Sustainable Cities and Society 48 (2019) 101547

Contents lists available at ScienceDirect

Sustainable Cities and Society

journal homepage: www.elsevier.com/locate/scs

A performance-based framework to prioritise underutilised historical buildings for adaptive reuse interventions in New Zealand

Itohan Esther Aigwi[a,*], Temitope Egbelakin[a], Jason Ingham[b], Robyn Phipps[a], James Rotimi[a], Olga Filippova[c]

[a] School of Built Environment, Massey University, Auckland, New Zealand
[b] Department of Civil and Environmental Engineering, The University of Auckland, Auckland, New Zealand
[c] Faculty of Business and Economics, The University of Auckland, Auckland, New Zealand

ARTICLE INFO

Keywords:
Adaptive reuse
Historical buildings
Heritage preservation
Seismic resilience
Framework
Town centre regeneration

ABSTRACT

While the efficacy of salvaging underutilised historical buildings to promote sustainable and resilient provincial urban areas in New Zealand has been identified from past studies, there is still an absence of a performance-based framework to rank optimal historical building alternatives for adaptive reuse interventions. This paper focuses on evaluating a performance-based Multiple Criteria Decision Assessment (MCDA) methodology to prioritise underutilised historical buildings for adaptive reuse intervention in a major provincial area in New Zealand, towards achieving a resilient town-centre regeneration for the area.

A focus group workshop was conducted with relevant stakeholders involved in an existing town centre regeneration agenda for Whanganui, to explore and balance their opinions for optimal selection of a vacant historical building for adaptive reuse intervention from a group of proposed buildings. The participant mix comprised a combination of building professionals, historical building owners/developers/users, legal, heritage, and council/community representatives.

The findings establish the usefulness of the validated framework in balancing the diverse interests of all stakeholders in the adaptive reuse decision-making process. Hence, this paper provides a significant contribution to the development of a methodology that integrates adaptive reuse stakeholders' diversified interests, for the selection of optimal case study building alternatives. The consensus of the multidisciplinary stakeholder group was found to be consistent and insensitive to reasonable changes in weighting. Also, the validated framework enabled the decision-makers to achieve a logical result, and support the visualisation of the impact of different priority aspects and criteria on adaptive reuse interventions in New Zealand.

1. Introduction

As the populations of New Zealand's major urban areas continue to rise, a significant proportion of large provincial areas (i.e., medium and small urban areas) exhibit decline or stagnancy in their population growth (Cameron, 2017; Jackson & Brabyn, 2017). Economist Shamubeel Eaqub has disparagingly invented a term for New Zealand cities currently facing severe decline or stagnancy in their populations as 'Zombie cities' (National Business Review, 2014), some of which are among New Zealand's earliest cities, with significant collections of historical buildings. Accordingly, some factors such as building conditions, socio-economic factors, and earthquake-prone building legislation, have been identified as causal triggers to the shrinkage of New Zealand's provincial areas, reflected through the high vacancy rate of historical buildings in these areas (Esther Yakubu et al., 2017). Based on these identified urban shrinkage triggers, recommendations have been made on how town centre regeneration via the reuse of older historical buildings could be used as a conscious strategy to promote compliance to the seismic regulatory demands of potential users of adapted buildings, and the retention of historical buildings (Esther Yakubu et al., 2017).

While several studies have noted the effectiveness of reusing historical buildings as a sustainable mechanism to motivate investors and to invest in the upgrade of underutilised historical buildings, the adaptive reuse approach has become even more popular towards building resilient urban areas (Aigwi, Egbelakin, & Ingham, 2018; Ball, 2002; Bromley, Tallon, & Thomas, 2005; Pearce, DuBose, & Vanegas, 2004; Rohracher, 2001). Accordingly, in a quest to select optimal

* Corresponding author.
E-mail address: i.aigwi@massey.ac.nz (I.E. Aigwi).

https://doi.org/10.1016/j.scs.2019.101547
Received 15 February 2019; Received in revised form 9 April 2019; Accepted 9 April 2019
Available online 24 April 2019

building alternatives for adaptive reuse intervention from a group of historical buildings, there tend to be some disparities in the opinions of the relevant stakeholders (Hong & Chen, 2017). Some multiple factors to be deliberated upon may also create a cumbersome decision-making process.

It is also noteworthy of the popularity of applying performance-based approaches to the public sector as an avenue for improving the effectiveness and efficiency of urban collaborative decision-making processes through evaluation based techniques (Baker, Sipe, & Gleeson, 2006). Performance-based approaches have been successfully applied in some developed countries including the USA, Australia, New Zealand, and Great Britain, in an attempt to promote decision-making in natural resource planning involving land use and building regulations (Frew, Baker, & Donehue, 2016). Consequently, the performance-based planning approach is usually developed based on the philosophy of the influence of land use as a function of its physical characteristics and intensity, rather than the influence of traditional zoning on the land use (Baker et al., 2006). When considering the decision-making process involving the ranking of underutilised historical buildings for adaptive reuse interventions, the performanced-based planning ideology could be applied to subjectively evaluate predetermined priority aspects and criteria to set quantitative boundaries on acceptable adaptive reuse levels. Accordingly, the two main components of performance-based planning in the context of prioritising historical buildings for adaptive reuse interventions should include: (i) the reuse priority aspects and criteria that will give a detailed description of a desired adaptive reuse outcome; and, (ii) the methodology to define the impacts of the measurement standards of acceptable limits of influence on the desired adaptive reuse outcome. Hence, the performance-based planning approach should be explored to promote urban resilience through the reuse of historical buildings in New Zealand.

It is within the context of the aforementioned that this paper asks the ensuing questions:

Q1. How can the diverse interests of all stakeholders in an adaptive reuse decision-making process be balanced?

Q2. How can vacant historical buildings be prioritised and ranked for adaptive reuse project interventions?

This paper, therefore, focuses on testing an integrated performance-based MCDA framework that will: (i) balance the diverse interests of all stakeholders involved in an adaptive reuse decision-making process; and (ii) prioritise and rank vacant historical building alternatives for adaptive intervention, in Whanganui, a New Zealand provincial area, towards achieving sustainable town-centre regeneration for the area. Following this, a creative approach through collaborative involvement of relevant adaptive reuse stakeholders is applied to test the framework. The framework is tested by attributing scores to the adaptive reuse potentials of the historical buildings to be prioritised, while considering the parameters of the prioritisation framework, to establish best adaptive reuse preferences for the alternative buildings. Additionally, to avoid potential drawbacks in the subjective allocation of weights to the priority aspects of the developed framework, a sensitivity analysis is done to check how stable the optimal selected alternative building would be under variations of the input parameters.

