to take action to reduce a threat posed by an earthquake, motivation can provide the initiative, direction, intensity and persistence to achieve a safer environment. It also nurtures people's self-efficacy and controls the willingness to make the decision to persist at a specific task or action in the face of distractions and competing priorities (Clark, 2006). Motivational theories seek to explain the rationale behind people's decisions, why they carry out a particular action, and how the outcomes of such actions help to achieve their objectives (Cavalier, 2000; Dahlgaard & Dahlgaard, 2003; Halepota, 2005). Three categories of motivational theories' relevance to decision-making examined in this study are theories such as Maslow's Hierarchy of Needs (Maslow, 1954), Acquired Needs theory (McClelland, 1971) and Alderfer's ERG theory (Alderfer, 1972). In addition, reinforcement theories that include Skinner's Reinforcement theory (1953), Higgin's Regulatory Focus theory (1998), and process theories such as expectancy theory of motivation (Vroom, 1964) and Porter and Lawler's Motivation Model (1968), were examined in this study. The review of these three categories of theories revealed three common components of motivation: (i) what prompts human behaviour; (ii) what channels such behaviour; and (iii) how the behaviour can be sustained. The first component implies that how intrinsic human factors such as perception of risk and behavioural control, needs, beliefs, attitudes relate to forces drives behaviour. The second component considers intention as the rationale for behaviour, ascertaining that an individual's behaviour is directed towards achieving a particular objective. The third component relates to a system orientation that describes how behavioural intention, and intrinsic and extrinsic forces, interact to either dissuade or reinforce behaviour.

Empirical studies adopting these motivational theories revealed that intrinsic human factors affecting decisions include attitude and beliefs, values placed on decision outcomes, social norms, perceived risk and behavioural control. Extrinsic motivators identified include benefits associated with decision outcomes, and positive and negative reinforcements such as incentives, punishments and sanctions (Cavalier, 2000; Kressler, 2003; Ryan & Deci, 2000). These findings complement some of the results from the application of theories discussed in the previous section, specifically regarding the first two components of motivation. Therefore, the third component defines the approach of the applied motivational theories by examining how a behavioural goal or intention, intrinsic and extrinsic forces, and the corresponding motivators interact to reinforce decisions and behaviour towards a particular direction. This approach would lead to understanding human decision motivational processes, and devising strategies aimed at enhancing building owners' adoption and implementation of seismic mitigation measures.

Overall, the review of theories both in risk mitigation decision and motivation discussed in this paper are different, although they are all concerned about the process that characterises human cognitive decisions and actions. These theories all assume that individuals have expectations regarding the outcomes of their decisions. Applying motivational concepts to the study of earthquake hazard mitigation decisions complements the existing approach by emphasising that decision-making is characterised by an influence from within and external to the decision-maker. Further, the commonalities between the motivational and seismic mitigation decision theoretical constructs provide additional rationales regarding the complementarity of motivation to existing research in earthquake mitigation decisions. For instance, people's expectations from behavioural or decision outcomes is central to the concept of outcome expectancy in the Social Cognitive Preparation theory, which is also a key construct of motivation. Likewise, people's perceptions about a task or situation or risks are central to the concept of perceived behavioural change. Such perception steers decisions about the acceptability of risks and is a core influence on decisions before, during and after a disaster. Hence, the concept of perception in both research realms is complementary to each. In view of these commonalities between motivational constructs and seismic mitigation measures decisions, it is reasonable to hypothesise that the concept of motivation is applicable to earthquake risk mitigation because of the supplementarity and complementarity of motivation and previous research in earthquake mitigation decisions. A motivational input is necessary as it is aimed at understanding and changing the behaviour and attitudes of building owners and other stakeholders involved in seismic hazard and risk mitigation. However, it is crucial to note that motivation does not directly influence the adoption of risk mitigation measures. Instead, it helps us to reason in a particular direction while using our knowledge and skills to effectively make appropriate decisions regarding the mitigation of earthquake risks. The application of the concept of motivation to earthquake risk management will supplement existing natural hazard and disaster management approaches because it combines several criteria such as economic, socio-psychological and behavioural to understand what motivates people's decisions and behaviour. The development of the conceptual framework is discussed in the next section.

CONCEPTUAL FRAMEWORK DEVELOPMENT

By integrating the theoretical fields of natural hazard management and motivation, and including a wider range of variables established in the literature, a comprehensive multi-phased conceptual framework, illustrated in Figure 1, was developed to examine how seismic retrofit decisions can be motivated and sustained. The framework builds upon existing research findings and the framework of Egbelakin *et al*. (2011a). The framework shows that the process of making seismic mitigation decisions comprises three inter-related stages that can be influenced by specific sets of motivators. The first stage concerns intrinsic factors within humans that prompt an intention to make decisions to achieve a particular goal (intention precursors), with intervening intrinsic motivators to proceed to the next phase. The second stage involves the factors that influence seismic mitigation decisions (decision-forming variables) and the corresponding extrinsic motivators that allow the decision-making process to advance to the last stage. This last stage describes a system orientation that combines the interactions of the variables in phases one and two and a collective stakeholders' approach in phase three, expecting to result in building owners' actual adoption and implementation of appropriate seismic mitigation.

