Building Organisational Resilience for the Construction Industry: Strategic Resilience Indicators

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Abstract: New Zealand has been affected by a number of natural disasters in recent years. One such example is the 2010 Christchurch earthquake that led to significant impacts to businesses, buildings and critical infrastructure. Construction organisations play an important role in reconstruction programs, and communities rely on their services, particularly post-disaster. Improving the resilience of construction organisations to natural disasters not only minimises the negative consequences to their organisations post-disaster and enhances their organisational performance during business as usual, but also helps to improve community resilience. However, very few studies have developed the concept of organizational resilience and none specifically in the construction sector. This paper identifies strategic resilience indicators for construction organizations. Triangulation analysis of the five studies, in-depth interviews and questionnaire surveys revealed leading indicators of organizational resilience which can help to develop a resilience framework for construction organizations. The findings suggest that the construction industry needs a framework that fosters resilience which itself can potentially enhance organisational capacity to recover quickly after a crisis or disaster.

1. Introduction
The 2011 Christchurch Earthquake, with a 6.2 magnitude, witnessed significant impacts on buildings, lifelines and infrastructure. This resulted in at least 181 fatalities, damage to 100,000 stone and brick buildings, and about 10,000 buildings needing to be demolished and re-built. The New Zealand government established a single body, the Canterbury Earthquake Recovery Authority (CERA), to manage the re-building. Post-disaster, construction organisations are often called upon to manage and carry-out the re-building and reconstruction works, from the demolition of damaged buildings to planning the next phase of rebuilding. Several studies [1][2][3] highlight that in order to ensure that the disaster recovery and reconstruction programs are successfully implemented, it is necessary for construction organisations to be resilient. Enhancing the resilience of construction organisations will help the construction industry to be more resilient. They are also able to respond and recover faster from disasters and continue to contribute their services to the community pre- and post-disaster. However, there is an absence of information on how the resilience practice within an organisation can help enhance the resilience of the construction sector. One possible reason for the lack of information is that the industry consists of various organisations, such as construction clients, planners, architects, contractors, suppliers, consultants and sub-contractors, all of which are unique within their organisational environment [4].

From a construction practitioners’ perspective, being resilient might well decide the survival of the affected organisation during a crisis or disaster, and it is imperative that organisations develop strategies based on key indicators, which make their organisation vulnerable to foreseen and unforeseen events.
To begin better understanding of what a resilience organisation may mean to construction organisations, this paper will present a review of existing organisational resilience and its indicators. It also provides an overview; from construction practitioners in New Zealand. Hence, the objective of this paper is to identify set of resilience indicators for construction organizations that will be beneficial from organisational resilience practice. Key indicators of resilience organisation are then presented, and five main indicators will be discussed. Finally, an overview of resilience organisation for the construction industry will be given.

2. Organisational Resilience Strategy in New Zealand

There are two distinct strategies identified in managing organisational resilience in New Zealand; Resilient Organisations (ResOrgs) and the New Zealand Ministry of Civil Defence and Emergency Management (MCDEM) strategy. ResOrgs; a group of researchers entrusted by the government to conduct public-good research programmes, has introduced the resilience benchmarking tools for improving organisational resilience. The MCDEM also presented their MCDEM capability assessment tool for evaluating and monitoring organisations’ compliance with the CDEM Act and to further to enhance organisational capability towards major crises. Despite both these tools being developed to help organisations in New Zealand to improve their organisational resilience, they are different in specific purpose and approach. On the other hand, the ResOrgs tool looks at the resilience of organisations from a broader business and commercial perspective, the MCDEM tool is more technically focused on CDEM, risk, emergency and business continuity management. The MCDEM tool is based around two National CDEM strategy objectives; 1. Enhance the ability of organisations to prepare for and manage emergencies, and 2. Ensure agencies/organisations are able to function to the fullest possible extent during and after emergencies. The tool uses 12 key performance indicators and its scope is associated with an organisation’s risk management plan, emergency response management plan, and business continuity management.

Meanwhile, in 2013 ResOrgs introduced the Resilience Benchmarking tool developed based on the research of [5] and [6]. ResOrgs use 13 indicators of organisational resilience, to help measure the resilience of organisations and they are divided into three interdependent attributes; leadership and culture, networks, and change ready [7]. This tool works by evaluating their resilience strengths and weakness for each indicator, and by benchmarking how they compare to other organisations of a similar size and sector. Other resilience tools reviewed include a benchmarking survey developed for the New Zealand Transport Agency (NZTA) for the purpose of assessing the compliance of Road Controlling Authorities with CDEM 2002 Acts [8], and a framework to measure the resilience of the New Zealand transport system developed for the NZTA in 2014. However, these tools are similar in scope and purpose to the MCDEM capability assessment tool and both the survey and framework have been developed for resilient infrastructure, therefore they were not considered further in this study.