2. Promoting urban resilience in New Zealand through the retention and reuse of underutilised historical buildings

The massive influx of migrants to New Zealand during the late-19th century led to the development and prosperity of New Zealand's earliest cities and huge investment in the built environment (Friesen, 2009). These present-day historical buildings serve as a physical link to the past and provide evidence of identity and origins of an area (Ahmad, 2006; Goodwin, Ingham, & Tonks, 2009). Moreover, many of the historical buildings in New Zealand's provincial town centres are assessed as earthquake-prone (Cattanach, Alley, & Thornton, 2008). An earthquake-prone building (EPB) is defined as a building or part that has the potential to collapse when its ultimate capacity is surpassed in the event of a moderate earthquake, and would probably injure or kill people in or near the building, or destroy other nearby properties (MBIE, 2017)

In New Zealand, a building is assessed as potentially earthquake-prone when it scores less than one-third of the New Building Standard (NBS) rating after a detailed seismic assessment has been conducted on it by certified structural engineers (NZSEE, 2017). The aftermath of the Canterbury earthquakes and a further risk of seismic occurrences in New Zealand have contributed to the increased quest for seismic resilience through the use of regulatory mechanisms (Paton & Johnston, 2017). As a pragmatic regulatory mechanism put in place by the New Zealand Government to promote seismic resilience during earthquakes, EPB owners are mandated to strengthen their buildings to a minimum requirement of 34%NBS rating within a specified timeframe. Otherwise, the buildings will be demolished (MBIE, 2017).

Although earthquake risks are mitigated through strengthening, the retrofit cost and other redevelopment costs to satisfy other building code requirements such as fire safety, disability access, indoor air quality, etc., are borne by building owners who are mostly interested in return on investment. Because most earthquake-prone historical building owners are unsure of the returns on investment in the strengthening and redevelopment process, they tend to abandon these buildings for demolition and relocate to urban fringes (Esther Yakubu et al., 2017). The potential choice of historical building owners abandoning their buildings for demolition could eventually result in changing previously vibrant provincial city centres into unattractive places (Martinez-Fernandez, Audirac, Fol, & Cunningham-Sabot, 2012). Consequently, demolition could negatively influence the economic and social vibrancy of the immediate locality, thereby leading to urban shrinkage (Esther Yakubu et al., 2017; Wiechmann & Pallagst, 2012). The detrimental impacts of city centre shrinkage include; loss of income from tourism; reduced tenancy; demolition of a significant proportion of the inner-city building stock; economic and population decline; reduced rateable income, and; loss of amenity and employment opportunities (Colvin, Fergusson, & Phillips, 2000; Schilling & Friedman, 2002). With the existence of these negative impacts, a vicious loop that raises the chances of residents relocating out of a depressed city centre is created (Friedrichs, 1993; Lang, 2000).

Evidence from New Zealand's historical census data has shown a downward spiral in the status of city centre vitality across provincial areas when compared to the major urban areas (Statistics New Zealand, 2018). Possible explanations as to why some present-day New Zealand provincial areas with a significant collection of historical buildings are in decline, and some are not, could be linked to the resilience phenomenon. The term "resilience" stems from the Latin word resilio, which means to bounce back (Klein, Nicholls, & Thomalla, 2003). The meanings and origins of resilience are even more ambiguous when applied in different ways (Blewitt & Tilbury, 2013; Chelleri, 2012; Davoudi, Brooks, & Mehmood, 2013; Folke, 2006; Kim & Lim, 2016; Meerow, Newell, & Stults, 2016), to different academic contexts (Adger, 2000; Friend & Moench, 2013; Lhomme, Serre, Diab, & Laganier, 2012; Pendall, Foster, & Cowell, 2010).

Accordingly, resilience has been progressively used in urban research, and defined as: the capacity of an urban system to maintain continuity or to rapidly bounce back to desirable functions during a disturbance, to positively adjust to change, and to swiftly transform the system towards sustainability (Meerow et al., 2016). Hence, an urban area becomes resilient when it can assess, strategize, and act in order to prepare for, and respond to disturbances which could be natural or manmade, expected or unforeseen, sudden or gradual. General academic focus on urban resilience is mainly on three fundamental aspects: climate change, terrorism, and natural disasters (Coaffee, 2008; Pickett, Cadenasso, & Grove, 2004; Sharifi & Yamagata, 2016). Accordingly, typical urban resilience strategies put forward by policy regulators are usually conceived in line with these above three fundamental aspects towards minimising the risk of disturbances posed to an urban system.

Since typical New Zealand city centres feature old historical buildings, the majority of which are underutilised, the conservation and reuse of these buildings could go a long way in contributing to the growing need for urban resilience in declining New Zealand cities. The adaptive reuse trend has been noticeably recognised from previous studies as a performance-based planning approach to improve urban resilience and sustainability through the reuse of vacant historical buildings (Aigwi et al., 2018; Ball, 2002; Bullen, 2007; Bullen & Love, 2010, 2011a, 2011b, 2011c; Douglas et al., 2006; Langston & Shen, 2007; Latham, 2016; Pearce et al., 2004; Wilkinson, James, & Reed, 2009). The practical reuse inclinations from these studies emphasise the need to retain the original identity, character, structure and real significance of older historical buildings through the adaptive reuse process.

Furthermore, the growing perception that it is more economical to repurpose historical buildings for newer functions rather than demolition and rebuild is one of the significant factors that have contributed to the vast interest in the adaptive reuse approach (Ball, 2002; Pearce et al., 2004). Other studies have identified that performance upgrading of historical buildings through adaptive reuse usually have a tremendous influence on the promoting the resilience and sustainability of a built environment (Bromley et al., 2005; Rohracher, 2001). In a quest to minimise the social and economic costs of redeveloping an urban area to be more resilient and sustainable, the adaptive reuse approach could be beneficial to governments, communities, building owners, and developers (Bullen & Love, 2011a; Wilkinson et al., 2009). As many cities have started to realise that an essential aspect of any successful urban regeneration plan is the reuse of historical buildings for new functions, the objectives of adapting historical buildings appear to overlap with several desired outcomes of resilience and sustainability (Ball, 1999). Accordingly, the adaptive reuse approach if embraced by relevant decision-makers, could, therefore, serve as a useful performance-based mechanism to motivate investors to invest in retaining and upgrading underutilised historical buildings, towards creating resilient city centres in New Zealand.