Intention Formation Phase

As illustrated in Figure 1, the first stage comprises the formation of intentions to prepare for earthquake disaster. "Intention" or willingness to adopt seismic mitigation measures is a behavioural attribute evoked by human intrinsic factors or stimuli to explain why some individuals and not others are involved in earthquake risk mitigation (Paton, 2003). In relation to long-term mitigation, specifically structural modification of existing EPBs considered in this study, intention should not be taken to automatically imply their conversion to actions or decisions because of the presence of moderators such as uncertainty in earthquake probability and severity which limit the predictive capabilities of behavioural intentions (Lindell & Perry, 2004). Explicitly, "intention to prepare" is conceptualised in this study as the extent to which an individual is willing to make decisions regarding whether or not to adopt seismic mitigation, and is initiated by 'precursors' such as risk perception, fatalistic attitude, critical awareness, perceived responsibility, past earthquake experience, hazard knowledge and proximity (Paton, 2003, Egbelakin *et al*., 2011a).

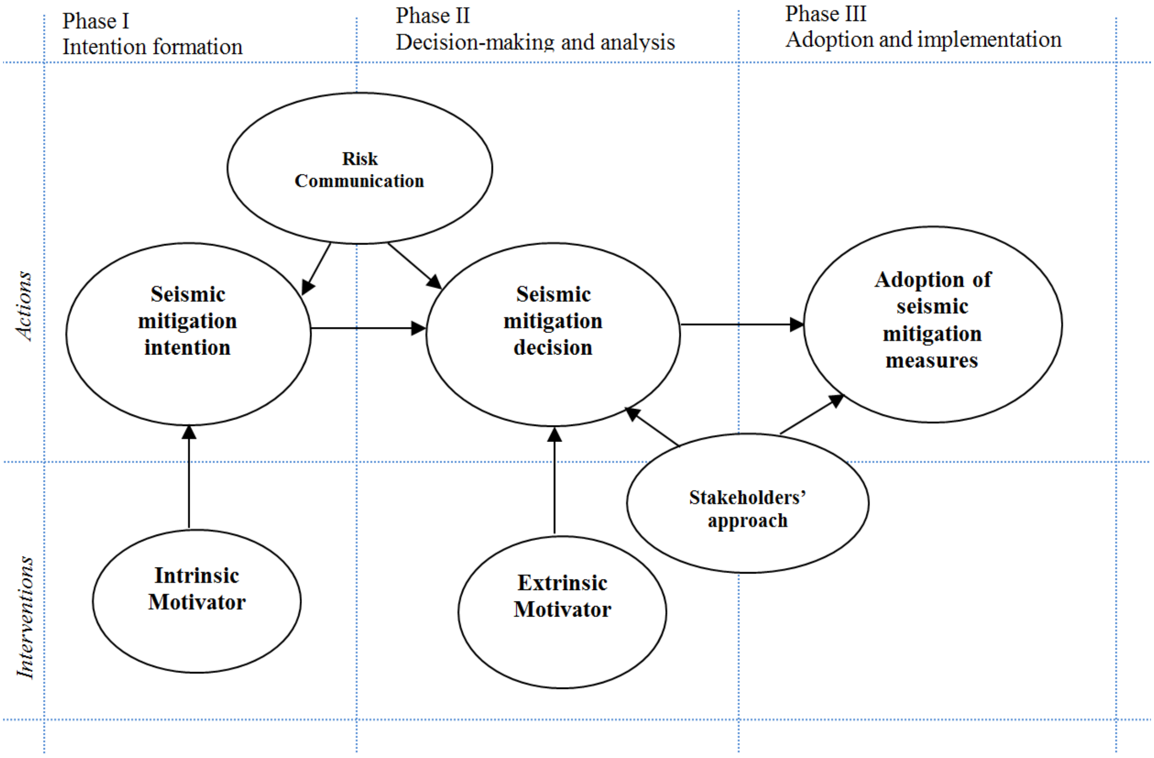

Figure 1: Conceptual Framework for Motivating Earthquake Mitigation Decisions

Predictors of seismic mitigation intention

Several factors have been identified in empirical findings in the earthquake risk management literature that have been attributed to predict behavioural intentions. These factors include risk perception, fatalistic attitude, critical awareness, perceived responsibility, past earthquake experience, hazard knowledge and proximity (Ajzen & Albarracín, 2007). Perception of risk is shaped by how people interpret and personalise hazard and its related impacts, and has been established as a valid precursor to disaster preparedness intention (Solberg *et al*., 2010). The degree to which critical awareness causes people to stop thinking about other tasks and focus on their vulnerability to earthquake risk was found to be a significant predictor of seismic mitigation adoption (Lindell & Perry, 2004). A fatalistic attitude about earthquake damage can affect intentions to prepare for natural hazards (McClure *et al*., 2007). Hazard proximity provides an indication of the geographic distance from the hazard source such as existing fault lines, and has been perceived as a potential risk when people make decisions regarding alternative locations to reside (Lindell & Hwang, 2008). Perceived responsibility denotes the extent to which an individual feels responsible for ensuring personal or close family members' safety (Mulilis & Duval, 1995). People who feel that they are responsible for preparedness against earthquake disasters are likely to develop behavioural intention to adopt mitigation measures. According to Lindell and Perry (2004), previous disaster experience has a direct effect on hazard mitigation intentions or decisions, but there are possibilities that additional unidentified variables mediate the effect of disaster experience on hazard mitigation adoption.

Effective risk communication and awareness programs are significant parameters that can ameliorate people's perceptions and intentions about risk mitigation (MacGregor *et al.*, 2008).