3. An Overview of Key Indicators for Resilience of Organisations

The literature on resilience indicators is vast, contains many methodological approaches and highlights the need for a process of development and validation of indicators that requires a number of specific steps. [9]-[11]. Cutter [12] further suggest the stages involve the development of a theoretical framework to provide the basis for variable selection, data weighting and aggregation, and validation. Tanguay [13] extracted relevant indicators from previous studies, interpreting the classification and categorization of indicators based on their frequency. However, most studies on resilience mainly focused on community and societal resilience, city resilience and infrastructure network resilience but they lack information on organisational resilience [2][14]. In 2007, ResOrgs initiated a project aimed at developing a tool for benchmarking the resilience of organisations. ResOrgs utilizes the organisational resilience model; Relative Overall Resilience (ROR) developed by McManus [5] as a conceptual basis for their research and the outcome from Stephenson’s work [6] in identifying indicators for resilient organisations. After considering the work of McManus [15][16][5], Stephenson [6] and Lee [17], ResOrgs identified 13 key
indicators of organizational resilience which have been used in the Resilience Benchmark Tools and are being implemented by ResOrgs for benchmarking the resilience of organizations in New Zealand. These 13 indicators are divided into 3 groups; leadership and culture, networks, and change readiness. They help to measure the resilience of organizations, to monitor processes over time, and to compare resilience strengths and weaknesses against other organizations [7]. In 2013, ResOrgs introduced the ‘Resilience Benchmark Tool’ for improving organisations’ understanding of resilience and its impact on organizational performance. It provides organisations with a tool for evaluating their resilience strengths and weaknesses for each of these indicators, and for benchmarking how they compare to other organizations of a similar size or in a similar sector. Meanwhile, the CDEM Capability Assessment tool is based around two national CDEM strategy objectives and 12 key performance indicators, and the scope is associated with an organisation’s risk management plan, emergency response management plan, and business continuity management for MCDE in 2014.

The key organisational resilience indicators introduced by [17] of ResOrgs will be used as a starting point in this study. Their applicability in the construction sector will be determined, they will be modified as appropriate, and they will then be used to assess the resilience of construction organisations in New Zealand. The decision to start with the ResOrgs tool and resilience indicators in this study was based on the experts and practitioners’ opinion collected from a preliminary study. In addition, the ResOrgs tool is considered the benchmark tool used by leading engineering and lifeline organisations in assessing their organisational resilience. It was decided to emphasis on the ResOrgs tool and its indicators as a baseline from which to develop a resilient organisations framework for the construction sector. This decision was influenced by the results of the preliminary study where construction practitioners and experts acknowledged that ResOrgs indicators were applicable and measurable for the construction sector. It is intended that these indicators can be used in setting a benchmark for measuring the resilience of construction organizations.

4. Methodology
The research methodology in this study consists of a triangulation analysis of literature review, questionnaire survey and in-depth interview to identify the most important indicators related to resilience of organisations in the construction industry. First, a comprehensive literature review was conducted to identify the most frequent resilience indicators mentioned in five studies related to resilient organisation. This study applied the methodology used by [13] and [18] in their research on selecting resilience indicators for cities. Initially, extended literature review on the five studies revealed 72 indicators related to organisational resilience. These indicators were compiled. The indicator recurrence or the indicators that overlap, the description of each indicator was reviewed. For example, this study considered the risk management planning and the planning strategies as the same indicators because they are both sides of the same issue. After classification of indicators, 27 indicators were selected to observe the frequency of use of these indicators in measuring the resilience of organisations by using Nvivo. The purpose is to compare the most frequent indicators used in previous studies related to organisational resilience with the results from questionnaire surveys and interviews undertaken in this research study.

Second, apart from extended review on the five studies, this study collected respondents’ views on whether the current resilience assessment tools and key resilience indicators were applicable to construction organizations. An electronic questionnaire survey was undertaken to elicit their views. Based on the feedback from construction practitioners and resilience experts in New Zealand, the researcher decided initially to use the 13 resilience indicators developed by Resilient Organisations (ResOrgs) in the questionnaire survey and interviews. The samples in this survey were building and civil engineering contractors in Auckland, Christchurch and Wellington and in total 118 respondents were selected, 50 answered which is a response rate of 42% and according to [19] and [20], the response percentage is acceptable. The questionnaires was composed of both closed-ended and open-ended questions and were divided into two sections; Section A consisted of general questions to identify the profile of respondents and organisations, and to get an overall view of their organisational resilience.
or disaster management practice pre- and post-disaster. Section B aimed to find out the respondents’ views and opinions on key resilience indicators. Since an extensive literature review on the organisational resilience indicators has been conducted by several studies [5][6][7][15][16][21], their findings form the basis for this questionnaire. The respondents were asked to rank the most important 13 indicators developed by ResOrgs in managing organisational resilience for the construction sector. A five-point Likert scale was used to capture the importance of the resilience indicators. Table 1 shows that from the completed replies, approximately two-thirds were from sub-contractors, while the others come from main contractors. Since more than 95 per cent of construction organisations in New Zealand are small to medium enterprises (SMEs) or sub-contractors which are usually affected by disasters and crises [22], the views from main contractors and sub-contractors should serve to establish an overview on the current practice of disaster management within the sector.