In the course of building resilient urban areas through adaptive reuse, it is important to balance the tradeoffs that exist between economic sustainability, built heritage preservation, socio-cultural, building usability and seismic regulatory aspects. In harmonising these highlighted aspects, a decision on the building alternative that will gain precedence for adaptive reuse intervention from a list of historical buildings needs to be agreed upon by adaptive reuse stakeholders. The characterisation of stakeholders in this context are persons who are being identified to have a direct or indirect interest in the reuse of underutilised historical buildings, including the operations and outcome of future reuse interventions on the buildings.

Nevertheless, a decision-making process to select optimal historical buildings for adaptive reuse project intervention involves diverse stakeholders who in most cases have conflicting viewpoints about adaptive reuse. Since these stakeholders all share a common goal of focusing on selecting the best historical building alternative for adaptive reuse, their diverse perspectives are deliberated upon until a consensus is reached. Each stakeholder group will typically interpret differently the reuse potentials of the historical buildings to be adapted (Hong & Chen, 2017). For example, while government representatives, architectural historians, and heritage advocates may be concerned about preserving heritage features of the historical buildings by ensuring heritage regulations are adhered to, structural engineers may be interested in reducing the number of deaths and property damages, especially in the event of a natural disaster. Conversely, building owners, developers, investors, and other building professionals may consider time as money throughout the adaptive reuse process (Wang & Zeng, 2010).

Consequently, in choosing a most suitable building alternative for an adaptive reuse intervention, these various factors to be considered by the decision-makers could create a complicated selection process because of the form of interaction that exists between these factors (Wang & Zeng, 2010). While built heritage preservation, for example, would potentially promote the mark of local recognition, the economic benefits from adaptive reuse intervention projects could influence the motivation for socio-cultural aspects and changes in public relationships. Therefore an evaluation-based adaptive reuse decision-making approach would be useful for this study to prioritise underutilised historical that could be retained for future generations while considering relevant priority aspects from extant literature.

2.1. Review of some existing adaptive reuse decision-making frameworks

A review of some of the existing methodologies that have been developed for the evaluation of adaptive reuse potentials for existing buildings. The review is done to establish if these existing methodologies have made attempts to balance the diverse interests of all stakeholders involved in an adaptive reuse decision-making process for historical buildings, and also prioritise vacant historical buildings for adaptive reuse implementation.

The “TOBUS” was developed to prioritise and select the best refurbishment solutions and cost estimation for existing office buildings (Caccavelli & Gugerli, 2002). This framework was developed for office building owners, construction professionals and real estate investors to analyse the indoor environmental quality, energy consumption, physical state and functional obsolescence of the buildings' elements and services. Although the design of the TOBUS allows its users to address professional and multi-disciplinary problems associated with the refurbishment of buildings, it targets only office buildings. In a similar study, (Love & Arthur Bullen, 2009), examined the use of “NABERS” (National Australian Built Environment Rating System) to assess the influence of occupants behaviour on the environmental performance of adapted commercial buildings. The underlying methodologies of both the TOBUS and NABERS frameworks are not appropriate for this study because they: (i) are incapable of prioritising and ranking most suitable building from a pool of existing buildings for adaptive reuse implementation (ii) do not consider economic, socio-cultural, heritage preservation, and creative values of existing buildings. Moreover, although the addressed environmental aspects in these two frameworks are important, the occupant's survey and checklist methodologies are unable to deal with subjective views of stakeholders involved in an adaptive reuse decision-making process for vacant historical buildings.

Furthermore, the ARP (adaptive reuse potential) model was developed to identify and evaluating the embedded physical life of obsolete historical buildings at any point of the buildings' life cycle, to establish a right timing for adaptive reuse intervention on buildings (Langston & Shen, 2007). This method is capable of transforming traditional decision-making procedures, to better sustainable strategies, practices, and outcomes. Moreover, the application of the ARP method to evaluate the embedded physical life of historical buildings requires the estimated present age (in years), and the projected physical life (in years) of the buildings. Some obsolescence factors (i.e., economic, social, functional, physical, technological, and legal) of the buildings are also required to evaluate the adaptive reuse potential of historical buildings because of their negative impact of reducing the useful life of the buildings. A similar study was conducted by (Conejos, Chew, & Yung, 2017) based on the ARP model to develop the AdaptSTAR model, which is a subjective checklist of adaptive reuse design plans. The purpose of the AdaptSTAR model was to establish the consideration of adaptive reuse in the initial design process of new buildings, towards maximising future adaptability of existing buildings. However, the methodologies of both the ARP and AdaptSTAR models are not suitable for the study discussed in this paper because they both require continuous monitoring of new buildings and expert assessment of obsolescence factors. Hence, some of the parameters in the adaptive reuse existing models have allowed the authors of this paper to form an initial list of criteria to measure the priority aspects of the proposed prioritisation framework that would be used to balance the diverse interests of all adaptive reuse stakeholders,