Intrinsic motivators

As conceptualised in this study, intrinsic motivators are necessary to expedite the transitional process of transforming seismic mitigation intention to a decision because the intention to adopt long-term hazard mitigation can change over time in the presence of other competing needs (see Figure 1). Four intrinsic motivations adopted are story-telling, the use of policy entrepreneurs, mass media and encouraging pro-social mitigation behaviour. Story-telling from past earthquake experiences and coping strategies among family and community members can augment the level of acceptability of earthquake reality, and address change in people's preparedness decision by casting the key information somewhere along a wide range of sense-making possibilities (Brown *et al.*, 2009). Empirical findings have documented the fundamental role that policy entrepreneurs play during the policy formulation and adoption process, which entails mobilising community support for relevant policies and ensures it stays on the agenda until the desirable objectives are achieved (Wood, 2004). The media can be used to improve the salience of earthquake risk issues, and can influence people's preparedness towards hazard mitigation by constructing, amplifying and dramatising the extent of risk exposure (Paton, 2006). Pro-social behaviour refers to voluntary actions that are intended to help or benefit the society, which includes the act of promoting seismic rehabilitation of EPBs (Goodwin, 2009). For instance, the values that individuals or a group of people assign to heritage buildings can promote earthquake risk mitigation behaviour and action towards EPBs as some of these buildings have heritage attributes.

Summarising the discussion on the intention formation phase, it is plausible to conclude that risk perception, fatalistic attitude, critical awareness, perceived responsibility, past earthquake experience, hazard knowledge and proximity are proposed variables required to initiate the reasoning process that underlies whether a protective behaviour will be developed or not. That is, some level of their presence is required for the seismic mitigation adoption process to commence. Likewise, the application of the intrinsic motivators would enable a low motivated person to progress to the decision stage and sustain the motivation of the already motivated individual.

Decision-making and Analysis Phase

The decision-making and analysis phase is an intermediary stage between the formations of intention and the actual adoption and implementation of seismic mitigation (see Figure 1). This phase refers to the extent that a building owner has developed the intention to retrofit, and has analysed critically the decision whether to adopt seismic mitigation and to what seismic performance standard required for the EPB.

Predictors of seismic mitigation decision

Seismic retrofit decision-making can be influenced by resource requirements, mitigation efficacy, trust in stakeholders' relationships, perceived benefits of adopting seismic mitigation, regulatory requirements and stakeholder characteristics (Egbelakin *et al.*, 2011a). Perceived benefits of retrofitting such as ensuring safety, financial returns and public recognition refer to the extent to which people's judgement regarding the cumulative rewards obtainable from retrofitting their EPBs influence their decision to adopt mitigation measures (Egbelakin, 2013b). The efficacy of earthquake-related policies and regulations relate to the extent that the formulation and implementation of these regulations affects building owners' adoption of mitigation measures (Lindell & Prater, 2000). Stakeholder characteristics affect mitigation decisions through the acceptance or non-acceptance of information regarding earthquake risk mitigation (Arlikatti *et al.*, 2007). Resource requirements describe the beliefs about the adequacy of knowledge, skills and resources that include finance, materials and equipment to mitigate disaster impacts (Johnston *et al.*, 2005). Seismic adjustments efficacy denotes presumed success of risk mitigation measures, such as the extent to which the structural designs adopted in the retrofitting of EPBs is perceived to protect both persons and property in an earthquake event (Lindell *et al.*, 2009). Trust in stakeholder inter-relationships determines the credibility of risk information accorded to hazard management experts (Siegrist & Cvetkovich, 2000). Lack of trust undermines the assumptions that people make concerning the motivation of those providing the information, their competence and the reliability of the information given (Earle, 2004), and consequently their decision to adopt seismic mitigation.

Extrinsic motivators

Extrinsic motivators introduced at the second phase would allow a seismic retrofit decision to proceed to the final adoption and implementation stage through the use of incentives. The extrinsic motivators adopted are financial-based incentives (McClean, 2009), technological-based incentives (Lindell & Perry, 2004), regulatory-based incentives and property-market based incentives (Egbelakin, 2013b). Financial incentives could enhance the adoption of seismic hazard mitigation by reducing the initial cost of implementation (McClean, 2009). Financial incentives considered in this study are: reduction in consent fees, tax credits and deductibles, reduced insurance premium, public low-interest loan programs, reduced permit fees, fee waivers and a cost-sharing approach. Technological innovations, such as sustainable and cost-effective seismic retrofitting design solutions, signify a more advanced way of achieving risk reduction because they could reduce the trade-off between efficacy and cost. Regulatory-based incentives include: implementing mandatory disclosure of earthquake risks at the point of sale/rent; comprisal of seismic risks in property valuation assessments; implementing sanctions for building owners not retrofitting their EPBs; improving building standards, guidelines and building code; implementing a grading system; developing public policies tied to seismic strengthening to promote earthquake hazard mitigation, specified permitted uses, plot ratios or site intensity zoning; and mandating the use of transferable development rights (Egbelakin *et al.*, 2013)

Three property-market based incentives proposed are: mandatory recognition of seismic risks in property valuation assessment; public awareness and education programs about seismic risks for property market stakeholders; and creating value for seismic risks in the property market (Nakhies, 2009). A stakeholders' approach refers to a collective system orientation that combines the interactions of the constructs in the first and second phases (seismic mitigation intention and decision-making phases), immersed in a "social context" to influence the adoption of seismic mitigation decision and adoption. A seismic mitigation decision immersed in a social context is significant for social relationships and developments that foster collective protective actions against environmental threats (Egbelakin, 2013a).

To summarise the discussion on the decision-making and analysis phase, the identified factors influencing seismic risk mitigation decision could be enhanced by the presence of the extrinsic motivators, allowing a less motivated property owner to progress from the decision-making and analysis phase to the adoption and implementation phase. Similarly, the application of the stakeholders' approach depicts that the immersion of the first two phases in a social context would have a significant effect on all stages of the protective actions and seismic mitigation adoption and implementation.