Table 1. Characteristics of respondents from the questionnaire survey

| Respondent characteristics | No. of Respondents (total 50) | (%) |
|----------------------------|-----------------------------|-----|
| Designation                |                             |     |
| Director                   | 25                          | 50.0|
| General Manager            | 13                          | 26.0|
| Project Manager            | 7                           | 14.0|
| Contract Manager           | 5                           | 10.0|
| Years of experience        |                             |     |
| 0-5                        | 0                           | 0.0 |
| 6-10                       | 1                           | 2.0 |
| 11-15                      | 1                           | 2.0 |
| 16-20                      | 8                           | 16.0|
| 21 and above               | 40                          | 80.0|
| Sub-sector                 |                             |     |
| Building and structure     | 21                          | 42.0|
| Civil engineering          | 29                          | 58.0|
| Type of organisation       |                             |     |
| Main contractor            | 14                          | 28.0|
| Sub-contractor             | 36                          | 72.0|

Third, in addition to the literature review and questionnaire survey, semi-structured interviews were conducted with 23 construction practitioners from construction client and contractor organizations. The primary objective of the interviews was to find out the experts’ views and opinions on the existing resilience assessment tools. They were mainly project senior executives of the organisations, usually directors, senior managers and senior contract managers. Each interview lasted approximately 30 minutes and covered a number of topics related to organizational resilience in the construction sector. During the course of the interviews, the construction practitioners were questioned about their views on current practice of organisational resilience, existing resilience assessment tools and key resilience indicators. The interviews were also used as the basis for appraising the resilience indicators for the construction industry and their applicability in developing an assessment tool for construction organizations. The interview transcripts are subjected to qualitative analysis using Nvivo software. This software identified key themes in the literature review, questionnaire surveys and in-depth interview which helped to identify the most important key resilience indicators regarding construction organizations. Table 2 shows the characteristics of respondents from the interview sessions.
Table 2. Characteristics of respondents from the semi-structured interviews

| Characteristic | No. of Respondents (total 23) | (%) |
|---------------|-------------------------------|-----|
| Designation   |                               |     |
| Director      | 5                             | 21.7|
| General Manager | 4                           | 17.4|
| Project Manager | 10                         | 43.5|
| Contract Manager | 4                           | 17.4|
| Years of experience | 21 and above           | 100.0|
| Type of organisation |                   |     |
| Client        | 4                             | 17.4|
| Main contractor | 8                           | 34.8|
| Sub-contractor/SMEs | 11                         | 47.8|

Comparison of the results from the literature review, questionnaire surveys and in-depth interviews were carried out using the triangulation method. Black [23] stated that triangulation can improve reliability by eliminating judgmental bias. Similarly, in the context of construction management research, triangulation as an appropriate research approach to understand phenomena that influence organizations in the construction industry. The findings proved useful in the identification of the most significant indicators. The most significant resilience indicators will be validated in a follow-up survey involving 23 representatives from the same construction practitioners in the interview seasons. Finally, this paper will present the 5 most important resilience indicators for construction organisations.

5. Results and Discussion

5.1 Strategic key resilience indicators

Comparison of the resilience studies reveals that there are different approaches to describing indicators or creating dimensions for resilience indicators. Most resilience indicators describe tools of prevention, characteristics of the situation and critical infrastructure regardless of dimension of resilience [13], [18]. Most resilience studies aim to integrate specific objectives and priorities in disaster management perspectives. Due to limited studies in organisational resilience, this study focused on only 27 indicators from five studies related to resilience of organisations. One of the objectives of this study is to observe the frequency of the use of these indicators. Table 3 presents the 11 indicators that were used 3 times or more in the five studies. These most frequent indicators were identified as significant indicators in developing assessment tools to measure the resilience of organisations. These can be used in developing an assessment tool for enhancing the resilience of construction organisations.