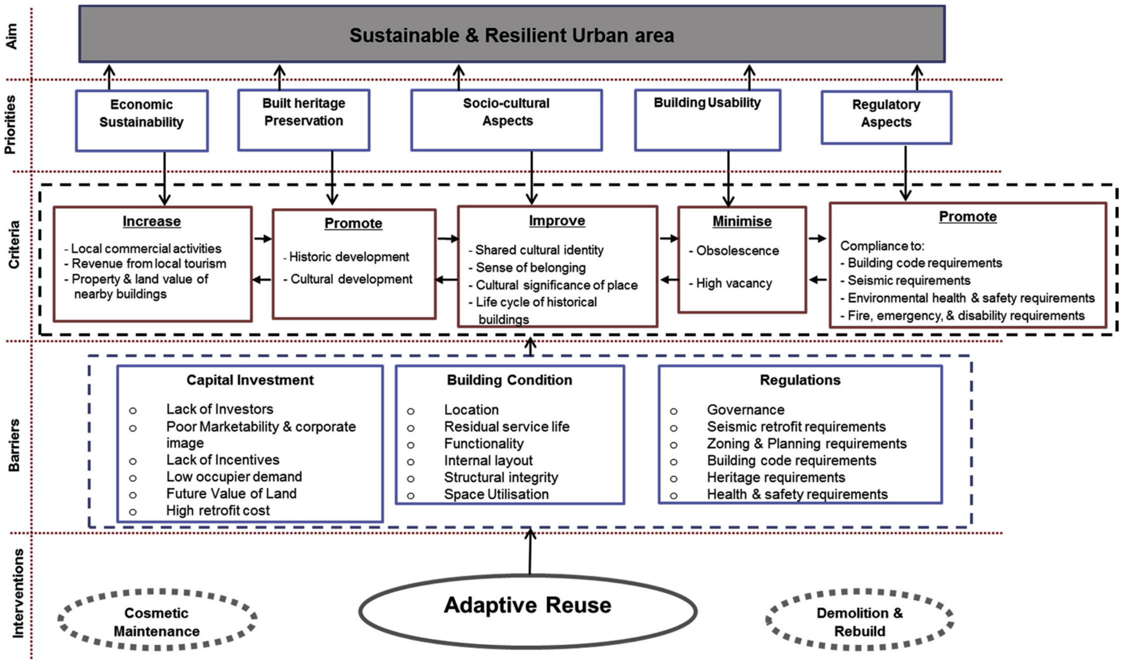


Fig. 1. Adaptive reuse prioritisation framework development.

when prioritising optimal vacant historical buildings for adaptive reuse implementation.

2.2. Development of the prioritisation evaluation framework

2.2.1. Definition of the priority aspects and criteria

Appendix 1 describes in detail the five main priority aspects of the prioritisation evaluation framework shown in Fig. 1.

3. Material and methods

The focus of this study is on testing a framework to: (i) balance the diverse interests of all stakeholders involved in an adaptive reuse decision-making process; and (ii) prioritise and rank vacant historical building alternatives for adaptive intervention. To achieve these two main objectives, the multiple criteria decision assessment (MCDA) is adopted to offer a formalised process for providing both systematic and transparent support during the decision-making process (Belton & Stewart, 2010). There are typically four significant phases when using the MCDA technique (McKenna, Bertsch, Mainzer, & Fichtner, 2018): (i) identifying, understanding and establishing the alternatives and criteria; (ii) defining and elicitating both inter-criteria preferences (scores) and intra-criteria preferences (weightings), and other qualitative information; (iii) ranking best alternative by aggregating the choice functions; and (iv) exploring the sensitivity of optimal outcome with reference to variations of all assessed parameters.

The combined analytical hierarchy process (AHP) and Fuzzy-Delphi (FD) MCDA methods have been reviewed for the development of the prioritisation framework because of the complex multi-criteria nature of the adaptive reuse decision-making process. The AHP which falls under the utility theory is a widely applied approach for reducing multi-dimensional problems to a one-dimensional form (Saaty, 2004). The AHP, usually signified by a hierarchical structure, can measure perfect balances of both intangible and tangible criteria by adaptive reuse stakeholders. The AHP has a crucial feature of quantifying the subjective judgments made by decision makers, through assigning corresponding mathematical values to options, by the relative importance of the options being considered (Yang & Lee, 1997). Also, the FD method is an appropriate technique that will be used as a construct to handle the issues of uncertainty and ambiguity that may occur in the survey techniques and responses of the MCDA process (Chang, Huang, & Lin, 2000). The combination of the AHP and FD techniques is an effective and efficient group communication approach that will evade major psychological distractions pertinent to round-table deliberation, designed to systematically elicit decisions from selected experts. A vital strength of the AHP-FD method would be the anonymous merging of ideas from different experts, using iterations and structured feedback responses, that will prevent group domination when reaching a consensus (Hsueh, Lee, & Chen, 2013). Also, the fuzzy logic addresses artificial uncertainty and ambiguity by representing the level of preferences with ratios or exact numbers. Fig. 2 depicts the research design logic of this study.

3.1. Data collection

A focus group interview was conducted with relevant stakeholders, to explore and balance their opinions for prioritising an optimal selection of a vacant historical building for adaptive reuse intervention, from two proposed building alternatives. The focus group workshop was chosen as the most appropriate data collection technique for this study due to the provided opportunity of testing assumptions and gathering beliefs and opinions from experienced participants (Krueger & Casey, 2014). The workshop was conducted with relevant stakeholders representing different portfolio and striving for a common goal, which is the sustainable regeneration of Whanganui's town centre. A total of 22 local participants were selected for the workshop. The participant mix comprised a combination of building owners/developers/users of historical buildings (23.6%), building professionals (18.2%), legal representatives (4.6%), heritage representatives (18.2%), and local government council representatives/community representatives (31.7%).

3.2. Case study buildings (Alternatives)

Using the multi-stage random sampling approach (Gravetter & Forzano, 2018; Noor Ul Amin, Arif, & Hanif, 2018), 12 buildings were initially selected out of about 400 vacant historical buildings in Whanganui's town centre, and eventually narrowed down to two

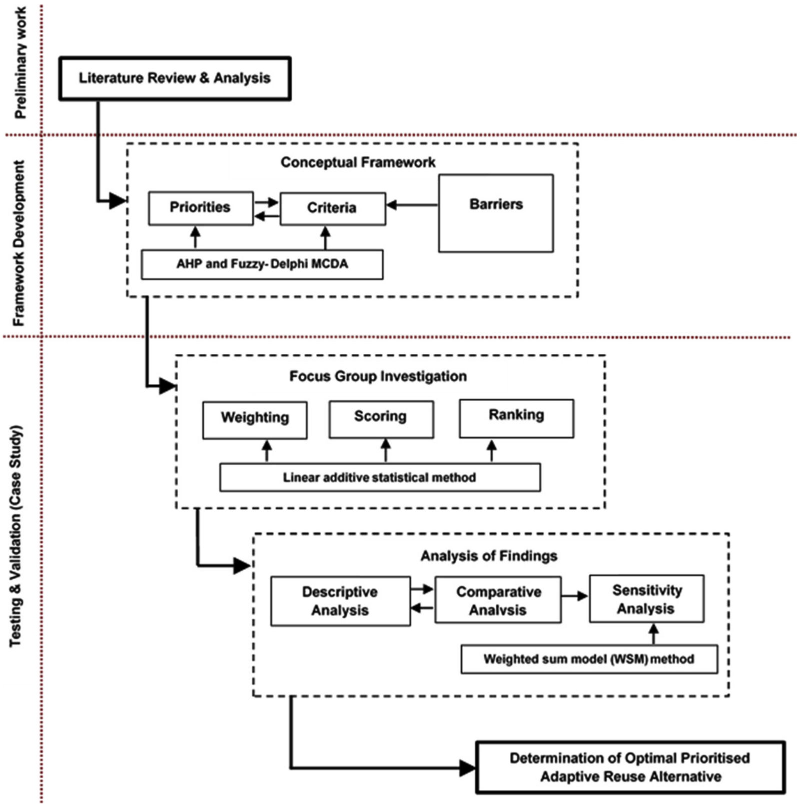
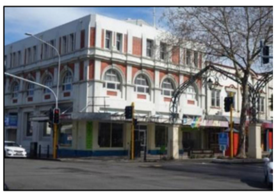


Fig. 2. Research Design and logic.