Adoption and Implementation Phase

The final phase relates to the adoption and implementation of seismic mitigation measures. In this phase, all the factors identified as influencing the decision to adopt mitigation measures have been assumed to be satisfactorily considered and enhanced. Hence, a seismic mitigation measure likely to be most effective at achieving protection and other related benefits, and logically feasible to implement, would be adopted and implemented.

FRAMEWORK VALIDATION

The validation of the framework conceptualisation is presented in this section. Theoretical validation was adopted to examine the framework's internal validity, alongside subject matter expert (SME) validation, which was used to assess the external validity and applicability of the developed framework to real-life situations. Details of the validation are discussed in subsequent sections.

Theoretical Validation

The framework illustrated in Figure 1 describes the adoption of seismic mitigation as a reasoning process that comprises of three sequential phases, which are cross-validated by examining the major theoretical frames (models) supported by previous literature on earthquake risk mitigation, decision sciences and motivation (see Figure 2), and which have been reviewed in the last three section on earthquake literature.

Figure 2 shows the relationships among the theoretical frames, dimensions of seismic mitigation phases, constructs and the successful adoption and implementation of seismic mitigation. Ten theoretical frames mapped with the dimensional phases of mitigation decisions provide empirical support for the development of the framework. Six theoretical frames from earthquake risk mitigation are TRA, Theory of Planned Behaviour, Protection Motivation Theory, PrE, PDAM and the Social Cognitive Preparation Model. While the remaining four frames emerged from the review of the motivational theories include Skinner's Reinforcement theory, Higgin's Regulatory Focus theory, Goal-setting theory and Expectancy theory emerged from the review of the motivational theories. In addition, the six main constructs conceptualised for predicting building owners' likelihood to adopt seismic mitigation are derived from these 10 theoretical frames. For instance, Theory of Planned Behaviour maps into seismic mitigation intention, while Protection Motivation Theory maps into seismic mitigation decision, and the intrinsic and extrinsic motivator constructs. The mapping of the theoretical frames, dimensions of seismic mitigation decision phases, constructs and successful adoption and implementation of seismic mitigation provide a theoretical validation of the conceptualisation of the framework used in this study.

