Sociological and Behavioural Impediments to Earthquake Hazard Mitigation

Egbelakin, T.
University of Auckland, New Zealand
(email: tegb001@aucklanduni.ac.nz)

Wilkinson, S.
University of Auckland, New Zealand
(email: s.wilkinson@auckland.ac.nz)

Abstract

Implementing earthquake hazard mitigation programs has been a major challenge in New Zealand. Seismic retrofitting is one of the many ways used to reduce earthquake risks. Over the past decades, research in New Zealand on earthquake hazard mitigation has been on understanding seismic structural responses and performance, developing advanced design methods, systems and standards and improving building codes to reduce losses from earthquakes. However, owners of earthquake prone buildings (EPBs) have been slow to introduce retrofitting techniques and implement appropriate seismic retrofit standards. The objective of this paper is to analyse the sociological and behavioural factors influencing building owners in their seismic retrofitting decisions. The study aims to expand the field of seismic retrofitting by adopting a socio-behavioural perspective to enhance implementation. Case study methodology was adopted and 33 interviews were conducted. Interviews were conducted within four regions in New Zealand which were chosen on the basis of the earthquake risk the region posed. The interviews were conducted with stakeholders involved in the seismic retrofit decision-making process. Semi-structured questionnaires were used and analysed by means of content analysis, using standard trends and pattern identification procedures. This paper provides the empirical findings on how behavioural and sociological factors undermine the probability of successful implementation of earthquake hazard mitigation in New Zealand. The main findings include the role of perception in diminishing earthquake hazard mitigation and the difficulties in accessing the benefits and values of seismic retrofit. The findings suggest that there is a need for all stakeholders involved in retrofit decision-making to have a good understanding of the risks that are faced and the implications of their decisions. This paper further recommends that, for seismic risk mitigation to be successful, the identified impediments need to be addressed.

Keywords: impediments, earthquake-prone buildings (EPBs), seismic retrofit implementation and decision-making
1. Introduction

Earthquakes are one of the world’s greatest disasters. Though it is generally accepted as an uncontrollable force of nature, however unnecessary loss of lives, properties and social disruptions can be avoided or minimised. Loss of lives and minimising disruption can be achieved by appropriate implementation of mitigation decisions and actions. Implementing seismic retrofit of earthquake prone buildings (EPBs) is one of the many ways of reducing earthquake hazards. Although, the global seismic community has placed emphasis on understanding the scientific nature of earthquakes, such as ground motion and movements, providing technical solutions as well as legislative means to ensure that earthquake hazard mitigation measures are implemented, these efforts have not yielded adequate success. Seismic retrofit implementation lags behind advances in scientific and engineering understanding. For instance in New Zealand, Johnston et al. (2006) and Stevens and Wheeler (2008) established the prevalence of low response from owners to retrofit their EPBs. One of the reasons that implementation lags so far behind is that relatively little attention has been focused on how to enhance seismic retrofit implementation from a sociological and behavioural perspective. As a result, there remains an inadequate understanding of the impediments associated with implementing earthquake hazard mitigation technologies and strategies of how to overcome them.

The paper is part of a research study on incentives and motivators for improved seismic retrofit implementation in New Zealand, funded by the Foundation for Research, Science and Technology. The overall research objective is to investigate strategies that could motivate owners of EPBs to voluntarily retrofit beyond what is legally required and also to develop a quantitative tool that will demonstrate the financial, social and environmental implications of such decisions. The primary focus of this paper is to identify key obstacles that hinder successful implementation of seismic retrofit of EPBs adopting a socio-institutional approach. This will help to understand why different categories of owners of EPBs are reluctant to implement risk reduction measures and to learn ways that will increase their likelihood of taking actions that will reduce their vulnerability to seismic risks. The study examined the decision making processes of several stakeholders involved in seismic retrofit implementation and how public policy processes influence decisions to retrofit or not and what level of retrofit to adopt, if strengthening is a choice. Critical barriers were identified and their impacts on earthquake risks mitigation in New Zealand discussed.