Table 1
Comparative characteristics of the two alternatives.
Source: Authors – Physical observation and review of existing building document

Characteristics	**Alternative *A1* - *Thains Building***	**Alternative *A2* - *Wakefield Chamber***
		
Year of Build	1908	1929
Ownership	Private	Government
Location	Corner site Mainstreet entrance (i.e., gateway building to CBD from the south)	Corner site
Natural disaster risks	Earthquake-prone; 5% NBS rating Flooding	Earthquake-prone; < 34% NBS
Number of storeys	Three	Four
District Heritage category	Class B	Class B
Main construction materials	Unreinforced brick masonry; Timber	Concrete frames; Unreinforced brick masonry
Façade/ Parapet/ Verandah	Yes	Yes
Frontage plaster	Yes	No
Frontage brick masonry	Yes	No
Frontage concrete	Yes	Yes
Frontage timber/ Steel	No	No

critical case study building alternatives by the local council for ranking. The multi-stage random sampling approach was adopted because it allows large clusters of historical buildings to be broken down into smaller groups in multiple stages to attain a more manageable data collection from a geographically discrete population that requires face-to-face contact. Although a drawback to the multi-stage random sampling technique is that it requires a high level of subjectivity, it is famous for its high degree of flexibility, and its cost and time effective probability design (Jackson, 2015). Table 1 shows some comparative features of the two selected building alternatives.

3.3. Application of the prioritisation framework

Participants of the focus group workshop were engaged to explore the applicability and validity of the framework to prioritise the optimal selection of vacant historical buildings for adaptive reuse intervention.

To avoid bias in the decision-making process, the 22 participants were randomly grouped into four categories, with each group having a unique colour code. The groups were colour-coded into blue, green, purple, and red groups, and had a minimum of 5 and a maximum of 6 participants respectively.

The validation exercise involved the application of weights to each priority aspects and their criteria and also applying scores to the alternative case study buildings. The essence of the weighting and scoring technique was to allocate a number to separate alternatives, priorities, and criteria to reflect the value judgment of the decision makers (Belton & Stewart, 2010). The weights allocated to a specific criterion reflect its relative importance in the decision-making process and are an essential aspect of generating learning outcomes from the MCDA process (Wright & Goodwin, 2009). The scores indicate the relative importance of separate alternatives for each criterion.

The statistical approach for testing the prioritisation framework followed the linear additive principle for the weighting and scoring. The linear additive statistical technique has been adopted for this research due to the independent nature of the different criteria, and, uncertainty is not incorporated into the model (Belton & Stewart, 2010). Accordingly, a three-stepped weighting and scoring process was used to weight the priority aspects and criteria and score the alternative buildings, as proposed in the linear additive statistical approach is discussed in the following section.

3.4. The weighting and scoring process

The formal definition of the additive weighted scoring principle is as follows (Kaluzny & Shaw, 2009): For n alternatives and m criteria, let the score of alternative j about criterion i be $v_{i\,j}$. Also, let the weight assigned to priority aspects i be Wi, and standardised so that $\sum_{i=1}^{m} Wi = 100$. The combined score of an alternative j is assessed as $S_j = \sum_{i=1}^{m} v_{ij} Wi$. The alternative that has the maximum score after the weighting and scoring procedure becomes the preferred solution. The arrangement of alternatives from highest to lowest scores therefore provides a final consensus priority.

The first step involved the use of a local scoring scale (i.e., between 0–10) to compare the alternative case study buildings on how well they will fulfil each criterion (Belton & Stewart, 2010). Ten being the most likely desired alternative, zero the least likely, and scores ranging between 0–10 for other alternatives that lie within the least likely to most likely scenarios (Kipp, Hatton, & Seville, 2017). Since only two alternative buildings were proposed for this study, once the highest score of 10 is assigned to one of the buildings for each criterion, the second building then scores 0. The second step involves determining a weight that will indicate the relative importance of each priority aspect and criteria within the framework, to the decision makers. The third step involves allocating points totalling 100 to individual criterion within each separate priority aspect. However, to get the actual weight for each criterion under a priority aspect, the weight for that particular priority aspect was multiplied by the weight of each criterion and divided by 100. The workshop facilitators guided each group to support the group leaders. Appendix 2 shows the weighting and scoring procedure for all groups.

3.5. Selection of the preferred alternatives

A decision on agreed alternatives is the final step in the MCDA process, after the scoring and weighting processes. The information required to make a final decision originates from a decision matrix which provides the results from the weighting and scoring processes. The decision matrix presents the total scores at the bottom (refer to Appendix 2). The result is a performance matrix which involves assigning a weight to a criterion and then multiplying that criterion by its score relative to each alternative building. The total weighted score of the MCDA was then achieved by comparing the total weighted scores for each alternative ***A1*** *and* ***A2*** and converted to a percentage by dividing by the total possible score for the priority area. Although bearing in mind that the criteria for each score were different, the alternative with the highest total score (i.e., in percentage) was the preferred choice.

3.6. Results and analysis of findings

The development and testing of the prioritisation framework with the focus group participants enabled the selection of the optimal historical building alternative for adaptive reuse intervention in Whanganui. From the two alternatives that were presented, ***A2*** was given priority by all four (Blue, Green, Red, and Purple) focus groups. A breakdown of the decision-making process for each group is given in the subsequent sections.