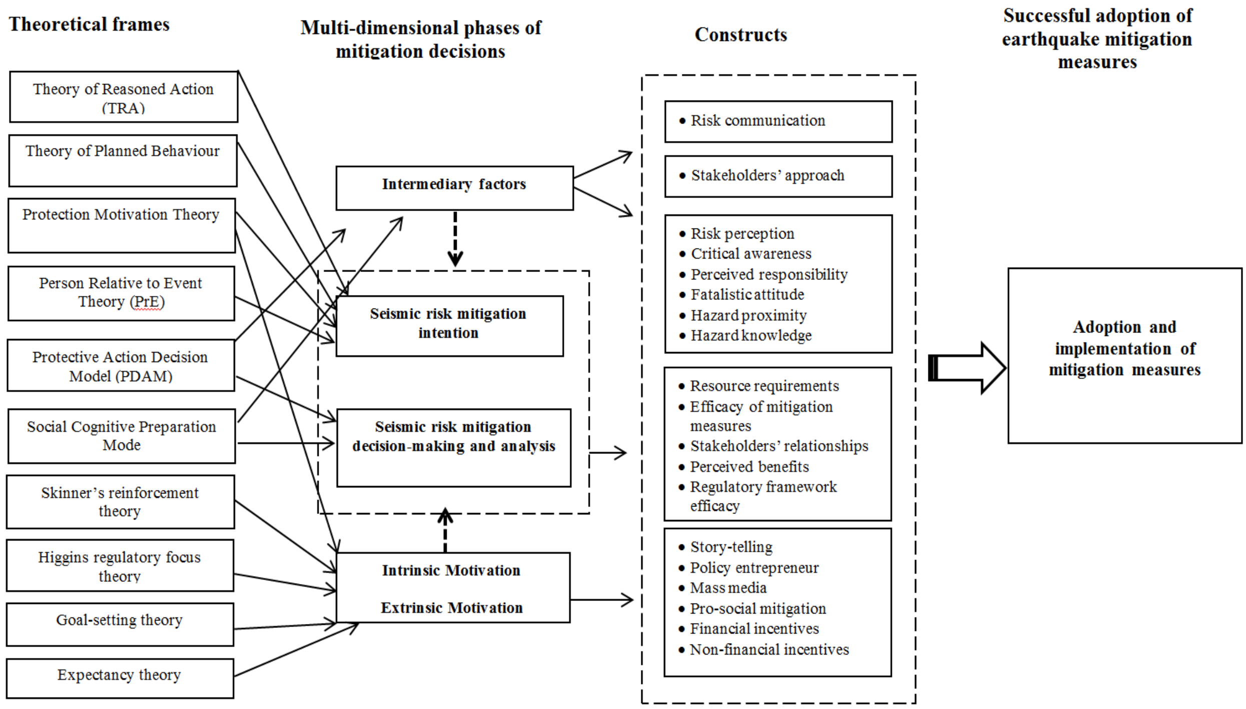

Figure 2 Theoretical formulation and validation of the framework

INTERVIEWING SUBJECT MATTER EXPERTS

SMEs were used to examine the external validity and applicability of the developed framework to real-life situations. An SME is a person who is an expert in a particular area, activity or topic (Sugar & Schwen, 1995). The research is mindful of the need to examine the developed framework's capabilities, appropriateness and limitations, for addressing the research problem reported in this article, hence the engagement of SMEs to assess the conceptual framework before commencing on empirical testing. Five SMEs who have been involved in earthquake risk mitigation in New Zealand for at least 20 years were selected. Face-to-face interviews were conducted with selected SMEs that comprised two private building owners, two directors from the city councils and one director of a property valuation company. In order to preserve anonymity and facilitate further discussion regarding the research findings, individual SMEs were assigned with a code: SME1, SME2, SME3, SME4 and SME5, respectively. Table 1 provides a summary of the SMEs used in this study. To facilitate the interviewing process, an interview guide was developed. This consisted of: (i) a brief introduction to the research process; (ii) a list of questions; and (iii) the framework diagram showing the influences and inter-relationships among the motivators and the three sequential processes of seismic risk mitigation decision and adoption of measures. Accounts of the SME's opinions are presented in the following subsections.

Table 1: Profile of SMEs

SMEs	Experience in Earthquake Risk Mitigation
SME 1	• Has over 30 years international experience in structural and earthquake engineering in a multi-discipline context. • Has developed a wide understanding of all aspects of earthquake "engineering" including technical, economic, social and insurance aspects. • Has been responsible for many commercial, industrial and infrastructure development projects and his wide range of consulting experience includes technical, management and business development roles
SME 2	• Has over 20 years of work experience in earthquake risk mitigation in both New Zealand and overseas. • Has a very good understanding of the Building Act and engages with the document on a regular basis.
SME 3	• Over 20 years of experience in earthquake and natural disaster mitigation in New Zealand • Has very good knowledge of relevant legislative documents used for earthquake risk mitigation • Has valued opinion on policy-type issues around earthquake risk mitigation
SME 4	• Over 25 years of experience in government Liaison – and Policy Advocacy • Has close working knowledge of local and central government public policy processes affecting housing an property developments in New Zealand • Has valued knowledge in Housing stock management and tenancy management
SME 5	• Over 20 years of experience in earthquake and natural disaster mitigation in New Zealand • Heads the building control Team that • Provide specialist reviews of building • consents, fire safety advice, administer the building warrant of fitness system and deal with building claims • Provide advice and input into administration of the Building Act and local EPB policy

Discussion of Interview Findings

During the interviews, the risk mitigation decision framework diagram was presented to the five experts. The key issues listed below were presented to the SMEs and discussed in subsequent subsections.

1. Adequacy of the framework to reduce the complexity of the seismic risk decision-making process in order to ensure that owners of EPBs adopt preventive measures;

2. Practicality of the identified motivators and their potential impact on earthquake risk mitigation.

Framework's Adequacy to Reduce the Complexity of the Seismic Risk Decision-Making Process

A consensus was obtained among all the five SMEs regarding the need for a workable framework or strategy that can be used to reduce the complexity surrounding earthquake mitigation decisions and to enhance building owners' earthquake mitigation decisions. A strategy is necessary considering the impacts of the recent Christchurch earthquakes and the potential to prevent large-scale losses from future earthquake disaster. All five SMEs agreed that, to a great extent, the framework has fulfilled this purpose. In the discussion regarding whether the framework is adequate to reduce the complexity of the seismic risk decision-making process for owners to adopt preventive measures, the experts agree with the three simplified decision-making processes proffered by the framework. An agreement was obtained among all experts that the three sequential phases – (i) earthquake mitigation intentions; (ii) earthquake mitigation decisions; and (iii) the actual adoption and implementation of hazard mitigation measures – have simplified the complexity that surrounds the decision-making process.

In view of the definitions attached to each phase, all the SMEs pointed out that these three phases are relevant to mitigating natural hazard risks because of the inherent problems and complexity associated with earthquake risk mitigation. SME3 believes that *the large number of stakeholders that the building owners have to deal with during the process of retrofitting could be attributed to such a complexity.* He explained that the proposed simplified and step-by-step process will enable the stakeholders to understand their respective roles and limitations, thus reducing building owners' confusion regarding assessing several recommendations from all the stakeholders. SME2 pointed out that these phases are important because it provides a step-by-step approach to ensure that earthquake mitigation measures are actually adopted and implemented. He added that the framework would likely help to reduce the dilemma of procrastination that is particular to earthquake hazard management, which results in the delay of mitigation decision because the immediacy of threat cannot be justified coupled with the inability of the governmental regulatory mechanisms to mandate specific timelines for adopting risk mitigation measures. SME1 mentioned that the recent Christchurch earthquakes had demonstrated the need to put in place a simplified strategy centred on motivating property owners to adopt risk mitigation measures. This was because most of the damaged unreinforced masonry buildings were as a result of inaction by the owners to implement a "make-safe work practice" on their properties such as in the case of 382 Colombo Street and the Forsyth Barr building. Hence, the need for a gradual and monitored step-by-step motivational approach process to earthquake risk mitigation.