2. Earthquake hazard mitigation in New Zealand

Seismic activities occur in New Zealand every day. Though most are small, about 100-150 annually, are large enough to be felt (GNS Science, 2009). Also, about 18 major earthquakes have occurred since 1848 in New Zealand (GNS Science, 2009). Strengthening of EPBs has a major advantage of reducing seismic risks. Nuti and Vanzi (2003) suggested that conducting standard reliability analysis would clearly demonstrate the economic benefits accruing from seismic strengthening of EPBs. Also, Langston et al, (2007) highlighted the significance of strengthening older buildings over demolition and construction of new ones. Similarly, Stevens and Wheeler (2008) emphasized that retaining the quality of existing buildings plays a key role in ensuring sustainability of the construction industry and our communities as a whole. In New Zealand, compliance to earthquake building standards is
The Building Act (2004) seeks to reduce the level of earthquake risks to the public over time, recommending minimum level of seismic retrofit (one-third of the strength of a new building). The Act further delegates territorial authorities (TA) to determine the level of seismic retrofit appropriate to their regions. Some TA’s adopt two-third while others adopt one-third of the code requirement. However, the minimum requirement stipulated by the Building Act (2004) will not completely eliminate the danger in EPBs (DBH 2004). It was argued that one-third of the strength of a new building does not totally eliminate non-ductile failure mechanism and critical structural weaknesses in EPBs. The New Zealand Structural earthquake Engineers (NZSEE) therefore recommends two-third of the new building standard as an appropriate level to remove the danger. This reduces the risk from about twenty to around three times that of a new building (NZSEE, 2008).

Anecdotal evidence suggests that adopting high seismic standards in the local mitigation policies is rather difficult politically as it places additional economic burden on a particular group of people such as building owners, land developers and property investors. It is also difficult because benefits associated with seismic strengthening cannot be easily demonstrated (EERI Report, 1998). Egbelakin and Wilkinson (2008) found that owners of EPBs are usually faced with the dilemma of what levels of seismic retrofit to adopt within their limited budget when making decision about seismic rehabilitation. Hopkins (2005) and Stevens and Wheeler (2008) revealed that building owners have been noted to adopt lower level of seismic retrofit regardless of consulting engineers’ recommendations. Also, implementation of seismic strengthening has been slow and in some cases was never carried out. Tierney (2004) explained that seismic retrofit implementation is one of the most important challenges facing hazard mitigation. An important area in hazard reduction identified by the earthquake Engineering Research Institute (EERI) as well as the New Zealand Historic Places Trust (NZHPT) is to focus on how to motivate building owners to voluntarily improve the seismic performance of their buildings. An understanding of the obstacles hindering the implementation process is essential in order to fully motivate owners to strengthen their EPBs beyond what is legally required. This paper investigates why seismic retrofit implementation in New Zealand is experiencing a rather slow progress despite New Zealand high seismicity and risks. Critical impediments to implementing risk reduction measures are examined. Sociological and behavioural impediments to earthquake hazard mitigation are reported in this paper.

3. Research method

Exploratory qualitative research design was adopted and interviews chosen as the method of data collection. Four cities in New Zealand were used as case studies. The cities were chosen based on their seismicity, hazard factor, percentage of retrofitted EPBs and the probability of earthquake occurrence (see Table 1).
Individual stakeholders involved in seismic retrofit implementation were considered as the unit of analysis. Personal face-to-face interview was chosen as it allows in-depth understanding of the topic and the use of intensive probing questions to gain more insight into the research problem. The interviews ranged between one to two hours with majority taking a little more than an hour and are audio-taped. 33 interviews have been conducted to date. The stakeholders identified for the research include; building owners, professionals and consultants, managers of insurance, financial and governmental organizations that have been involved in decision-making process of seismic rehabilitation of EPBs.

In identifying the critical impediments and analysing interviews, the main focus has been on perception of earthquake risks and benefits of mitigation actions. The main questions are as follows:

- What is your perception about earthquake risks and its occurrence in your region?
- Given the nature of your business/profession, what strategies do you use in reducing these risks?
- Can you describe the benefits and values you associate with seismic retrofit implementation?