3.6.1. Focus group 1 – blue

Data from the weighting and scoring process showed that the blue group considered ***A2*** as a preferred alternative for adaptive reuse implementation towards regenerating Whanganui's CBD streetscape. The results from this group indicate the participants' beliefs of ***A2*** to contribute more to improving the economic sustainability of Whanganui's CBD (28%) as compared to ***A1*** (7%). Also, ***A2*** was preferred due to some identified potentials of contributing towards built heritage preservation (15%) and seismic resilience (15%) in the assessment criteria. The results also suggest that an adaptive reuse intervention using ***A2*** will contribute towards improving the economic activities of the CBD by increasing growth in the retailing, tourism and leisure sectors, hence leading to the local community's increased spending power. Accordingly, property owners or developers could yield economic returns from the adaptive reuse of ***A2***. However, the least priority was given to promoting the community socio-cultural aspects (7%) through the adapting ***A2*** for new purposes.

3.6.2. Focus group 2 – green

The green group also preferred ***A2*** to be used as a benchmark building for the adaptive reuse as the participants of this group ranked heritage preservation as the priority contribution from ***A2*** (22.5%) and ranked the ease of reusing building as least priority (3.5%). This preference placed emphasis on the need to protect historic townscapes, built heritage and promote cultural linkages, which has great potentials in contributing to sustainable development of the town centre through the adaptive reuse intervention of ***A2***.

3.6.3. Focus group 3 – purple

With a total standardised weighted score of 42.45% and 57.55% for ***A1*** and ***A2*** respectively, the participants of the purple group preferred ***A2*** as the most suitable building that will deliver economic sustainability (22.50%), followed by socio-cultural values (16.80%) to Whanganui's main street if its existing use is changed for other functions. The highest priority given to economic sustainability denotes that there could be a considerable increase in the value of ***A2***, as a result of an increase in commerce and reinvestment opportunities, aesthetic appeal, and tourism of the area. Accordingly, an increase in the property's value will lead to a corresponding increase in the tax revenue on the property to the local council. This resultant increase becomes significant because property taxes are considered the single most significant source of revenue generation for New Zealand's local authorities. Although ***A1*** was highly prioritised by this group to promote the preservation of built heritage (20%) for the area, the least was given to the socio-cultural aspects (0%). This 0% score for ***A1*** suggests that the purple group participants do not believe that there will be any form of socio-cultural benefits to the town centre regeneration strategy if ***A1*** is redeveloped. On the flip side, building usability (3.25%) was the least preferred priority aspect for ***A2***, as ranked by the participants of this group. However, demand for a successfully adapted ***A2*** will potentially optimise the value of the buildings by acknowledging their residual usefulness.

3.6.4. Focus group 4 – red

Overall, findings from the weighting and scoring process indicate that the participants of the red group preferred ***A2*** (87.25%) to ***A1*** (12.75%). Just like the other three groups, the highest weighted priority aspect for ***A2*** was economic sustainability (40%), closely followed by building usability (21.25%). The participants of the red group believe changing the use of ***A2*** with a community endorsed new use and target market for the building as a starting point, will go a long way in improving the value of other old historical buildings in Whanganui's town centre. Additionally, this preference insinuates that repurposing existing buildings for other functions such as residential (apartments), commercial (retail and offices), and mixed-use (residential and commercial) will serve as a viable opportunity for the area to regenerate economic sustainability by reducing the vacancy rate and natural decay of ***A2*** (See Appendix 2).

However, while heritage preservation, socio-cultural aspects and seismic resilience were the least preferred priority aspects with total standardised weighted scores of 10%, 10% and 6% respectively for ***A2***, three significant priority aspects (economic sustainability, heritage preservation and socio-cultural aspects) all had 0% scores because they were not rated at all for ***A1***. The possible basis for 0% scores could be the participants do not in any way agree that ***A1*** will contribute economic sustainability (i.e., increased job creation, revenue from tourism, and local commercial activities), heritage preservation (i.e., visual heritage retention, sense of place, historic and architectural sustainability), and socio-cultural values (i.e., feeling of belonging, shared cultural identity, etc.) to the regeneration of Whanganui's main streetscape.

3.7. Sum weightings of all four focus groups

Table 2 presents a decision matrix for the total standardised weighted scores from all four focus groups. From the two alternatives that were presented at the workshop, ***A2*** was most preferred by all four groups (refer to Appendix 2 for details). The total standardised weightings for ***A2*** was 69.9% compared to 30.1% for ***A1***. The weightings for the optimal priority aspects was also gained. Economic sustainability (33.75%) in terms of ***A1*** and ***A2*** being capable of financing themselves through a commercially viable new use, increasing local commercial activities and revenue from tourism, was given the highest weight by all four groups. This result is not surprising as economic sustainability is also highlighted as the focus for Whanganui's sustainable and resilient town centre regeneration strategy (Whanganui District Council, 2016). Following economic sustainability was built heritage preservation and building usability aspects with a weight of 21.25% each. It was followed by built heritage preservation of 13.13%. Socio-cultural aspects and seismic resilience had lower total standardised weighted scores of 12.50%, 11.25% respectively. These low results imply that although socio-cultural aspects and seismic resilience are critical priority aspects, they have not been considered by the focus group participants in this study as immediate factors for the sustainable regeneration of Whanganui's town centre.

Table 3
Decision matrix for optimal chosen alternative.
Source: Authors

Total standardised weighted scores	*Wi*	Alternatives	
		A1	*A2*
Groups			
Blue		25.20%	74.80%
Green		40.00%	60.00%
Purple		42.45%	57.55%
Red		12.75%	87.25%
Final prioritised alternatives		**30.1%**	**69.9%**
Priority aspects (*Pi*)			
Economic sustainability (P_1)	W_1 = 33.75	8.88%	24.88%
Built heritage preservation (P_2)	W_2 = 21.25	8.13%	13.13%
Socio-cultural aspects (P_3)	W_3 = 12.50	0.75%	11.75%
Building usability (P_4)	W_4 = 21.25	8.41%	12.84%
Seismic resilience (P_5)	W_5 = 11.25	3.94%	7.31%
Final Prioritised Alternatives		**30.1%**	**69.9%**
Ranking		1	2*

* Indicates the optimal chosen alternative.

3.8. Determination of optimal prioritised adaptive reuse alternative

Considering the decision matrix with the two alternatives $A1$ and $A2$ and the five priority aspects P_1, P_2, P_3, P_4, and P_5, when the weighted sum model (WSM) technique is used (Triantaphyllou, 2013), the optimal chosen alternative and ranking of the two alternatives is shown in Table 3 from the equation:

$$Pi = \sum_{j=100}^{N} a_{i,j} W_J, \text{ for } i = 1,2,3, \ldots, M. \tag{1}$$

The WSM technique is governed by the additive utility supposition. The most preferred alternative is that which matches up to the largest priority value (Triantaphyllou, 2013).