Three experts (SME1, SME3 and SME4) shared the view that the second and last phases (i.e. mitigation decision and the adoption phases) are more important than the first intention phase. They explained that the decision and adoption phases deal with more familiar and anticipated demands that accompany earthquake risk mitigation issues, while the formation of intention focus is centred on the individual and it may be difficult to ascertain its influence directly on overall earthquake vulnerability reduction. SME1 mentioned that:

> *It would be difficult to understand and estimate the differences that could result from various owners' intentions to adopt seismic mitigation measures. The council, for instance, may find it difficult to incorporate managing the attitudes of its EPB owners towards retrofitting in its risk mitigation policy. I think the decision and adoption stage requires more attention.*

From another perspective, SME5 pointed out that the three sequential phases are equally important to ensure an EPB owner's continued interest in expending money on mitigating low-probability risks such as earthquakes. SME5 expressed that:

> *If an owner does not develop intentions, and such intentions are nurtured to the decision-making phase, there is no way an EPB property owner would be encouraged to adopt risk mitigation measures unless there are personal intrinsic evaluation of the benefits associated with retrofitting, most especially in this prevailing property market condition and regulatory environment. The pre-requisite for continued property owners' interest and response to natural earthquake risk mitigation requires a continuous awareness and cost-effective approach that ensures that owners of EPBs constantly think and discuss about the consequences of another*

earthquake event. In my opinion and experience as a building owner who has retrofitted several EPBs, the three phases are important.

SME5 seems to suggest that the first intention formation phase is particular to the property owners and should be taken seriously since they make the final decision whether or not to adopt risk mitigation measures, and the extent of seismic performance they choose to adopt. SME2 supports this argument and added that the building owners are very important in this decision and their needs should also be considered. Further, SME2 emphasised that the simplified process allows various activities within each phase to be assigned to the best person who can handle it during the decision-making process. For instance, the council and heritage preservation organisations could help out in the first phase, while the two other phases are handled by the concerned stakeholders. According to him, in this way all the three phases identified in the framework can be monitored and implemented successfully.

It is acknowledged in this study that different stakeholders may have different emphases on the importance of the three identified phases, which is reflected by their respective roles and responsibilities in relation to earthquake hazard and disaster management. The framework developed in this study would provide a system of clear linkages of sharing earthquake risk information among the stakeholders and also ascertain that the needs of the main decision-maker and the public in disaster preparedness are not underestimated. Accordingly, it is reasonable to include the intention formation phase in the framework because it focused on bringing together the needs and opinions of the different people that could be affected in an earthquake disaster.

Experts' Opinions on Practicality and Comprehensiveness of the Framework

In view of the practicality and comprehensiveness of the resulting seismic risk mitigation decision framework, all the SMEs shared the opinion that the framework has, to a great extent, identified all the factors affecting the adoption and implementation of adequate risk mitigation measures in New Zealand and the corresponding key motivators to improve the adoption and implementation process. SME1 expressed that:

The proposed framework is very comprehensive and would be useful during this Christchurch recovery and rebuilding period, if we focus now on improving existing building stock. The cost to the country resulting from the Canterbury earthquakes is reportedly between 8-10% of GDP. New Zealand, as a small country, has a disproportionately high percentage of national wealth located in a small number of urban centres, where the loss of any one of these cities such as Christchurch can have extreme consequences for the country as a whole. Therefore the proportionate cost risk of a major natural disaster in a large city is higher in New Zealand than an international average. Possibly, the threshold for addressing earthquake risk mitigation needs to respond to this.

The overall impact and cost of a future disaster in New Zealand is dependent on how prepared the community is for such a disaster and how long it takes to recover, which depends on the level of damage sustained by the buildings and how quickly communities can re-establish usable housing and liveable environments. The implementation of some of the findings from this study may go a long way to help prevent significant economic losses in a major earthquake disaster.

In somewhat similar lines to the above statement, SME2 agrees that the proposed motivators are necessary because it tends towards achieving voluntary risk mitigation. This is very important for the New Zealand environment, considering people's individualist nature towards natural hazard management and the government's emphasis on only life-threatening collapses. SME2 specifically mentioned:

> *Your emphasis on using several mechanisms to initiate the voluntary adoption of adequate seismic mitigation measures is singularly important because there is too much emphasis on eliminating only the risk of life-threatening collapses, which has proved insufficient to deal with the harsh reality of disaster consequences, as in the case of the Christchurch earthquakes.*

He further explained that although the main objective of earthquake preparedness is to protect lives, mere survival is inadequate, especially from a city-wide perspective. National government policy must recognise that their responsibilities lie beyond basic safety. Seismic risk mitigation should entail preparing all our structures, networks and organisations so that expected losses are not catastrophic to the country's economy. In my opinion, the framework has identified a list of motivators and incentives to promote voluntary earthquake risk mitigation because using regulatory mandates alone have not been very effective for improved earthquake risk mitigation as recently experienced in the Christchurch earthquake events. SME3's opinion regarding the conceptual framework reads:

> *I think the motivators are widespread across several stakeholders and sectors. Earthquake risk mitigation programs are effective when they balance the needs and resources of all stakeholders. A mandatory program that no building owner can afford, or that causes enormous short-term disruption to achieve a hypothetical long-term result, will accomplish little. On the other hand, programs designed for the convenience or benefits of certain individuals don't often get the job done for the community. Thus a political support combined with regulatory instruments and community willingness must be in sync to achieve effective risk mitigation. In my opinion, these set of motivators have adequately balanced the needs and activities of all the stakeholders to achieve effective risk mitigation.*

However, SME1 and SME3 pointed out that the framework is only sufficient to provide an overview of the influential property owners' motivators. SME5 added that the framework could consider the economic implication of these motivators, and how the stakeholders involved in designing them would develop and compare a cost-benefit analysis of the provision of these against non-provision, given the likelihood of an earthquake in a certain area.