### 4. Participant characteristics

The data collected comprises of different types of participants. Table 2 summarises the different characteristics of the participants, used as the main unit of analysis. The majority of the participants are in the senior management category. 45% were building owners, while 55% are other stakeholders in seismic retrofit decisions. Within the building owners category, they range across three types; private (53.3%), Public owners (26.7%) and Non-profits (20%). About 42% of the participants have personally experienced earthquake, while 57.6% are without earthquake experience. The average working experience of the participants in seismic retrofit implementation is 5.5years, with a minimum and maximum of 3years and 8years. The average of 5.5years experience indicates that, most respondents have reasonable working experience in seismic retrofit implementation, hence the reliability of the data.
### Table 2: Participants Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Category</th>
<th>No</th>
<th>Percentage</th>
<th>Characteristic</th>
<th>Category</th>
<th>No</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participants</td>
<td>Building owners</td>
<td>15</td>
<td>45.5</td>
<td></td>
<td>≤ 5 Years</td>
<td>3</td>
<td>9.1</td>
</tr>
<tr>
<td></td>
<td>Professionals</td>
<td>6</td>
<td>18.2</td>
<td></td>
<td>6 - 10 Years</td>
<td>7</td>
<td>21.2</td>
</tr>
<tr>
<td></td>
<td>Insurance providers</td>
<td>3</td>
<td>9.1</td>
<td></td>
<td>11 - 15 Years</td>
<td>6</td>
<td>18.2</td>
</tr>
<tr>
<td></td>
<td>Governmental Organisations</td>
<td>5</td>
<td>15.2</td>
<td></td>
<td>16 - 20 Years</td>
<td>8</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td>Property Valuers</td>
<td>4</td>
<td>12.1</td>
<td></td>
<td>21 - 25 Years</td>
<td>4</td>
<td>12.1</td>
</tr>
<tr>
<td>Type of Ownership</td>
<td>Private Owners</td>
<td>8</td>
<td>53.3</td>
<td>Location</td>
<td>Wellington</td>
<td>8</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td>Public Owners</td>
<td>4</td>
<td>26.7</td>
<td></td>
<td>Gisborne</td>
<td>10</td>
<td>30.3</td>
</tr>
<tr>
<td></td>
<td>Nonprofits</td>
<td>3</td>
<td>20.0</td>
<td></td>
<td>Christchurch</td>
<td>7</td>
<td>21.2</td>
</tr>
<tr>
<td>Designation</td>
<td>Upper mgt</td>
<td>23</td>
<td>69.7</td>
<td></td>
<td>Auckland</td>
<td>8</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td>Middle mgt</td>
<td>7</td>
<td>21.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Professionals</td>
<td>3</td>
<td>9.1</td>
<td>Personal</td>
<td>Yes</td>
<td>14</td>
<td>42.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>experience of</td>
<td>No</td>
<td>19</td>
<td>57.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>earthquake</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Data analysis

In order to analyse the data collected from interviews, the recorded interviews were transcribed. The transcripts provided a complete record of the interviews which facilitated the content analysis of the discussions. The main aim of this analysis was to identify trends and patterns or themes that appeared in individual interviews, or reappeared among various interviews. Attention was paid to ‘how’ words or sentences were expressed by the interviewees. In order to ensure reliability and validity of the results, care was taken so that the information provided by the participants was transcribed accurately and the information validated by the participants. The analysis of the 33 interviews was done in two ways. Firstly, each interview was analysed in terms of an individual case study (using the participants as the unit of analysis), i.e. ‘within case’. Secondly, the cases were analysed ‘across case’ (using the regions as a case), a process which enabled interim conclusions to be drawn on the research questions and propositions and a model to be inductively developed for testing in second research stage. Finally, all of the identified themes and sub-themes were categorised separately in relation to different regions (Tables 3 and 4) and subsequently discussed.

6. Critical impediments to seismic retrofit implementation

The research findings demonstrate that several factors act as impediments to seismic hazard mitigation and are categorised under two major headings namely; behavioural and sociological
impediments. The findings further indicate the need to address the socio-behavioural constraints facing hazard implementation for seismic retrofit to make any meaningful impact. Details of the research findings are summarised in Tables 3 and 4.