3.9. Sensitivity analysis to determine the most critical priority aspect

As the optimal alternative scores have been determined for all priority aspects, it is assumed that the scores are fixed, and the weight distribution is adjustable. The final generated conclusion may be impacted by adjusting the allocated weights across each criterion and priority aspects. To evade potential drawbacks and gaming when weights are subjectively allocated, a sensitivity analysis is deemed worthwhile to gauge the stability of an optimal selected alternative decision under variations in the input parameters (i.e., weights of each

Table 2
Decision matrix for the prioritisation framework from all four groups.
Source: Authors

Priority	Total standardised weighted scores (%)								
	Blue		Green		Purple		Red		*Wi*
	A1	*A2*	*A1*	*A2*	*A1*	*A2*	*A1*	*A2*	
Economic Sustainability (P_1)	7.0	28.00	21.00	9.00	7.50	22.50	0.00	40.00	W_1 = 33.75
Built Heritage Preservation (P_2)	5.0	15.00	7.50	22.50	20.00	5.00	0.00	10.00	W_2 = 21.25
Socio-Cultural Aspects (P_3)	3.0	7.00	0.00	20.00	0.00	10.00	0.00	10.00	W_3 = 12.50
Building Usability (P_4)	10.2	9.80	6.50	3.50	13.20	16.80	3.75	21.25	W_4 = 21.25
Seismic Resilience (P_5)	0.0	15.00	5.00	5.00	1.75	3.25	9.00	6.00	W_5 = 11.25
	25.20	**74.80**	**40.00**	**60.00**	**42.45**	**57.55**	**12.75**	**87.25**	**100**

Table 4
The sensitivity of priority weights, and absolute-top and per cent-top changes.
Source: Authors

Priority aspects (*Pi*)	*Wi*	W_i* (AT)	PT (%)	Sensitivity
Economic sustainability (P_1)	W_1 = 33.75	31.26	93	0.01075
Built heritage preservation (P_2)	W_2 = 21.25	13.29	63	0.01587
Socio-cultural aspects (P_3)	W_3 = 12.50	8.88	71	0.01408
Building usability (P_4)	W_4 = 21.25	12.27	58	0.01724
Seismic resilience (P_5)	W_5 = 11.25	N.F.	N.F.	0

N.F. = Non-Feasible [i.e., δ value does not satisfy Eq. (3)].

priority aspects and scores of each alternative) (Caterino, Iervolino, Manfredi, & Cosenza, 2008). Moreover, the sensitivity analytical approach helps to determine the slightest change in the existing weights of each priority aspect, that can alter the current ranking of the optimal alternative solution. In most MCDA techniques, the genuine rank of each priority aspect usually represents the value of the assigned weights to the decision priority. However, the intuitive acceptance that a priority aspect that has the highest weight automatically becomes the critical one may not always be factual, as in some cases, the critical priority aspect is the one with the lowest weight (Winston & Goldberg, 2004). By observing the weights of the five priority aspects in Table 4, P_1 seems to be the most significant one. Accordingly, in this paper, a sensitivity analysis using the weighted sum method (Triantaphyllou, 2013) is performed on the weights of all priority aspects (W*i*) ranked by the four groups (refer to Appendix 2), to determine how much adjustment is required to generate a change to this current final preference.

The lowest absolute change $\delta'_{k,i,j}$indicated as absolute-top (AT) required to adjust the current weight W_k of P_k (i.e., W_1 of P_1) in order to reverse the current ranking of alternatives *A1* and *A2* is attained using Eq. (2) below (Triantaphyllou, 2013):

$$\delta'_{k,i,j} < \frac{(P_j - P_i)}{(A_{j,k} - A_{i,k})} \text{x} \frac{100}{W_k}, \text{ if } (Aj,\, k > Ai,\, k). \tag{2}$$

Also, the $\delta'_{k,i,j}$ value will become feasible if the condition in Eq. (3) is satisfied:

$$\frac{(P_j - P_i)}{(A_{j,k} - A_{i,k})} \leq Wk \tag{3}$$

From Tables 2 and 3, Eq. (2) becomes:

$$\delta'_{1,1,2} < \frac{(30.1 - 69.9)}{(8.88 - 24.88)}, \text{ or } \delta'_{1,1,2} < 2.49$$

Since $\delta'_{1,1,2}$ is < W_1 (i.e., 33.75), the AT value is feasible. Hence, the modified weight W_1* of P_1 for this case becomes:

W_1* = 33.75 – 2.49 = 31.26

Following the above procedure, the other modified weights W_2*, W_3*, W_4*, and W_5* as shown in Table 4 are derived. The corresponding degree of criticality of the i-th priority aspect, also referred to as the per cent-top (PT) value is derived when the AT value is divided by the weight *Wi* of each priority aspects (Caterino et al., 2008). Accordingly, the sensitivity value of *Pi* is the reciprocal of its PT value. For the AT and PT values that are non-feasible (N.F.) for robust priority weights, the coefficient of sensitivity will be zero. By considering the PT definition of sensitivity analysis, a survey of adjustments to the existing optimal alternative solution is observed in Table 4.

Building usability (P_4) is observed to be the most critical priority aspect of the decision-making process due to its lowest PT value of 58%, and a corresponding highest sensitivity coefficient of 0.01724. Three of the five priority weights (i.e., W_1, W_3, and W_5) may assume considerable variations in values without determining an optimal solution that is different from ***A2***. Only P_4 and P_2 with PT changes of 58% and 63% respectively are considered big enough to suggest that the optimal selected alternative ***A2*** for adaptive reuse intervention is sufficiently stable due to their high sensitivity coefficients.

4. Discussion

This paper examines the testing of a performance-based MCDA methodology that integrates diversified concerns for the selection of a most suitable historical building alternative for adaptive reuse intervention in Whanganui. The framework validation process helped to improve the understanding of workshop participants on how the adaptive reuse priority aspects regarding underutilised historical buildings could be weighted to rank an optimal solution using the performance-based concept towards delivering useful and sustainable planning results for Whanganui's urban regeneration pursuit. While the validation process of typical adaptive reuse decision-making processes tends to be posed with challenges of applying flexibility of opinions among the various stakeholders, this study applied the evaluation-based adaptive reuse prioritisation framework to explore and quantify the effectiveness of performance-based planning. Accordingly, the evaluation process was done to measure how, and under what circumstances performance-based evaluations could be applied to urban regeneration through the retention and reuse of optimal historical buildings in New Zealand.