CONCLUSION

The framework developed in this study addresses how EPB owners' adoption and implementation of seismic mitigation measures could be enhanced. The framework derives its strength by integrating theories and research in natural hazard management and motivation by amalgamating the different empirical findings and theories on risk decisions and motivation. Moreover, the framework addresses a broader range of factors from the social, regulatory, institutional, economic and behavioural perspectives that underlie human reasoning and judgements regarding disaster preparedness. The utility of the framework lies in its function to examine how human motivational orientations influence decisions regarding disaster preparedness, how individuals make choices regarding seismic risks mitigation, and how the motivational orientations can subsequently be used to predict voluntary adoption of seismic mitigation under specific conditions of the inter-related motivational factors. Thus, the framework developed in this study aims to address the gaps in literature and theory on how to induce, promote and sustain appropriate seismic risk mitigation decisions and actions. In addition, the framework extends research in earthquake risk mitigation by: (1) identifying the potential motivational and psychological mechanisms necessary to sustain seismic mitigation decisions to actual implementation; and (2) providing a theoretical step toward developing a comprehensive and holistic approach to understanding the risk mitigation motives. Such a measure would facilitate targeted strategies and interventions to reduce people's vulnerability to earthquake hazard.

A criticism in the area of natural hazard and disaster management research has been the lack of a holistic framework that can be scientifically tested and the lack of construct validation (2000). Therefore, the conceptual framework developed in this study needs to be empirically evaluated through quantitative or qualitative approaches before valid conclusions could be made about its applicability and success for reducing earthquake disaster vulnerability. More importantly, the framework for enhancing earthquake preparedness decisions incorporating a multi-disciplinary approach developed in this study has great potential for building property owners' and community resilience before adverse events.

REFERENCES

Ajzen, I. & Albarracín, D. (2007). Predicting and changing behavior: A reasoned action approach. *Prediction and change of health behavior: Applying the reasoned action approach*, 1-21.

Ajzen, I., Czasch, C. & Flood, M. (2009). From intentions to behavior: Implementation intention, commitment, and conscientiousness. *Journal of Applied Social Psychology*, *39*(6), 1356-1372.

Alderfer, C. P. (1972). Existence, Relatedness and Growth, Free Press, New York, NY.

Arlikatti, S., Lindell, M. K., Prater, C. S. & Johnston, D. (2007). Perceived stakeholder role relationships and adoption of seismic hazard adjustments. *International Journal of Mass Emergencies and Disasters, 25*(3), 218-256.

Asgary, A. & Willis, K. G. (1997). Household behaviour in response to earthquake risk: an assessment of alternative theories. *Disasters*, *21*(4), 354-365.

Bostrom, A., Turaga, R. & Ponomariov, B. (2006). Earthquake mitigation decisions and consequences. *Earthquake Spectra*, *22*(2), 313-327.

Brown, A. D., Gabriel, Y. & Gherardi, S. (2009). Storytelling and change: An unfolding story. *Organization*, *16*(3), 323.

Burton, I., Huq, S., Lim, B., Pilifosova, O., & Schipper, E. L. (2002). From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy*, *2*(2), 145-159.

Cavalier, R. (2000) Personal motivation: a model for decision making, Praeger, Westport CT, London.

Clark, R. E. (2006) Motivating individuals, teams, and organizations. Handbook of Human Performance Technology.

Dahlgaard, P. S. & Dahlgaard, J. J. (2003) Towards a holistic understanding of human motivation: Core values - the entrance to people's commitment? *AI & Society*, *17*(2), 150-180.

Department of Building and Housing (2004). The Building Act, Brookers Ltd, Wellington.

Douglas, M. & Wildavsky, A. (1982). Risk and Culture: An Essay on Selection of Technological and Environmental Dangers, California University Press, Berkeley.

Dowrick, D. J. (2003). Earthqauke risks reduction actions for New Zealand. Bulletin of the New Zealand Society for Earthquake Engineering (NZSEE), *36*(4), 249-259.

Earle, T. C. (2004). Thinking aloud about trust: A protocol analysis of trust in risk management. *Risk Analysis*, *24*(1), 169-183.

Egbelakin, T. (2013a). Earthquake Risks Mitigation - A Stakeholder's Perspective, Lambert Academic Publishing, Singapore

Egbelakin, T. & Wilkinson, S. (2010). Sociological and behavioural impediments to earthquake hazard mitigation. *International Journal of Disaster Resilience in the Built Environment*, *1*(3), 310-321.

Egbelakin, T., Wilkinson, S. & Ingham, J. (2014). Economic impediments to successful seismic retrofitting decisions. *Structural Survey*, *32*(5), 449-466.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. (2011a). Enhancing seismic risk mitigation decisions: a motivational approach. *Construction Management and Economics*, *29*(10), 1003-1016.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. (2013b). Improving regulatory frameworks for earthquake risk mitigation. *Building Research & Information*, *41*(6), 1-13.

Egbelakin, T., Wilkinson, S., Potangaroa, R. & Ingham, J. M. (2011b). Challenges to successful seismic retrofit implementation: a socio-behavioural perspective. *Building Research & Information 39*(3), 286 - 300

Egbelakin, T. K. (2013c). Incentives and Motivators for Enhancing Earthquake Risk Mitigation Decision. PhD Thesis PhD, University of Auckland. Auckland, New Zealand.

Goodwin, C. O. (2009). Identifying heritage value in URM buildings. *Journal of Structural Engineering Society New Zealand*, *22*(2), 16-28.

Halepota, H. A. (2005). Motivational theories and their application in construction. *Cost Engineering*, *47*(3), 14-18.

Higgins, E. T. (1998). Promotion and prevention: regulatory focus as a motivational principle. In Zanna, M. P. (ed.) Advances in experimental social psychology. Academic Press, New York, 1-46.