6.1 Behavioural impediments

There are several behavioural attitudes acting as impediments to seismic risks mitigation. The most prominent barrier is the perception about earthquake occurrence and its associated risks. The research focused on how perception of earthquake hazards influences mitigation decisions and actions. Perceptions of risks can be related to how people respond to risks and consequently the mitigation actions adopted (Dahlgaard and Dahlgaard, 2003). The findings in Tables 3 and 4 show that interviewees hold different attitude toward seismic risks mitigation. The general public perception about earthquake occurrence and its associated risks differ from those of experts and as well as the various stakeholders involved in seismic retrofit.

6.1.1 Perception about Possible Earthquake Event and Risks

Perception of risks plays an important role in decisions that people make (Slovic and Weber, 2002). Interviews findings in Table 3 show that 60-80% of the participants living in regions with low (case 1) and medium seismic risks (case 2) are not concerned about earthquake risks and its occurrence within their regions. While about 58% of the building owners do not perceive that they or their buildings are at risk from earthquakes, even after they have been informed by their city councils during the initial seismic assessment procedure. Also, about 87-91% of the participants in cases 1 and 2 are not ready to take any mitigation actions. These participants believed that an earthquake will neither happen in their lifetime nor have significant influence on their buildings. Therefore, there is little or no need for mitigation actions. This risk perception can be deductively associated with uncertainties in earthquake predictions and city council’s approach to mitigation (see Table 1). Minimal mitigation actions such as adopting the lowest seismic standard during rehabilitation of EPBs were only undertaken as a result of the obligatory nature of the seismic hazard mitigation policy. However, 87-98% of the participants in high risks regions (cases 3 and 4) showed great concern about earthquake risks. This can be attributed to the regions high susceptibility to earthquakes, public earthquake awareness and the city councils active approach to earthquake hazard mitigation. Despite the concern about seismic risks, only 62% of the participants in case 3 are willing to take mitigation actions soon, while 90% will delay till near future in Case 4. The authors found that in Case 3, the findings could be related to the recent significant earthquake, present insurance issues as a result of the earthquake and possible future changes in earthquake policy. While in Case 4, increased timeline for mitigation actions recently adopted in the earthquake policy could be attributed to delaying mitigation decisions. Regardless of the high awareness level about earthquake disaster in New Zealand, there is a strong assumption that earthquake will not have any impact on them or their buildings. This has a significant impact on mitigation decisions.
Table 3: Behavioural impediments

<table>
<thead>
<tr>
<th>Impediments</th>
<th>Case 1</th>
<th>Case 2</th>
<th>Case 3</th>
<th>Case 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perception about Possible earthquake event and risks</td>
<td>80% of participants are less concerned about earthquake risks and occurrence</td>
<td>60% of participants are less concerned about earthquake risks and occurrence</td>
<td>98% of participants are very concerned about earthquake risks and occurrence</td>
<td>87% of respondent are very concerned about earthquake risks and occurrence</td>
</tr>
<tr>
<td></td>
<td>91% not ready to take seismic mitigation action</td>
<td>87% not ready to take seismic mitigation action now</td>
<td>62% are willing to take seismic mitigation action soon</td>
<td>90% will delay seismic mitigation action till in the future</td>
</tr>
<tr>
<td>Possible causes</td>
<td>High probability of earthquake risks</td>
<td>High probability of earthquake risks</td>
<td>High public awareness of earthquake risks</td>
<td>Recent significant earthquake</td>
</tr>
<tr>
<td></td>
<td>Councils active approach</td>
<td>Councils active approach</td>
<td>High public awareness of earthquake risks</td>
<td>Present insurance issues</td>
</tr>
<tr>
<td></td>
<td>Present insurance issues</td>
<td>Present insurance issues</td>
<td>Possible future changes in earthquake policy</td>
<td>Possible future changes in earthquake policy</td>
</tr>
<tr>
<td>Perception that earthquake risks and losses are unavoidable</td>
<td>High; 64% losses are unavoidable</td>
<td>High; 52% losses are unavoidable</td>
<td>High; about 66% think losses can largely be mitigated</td>
<td>High; 88% think losses can largely be mitigated</td>
</tr>
<tr>
<td>Possible causes</td>
<td>Individual beliefs</td>
<td>Individual beliefs</td>
<td>Individual beliefs, professional understanding of seismic risks and its</td>
<td>Individual beliefs, professional understanding of seismic risks and its</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>associated losses</td>
<td>associated losses</td>
</tr>
<tr>
<td>Perception about financial involvement for earthquake mitigation</td>
<td>76% of the participants think that doubling seismic strength is equivalent to doubling cost of retrofit</td>
<td>56% of the participants think that doubling seismic strength is equivalent to doubling cost of retrofit</td>
<td>53% of the participants think that doubling seismic strength is equivalent to doubling cost of retrofit</td>
<td>36% of the participants think that doubling seismic strength is equivalent to doubling cost of retrofit</td>
</tr>
<tr>
<td>Possible causes</td>
<td>Lack of cost benefits analysis at the design stages, Years of experience in EPBs projects, Lack of in-house professionals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 6.1.2 Perception that earthquake risks and losses are unavoidable