Findings from the evaluated framework described in this paper enabled decision-makers to achieve a logical result, and also support the visualisation of the impact of separate priority aspects and criteria on the optimal selected alternative solution ***A2***. A potential increase in job creation from new building function and a corresponding increase in local commercial activities from changing the use of ***A2*** determined the rank. The sensitivity analysis reliably showed a reasonably steady effect concerning the robust and critical priority aspects of the decision-making process. Moreover, the studied alternatives ***A1*** and ***A2*** were critical to the MCDA process as a result of the discussion around them being specific to the impacts that the buildings might have towards achieving a resilient and sustainable town centre for Whanganui. Given that, the priority aspects and corresponding criteria were detailed to induce the participants to engage deeply with their opinions. Also, the use of case study buildings that are well-known to the participants helped to generate a stable impression for the real-world issues relating to adaptive reuse, and inferences based on their personal experiences with the buildings. These kinds of experiences are usually way better than what the workshop facilitators would have created and conveyed within a short period. As well, although the prioritisation framework was tested with only two alternatives ***A1*** and ***A2***, it is capable of comparing an unlimited number of alternatives depending on the context in which it is applied.

Furthermore, the weighting and scoring process enabled the participants in diverse positions to adequately express their viewpoints, hence creating room for the evaluation of influences among the various issues relating to using the adaptive reuse approach as a sustainable development intervention for vacant historical buildings in Whanganui's town centre. The findings imply that utmost efforts should be made on improving the economic viability of Whanganui's town centre by the urban regeneration decision makers. The lowest preference attributed to seismic resilience by all four focus groups could indicate that, because Whanganui is not located in a high seismic hazard region of New Zealand (MBIE, 2017), the participants did not consider the seismic resilience aspect of the framework as an immediate priority aspect that would contribute to a sustainable regeneration of the area. The final prioritised building outcome ***A2*** was accepted by all four focus group participants irrespective of their diverse backgrounds, with the adaptive reuse potentials for the building extensively recognised.

5. Conclusions

The study in this paper delineates the testing of a new approach to balance the adaptive reuse potential of underutilised historical buildings via a multidisciplinary stakeholder group and consensus of scores and weights based on five priority aspects, each containing a range of criteria. Accordingly, four separate sub-groups undertook the assessment. Their conclusions were found to be consistent and insensitive to reasonable changes in weighting. The effectiveness of a prioritisation framework to rank most suitable vacant historical building alternative for adaptive reuse project intervention in Whanganui, while balancing the diverse interests of relevant urban regeneration stakeholders has also been demonstrated by this study.

The framework consists of five priority aspects selected from the extant literature review. The priority aspects that were balanced include economic sustainability, built heritage preservation, socio-cultural aspects, building usability, and seismic resilience. The neighbourhood characteristics and local context of the of the case study urban area were considered in the identification of the priority aspects, which makes it very comprehensive. Based on the results of the weighting and scoring process, ***A2*** was preferred to ***A1***, and the most significant priority aspect that emerged was economic sustainability (24.88%). The second most significant priority aspect revealed that built heritage preservation (13.13%) has become more vital than safety concerns from seismic resilience. The implication of this finding is that a majority historical earthquake-prone building that has been abandoned for demolition due to lack of investment in seismic strengthening up to the required %NBS ratings are worthy of preservation. Furthermore, the results also reveal that socio-cultural aspects (11.75%), building usability (12.84%), and seismic resilience (7.31%), all contribute an important influence on the adaptive reuse project prioritisation process. However, while seismic resilience ranked far less important than other priority aspects, it may imply that the issue is yet to stimulate the necessary awareness of adaptive reuse stakeholders in delivering sustainable urban regeneration projects in New Zealand.

Furthermore, the recommended viable reuse for the selected alternative ***A2*** was for mixed-use purposes (i.e., residential – apartments; and commercial – retail and offices). Consequently, the influence that the selected functional change of ***A2*** will have on Whanganui's town centre regeneration strategy is that there would be an enhancement in the social and modal transportation diversity within its neighbourhood (Geyer & Quin, 2018). The target new use would also help to guarantee a more balanced socially cohesive neighbourhood for its potential users in aspects of convenience, walkability and smarter resource reuse. Potential users would be able to access several amenities within a single vicinity while saving time, and reducing costs of transportation and pollution. Also, increased foot traffic from the mixed-use development would benefit the retailers as most potential residential tenants would likely become steady customers as a result of convenience. The diversity of the mixed-use development poses a lesser economic risk for investors, especially in instances where a downturn in demand for commercial spaces would push an investor to benefit from the residential side. Additionally, the conversion of performance standards for mixed-use developments have been successfully implemented at the local government level in the United States for over 40 years, and in Australia for over 20 years (Wypych, Sipe, & Baker, 2005).

Three possible limitations of this study include: (i) although the weighting and scoring process using additive models can be justified with careful attention to structuring, linearity is frequently inappropriately assumed if not properly detailed; (ii) the development and testing of the framework solely for the New Zealand context; and (iii) the ranking of optimal alternative from only two case study historical buildings. However, the framework is flexible to compare and evaluate more than two building alternatives, which could be non-historical or new buildings in other locations and diverse settings. In such cases, the alternatives, priority aspects and criteria will depend on the interests of the decision-makers. Furthermore, time constraint is foreseen as a possible drawback of the framework's ability to compare and evaluate more than two alternatives using a focus group workshop. Hence, future studies involving more than two alternatives may consider providing extra time for workshop participants to rank optimal solutions.

The evaluation methodology of this study's performance-based framework could be used as a workable guide for other researchers and decision-makers who are striving to build resilient urban areas through the retention and reuse of historical buildings. Further studies may consider validating the framework with more than two buildings in other locations, and, developing it into a computerised decision support model.

Funding

This study was (partially) supported by QuakeCoRE, a New Zealand Tertiary Education Commission-funded Centre. This is QuakeCoRE publication number 0439.

Acknowledgements

The authors wish to thank Leighton Toy, Richard Thompson of Whanganui district council, Bruce Glavovic, An Le, and Ravindu Kahandawa, for their precious time and support throughout the development of this study. Also, all participants of the Whanganui focus group workshop, are appreciated for their vast contributions to this study.

Appendices 1 and 2. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.scs.2019.101547.

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