Johnston, D., Paton, D., Crawford, G., Ronan, K., Houghton, B. & Bürgelt, P. (2005). Measuring tsunami preparedness in coastal Washington, United States. Developing Tsunami-Resilient Communities, 173-184.

Kressler, H. W. (2003). Motivate and Reward: Performance Appraisal and Incentive Systems for Business Success, Palgrave Macmillan, Basingstoke.

Lindell, K. M. & Prater, C. S. (2000). Household adoption of seismic hazard adjustments: A comparison of residents in two states. *International Journal of Mass Emergencies and Disasters*, *18*(2), 317-338.

Lindell, M. & Perry, R. (2004). Communicating Environmental Risk in Multiethnic Communities. Sage Publications, Inc.

Lindell, M. K., Arlikatti, S. & Prater, C. S. (2009). Why people do what they do to protect against earthquake risk: Perceptions of hazard adjustment attributes. *Risk Analysis*, *29*(8), 1072-1088.

Lindell, M. K. & Hwang, S. N. (2008). Households' perceived personal risk and responses in a multihazard environment. *Risk Analysis*, *28*(2), 539-556.

Lindell, M. K. & Perry, R. W. (2000). Household adjustment to earthquake hazard: a review of research. *Environment and Behavior*, *32*(4), 461-501.

Linley, P. A., Joseph, S. & Seligman, M. E. P. (2004). Positive Psychology in Practice, Wiley.

MacGregor, D. G., Finucane, M. & Gonzalez-Caban, A. (2008). The effects of risk perception and adaptation on health and safety interventions. In Martin, W. E., Raish, C. & Kent, B. (Eds.): Wildfire risk: human perceptions and management implications. Resources for the Future Press, Washington, DC 142–155.

Maslow, A. (1954). Motivation and Personality, Harper, New York, NY.

McClean, R. (2009). Regulation and Incentives for Historic Heritage - Theoretical and Legislative, Overview Brookers Ltd, Wellington, New Zealand.

McClelland, D. C. (1971). Assessing Human Motivation. General Learning Press, Morristown, New York.

McClure, J., Sutton, R. M. & Sibley, C. G. (2007). Listening to Reporters or engineers? How instance based messages about building design affect earthquake fatalism. *Journal of Applied Social Psychology*, *37*(9), 1956-1973.

Mitchell, J. T. & Daniels, L. (2003). Motivation. In Borman, W. C., Ilgen, D. R. & Klimoski, R. J. (eds.). Comprehensive Handbook of Psychology, Wiley, New York. 225–254.

Mulilis, J. & Duval, T. (1995). Negative threat appeals and earthquake preparedness: A person relative to event (PrE) model of coping with threat. *Journal of Applied Social Psychology*, *25*(15), 1319-1339.

Mulilis, J. & Duval, T. (2003). Activating effects of resources relative to threat and responsibility in person relative to event theory of coping with threat: an educational application. *Journal of Applied Social Psychology*, *33*(7), 1437-1456.

Nakhies, P. (2009). Seismic upgrading – meeting the economic challenge, in Pacific Rim Real Estate (RIM) Conference, 18-21 January 2009, Sydney, Australia.

Paton, D. (2003). Disaster preparedness: a social-cognitive perspective. *Disaster Prevention and Management*, *12*(3), 210-216.

Paton, D. (2006). Disaster resilience: Integrating individual, community, institutional and environmental perspectives, in Paton, D. & Johnston, D. (Eds.). In Disaster Resilience: An Integrated Approach. Charles C. Thomas, Springfield, Ill, 306-319.

Paton, D. (2008). Community resilience: Integrating individual, community and societal perspectives, in Gow, K. & Paton, D. (eds.): Phoenix of Natural Disasters: Community resilience. Nova Science Pub Inc, New York. 13-31.

Porter, L. W. & Lawler, E. E. (1968). Managerial Attitudes and Performance, Irwin, Homewood, Illinois.

Rogers, R. (1975). A Protection motivation theory of fear appeals and attitude change. *The Journal of Psychology*, *91*(1), 93-114.

Ryan, R. M. & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68.

Sheeran, P., Trafimow, D. & Armitage, C. J. (2003). Predicting behaviour from perceived behavioural control: Tests of the accuracy assumption of the theory of planned behaviour. *British Journal of Social Psychology*, *42*(3), 393-410.

Siegrist, M. & Cvetkovich, G. (2000). Perception of hazards: The role of social trust and knowledge. *Risk Analysis*, *20*(5), 713-720.

Skinner, B. F. (1953). Science and Human Behaviour, The Free Press, New York.

Solberg, C., Rossetto, T., Joffe, H., Gayer, G., Leschka, S., Nöhren, I., Larsen, O. & Günther, H. (2010). The social psychology of seismic hazard adjustment: Re-evaluating the international literature. *Natural Hazards Earth Systems Science*, *10*, 1663-1677.

Sugar, W. & Schwen, T. (1995). Glossary of technical terms. In Kelly, L. (ed.) ASTD Technical and Skills Training Handbook. McGraw-Hill, New York.

Vroom, V. H. (1964). Work and Motivation, Wiley, New York.

Weber, E. U., Blais, A. & Betz, N. E. (2002). A domain-specific risk-attitude scale: measuring risk perceptions and risk behaviors. *Journal of Behavioral Decision Making*, *15*(4), 263-290.

Wood, R. S. (2004). Earthquake entrepreneurs: Local policy systems and the regulation of public risks in California. *State & Local Government Review*, *36*(3), 198-211.