The perception that earthquake risks and unavoidable losses are generally considered as “an act of God”, but the rate at which loses can be reduced varies across cases. In Table 3, similar high responses were observed in Cases 1 and 2 about losses in an earthquake event are unavoidable, but can only be minimally reduced (case 1-64%; case 2-52%). In cases 3 and 4, about 66-88% of the participants think that mitigation actions against seismic risks can largely be reduced. These findings could be attributed to individual beliefs, professional understanding and years of experience in seismic retrofitting earthquake prone buildings. Surprisingly, about 12% of building owners were
found to understand their seismic risks, their exposure and vulnerability but believe generally that earthquake is an act of God and that no actions can help alleviate the impacts of earthquake. This scenario is predominant among owners of older buildings (>50 years), whose buildings have been affected by previous earthquakes. It is possible that these owners have fatalistic attitude that dictates against attempts at risk reduction, or that the issue of mitigation is unachievable (Alesch and Petak, 2001).

6.1.3 Perception about financial involvement in earthquake mitigation

Insights from both interviews and literature show that there is a general preconception about the relationship between higher seismic strength and the cost of retrofit. The preconception is that doubling the seismic strength of a building will double retrofit cost. Table 3 shows that across cases, regions with high seismic risks—cases 3 and 4 (53% and 36% respectively)—agree to high standard of retrofit corresponding to higher cost while in Cases 1 and 2, 76% and 56% respectively also concurred. Responses in cases 3 and 4 could be attributed to the percentage of EPBs within these regions and high percentage of retrofitting that has been carried out, which gradually reduces this preconceived notion. Also, among building owners, the notion of high seismic strength directly correlating to higher cost is predominant among private and nonprofits owners. The public sector on the other hand understands the cost versus seismic strength phenomenon (Private-35.7%, Public-7.43% and non profits owners-21.4%). Public owners understanding of seismic strength and its associated cost can be due to the numbers of years of experience in EPBs projects. This is associated with the large number of earthquake prone buildings retrofitted by public owners, carried out people within a department over certain periods. However, private and non-profits owners understanding of seismic strength and cost could be as a result of lack of experience in retrofitting EPBs, as most of their earthquake prone buildings retrofitted usually range between 1-3 buildings and are usually carried out once in 10-15 years.

Other contributing factors could be lack of cost benefit analysis as previously highlighted by (Hopkins, 2006) and lack of availability of in-house professionals within their organisations. The cost of improving seismic performance of a building can vary widely making it difficult to adequately estimate the total amount involved. This variation largely depend on a number of factors such as location, type of structure, characteristics of individual buildings, rehabilitation scheme, level of performance desired and other works triggered by this decision. One of the participants mentioned that in one of his buildings, the difference between adopting 33% and 67% NBS was only NZD11,000. There is no evidence that there is a linear relationship between these two elements, even though, the circumstance surrounding each building differs.

6.2 Sociological impediments

Several international organisations and governments have recognised that sociologically related impediments to seismic hazard mitigation must be bridged for hazard mitigation to be successful. This section discusses various sociological constraints impeding the implementation of seismic hazard reducing measures.
Trust could have significant influence on mitigation decisions (Hopkins et al., 2006). Lack of trust and belief in seismic retrofit techniques and associated professionals was identified as an impediment to hazard mitigation in New Zealand (Egbelakin and Wilkinson, 2008). In Table 4, the findings show that these factors are highly inter-related; owners’ beliefs in professionals influence their levels of trust in the retrofit solutions and consequently the mitigation decision taken. Lack of trust and belief in seismic techniques and professional differs among the cases. In Case 1, only 22% of the participants indicate that they do not believe in seismic retrofit techniques available in New Zealand. Cases 2 and 4 have a close range of 42% and 48% respectively, while Case 3 has the highest percentage of participants (67%) with no trust and belief in engineering techniques. This study found that these differences across the cases may be due to the recent earthquake event in case 3 of which new buildings (not yet habited) were damaged by earthquake. The 67% response in Case 3 indicate how damage to a new building with supposed high seismic strength, can influence people’s perception of the design engineers. Also, the study uncovered that disparities among consulting engineers in New Zealand are mainly responsible for lack of trust and belief in seismic retrofitting. Engineers do not have a consensus on the appropriate level of seismic standard that should be adopted. Most owners become confused when two engineers recommend levels of strengthening that differs widely. Anecdotal evidence suggests that the confusion about engineer’s recommendations were interpreted by owners of EPBs as incompetence. Lazar (2000) emphasised the importance of competency in developing and maintaining trust and respect. This research suggests that professionals and regulatory authorities should pay more attention to the designs they recommend and approve. Also, building owners should be advised on the possible outcome of the retrofit solution chosen, in the event of an earthquake.
6.2.2 Difficulty in measuring benefits from seismic retrofit

Several benefits are associated with seismic hazard reduction, such as safety, loss reduction, quick business recovery, heritage conservation, social and environmental loss reduction. The major difficulty in evaluating and appreciating these benefits is that they only accrue in the future, at the time of an earthquake – an uncertain event. The interviews reveal that this difficulty can be an impediment to taking mitigation actions. Almost 90% of the participants across three cases (1, 2, and 3) could not account for the benefits of seismic retrofit, apart from safety. They argued that the spending is not justifiable, most especially when the occurrence of an earthquake is uncertain. This influences the decision to take any substantial mitigation actions against earthquake hazards. 80% of the owners of EPBs also complained there are little or no economic returns on retrofitting of EPBs, as seismic strengthening does not increase the property value of their building. Therefore, financial returns cannot be realised at the point of sale/rent. They added that seismic strengthening does not also increase the market competitiveness of the property. However, in case 4, about 79% of the participants feel that the money spent on retrofitting is a worthwhile investment. This finding can be attributed to their personal experience of the last recent earthquake in the region, where losses were incurred through damaged buildings and business disruptions and other social cost such as relocation. The authors found that costs of seismic mitigation are generally specific and obvious, borne by owners while the benefits are more diffuse and do not attach to any particular group of people, but rather to the whole society. It is therefore important to demonstrate the expected economic, social and environmental benefits associated with seismic retrofit during decision-making to assist owners in taking appropriate decisions.

7. Conclusions

Several factors acting as impediments to successful seismic hazard reduction measures have been discussed in this paper. The factors identified were grouped under two headings namely; behavioural and sociological impediments. The behavioural impediments discussed different facets of seismic risk perception and their influence on retrofit decision-making and implementation. Findings across major cities in New Zealand showed that though the level of awareness about seismic risks is relatively high, response to taking mitigation actions to earthquake risks is low. The most significant factor found to be responsible for the low response to seismic risks is the approach to seismic mitigation adopted by city councils and territorial authorities. This study suggests that hazard mitigation approaches used by governmental organisations involved in earthquake hazard mitigation needs to be reappraised. The social impediments identified include; lack of trust and beliefs in seismic techniques and professionals and difficulty in measuring benefits from seismic retrofit. The sociological impediments identified in this study are widespread across the risk zones. This study recommends that it is necessary for consulting engineers in New Zealand to reach a consensus on the acceptable level for seismic retrofit.

Furthermore, the study found that disparities in earthquake risk perception lie at the heart of disagreements about the best course of action between various stakeholders involved in mitigation plans. It is recommended that stakeholders involved in seismic retrofit decision-making develop a better understanding of the seismic risks faced and the implications of their retrofit decisions. The
future research will further seek to examine the comprehensive assessment of other impediments such as economic and institutional and their roles in decision-making.

References


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