Table 3. Indicators used three times or more in the five studies

| Frequency | Indicator                                | Dimension               |
|-----------|------------------------------------------|-------------------------|
| 5         | Planning strategies                      | Change ready            |
|           | Capability & capacity of internal resources | Network                |
| 4         | Roles & responsibilities                 | Leadership & culture    |
|           | Organisations connectivity               | Network                 |
|           | Silo mentality / Breaking silo           | Network                 |
|           | Leadership                               | Leadership & culture    |
Apart from literature review on the five studies, a survey was conducted by using the questionnaire survey in exploring whether the construction practitioners were familiar with organizational resilience, 84 per cent of the respondents state that they were aware of the term. Contrary from the five studies, this survey decided to use 13 indicators developed by ResOrgs New Zealand based on the feedbacks from preliminary survey. Table 6 presents the respondents’ views on the degree of importance of the 13 indicators developed by ResOrgs New Zealand, using a five point Likert scale. The purpose is to determine the significance of these indicators to be used on the proposed resilience strategy for the construction sector.

| Indicators                              | Importance (Mean Rating) |
|-----------------------------------------|--------------------------|
| Leadership                              | 4.84                     |
| Staff engagement                        | 4.50                     |
| Decision making                         | 4.47                     |
| Situation awareness                     | 4.34                     |
| Planning strategies                     | 4.31                     |
| Internal resources                      | 4.22                     |
| Proactive posture                       | 4.06                     |
| Effective partnership                   | 3.81                     |
| Innovation and creativity               | 3.81                     |
| Unity of purpose                        | 3.78                     |
| Stress testing plan                     | 3.69                     |
| Breaking silo                           | 3.59                     |
| Leveraging knowledge                    | 3.47                     |

Results from the survey noted that ‘leadership’ was ranked the highest mean rating of the organizational resilience indicators with a 4.84 mean rating. This was followed by ‘staff engagement’, ‘decision making’, ‘situation awareness’ and ‘planning strategies’ receiving 4.50, 4.47, 4.34 and 4.31, respectively. These five highest rated indicators can be regarded as the most important indicators in determining the resilience score in construction organizations. Usually, a boundary will be defined for marking the indicators as significant or non-significant. The researcher decided to focus on the top five significant indicators to develop a resilience framework for construction organizations based on the feedback from construction practitioners and experts on how far a construction SMEs is capable of measuring their resilience. In addition to the literature review and questionnaire surveys, in-depth interviews were conducted in this study. In the interview sessions, 100 percent of respondents were construction practitioners experienced in crises or emergencies, especially after the 2011 Christchurch earthquake, and were very familiar with disaster resilience or disaster management. This provides confidence that the opinions and suggestions from respondents are of value and appropriate to be analyzed in the context of organizational resilience towards disasters. Apart from the respondent’s views on the applicability of resilience benchmarking tools developed by ResOrgs and MCDEM for the construction industry, a secondary objective of the interview was to get the practitioners to rank the
indicators developed by ResOrgs. Table 5 shows that majority of the interviewers state that ‘decision making’ (mean = 4.83) is considered by most of the interviewees to be the most important indicator in managing construction organisations during crisis. Roles of ‘Leadership’ (mean = 4.70) occupied the second position in the list while ‘staff engagement’ (mean = 4.61), ‘internal resources’ (mean = 4.48) and ‘planning strategies’ (mean = 4.43) take the third, fourth and fifth position.

Table 5: Mean rating of key indicators of construction organizational resilience (in-depth interviews)

| Indicators                  | Importance (Mean Rating) |
|-----------------------------|--------------------------|
| Decision making             | 4.83                     |
| Leadership                  | 4.70                     |
| Staff engagement            | 4.61                     |
| Internal resources          | 4.48                     |
| Planning strategies         | 4.43                     |
| Effective partnership       | 4.39                     |
| Situation awareness         | 4.35                     |
| Leveraging knowledge        | 4.17                     |
| Proactive posture           | 4.13                     |
| Innovation and creativity   | 4.04                     |
| Unity of purpose            | 4.04                     |
| Breaking silo               | 3.70                     |
| Stress testing plan         | 3.65                     |

As expected, the results from the in-depth interview sessions had a similar pattern to the findings from questionnaire surveys, especially on the most important resilience indicators. This may be due to the fact that the majority of respondents from interviews and surveys were experienced in reconstruction works after the 2011 Christchurch earthquake, and are aware with the important of disaster resilience for the construction industry. From the triangulation analysis of the data from the literature review (five studies), in-depth interviews and questionnaire surveys, 16 potential resilience indicators for construction organisations have been identified. These 16 potential indicators were re-circulated to the same 23 construction practitioners in the second round interview. The order of the list of indicators for each interviewer was randomized as part of the process in controlling the bias in this study. The respondents were then asked to re-assesses their rating on the most significant indicators actually for developing resilience framework for construction organisation. Table 6 summarizes the result of the second round interviews, which showed the percentage on the important of each resilience indicators for construction organizations.

Table 6: Percentage of respondents indicating the important of resilience indicators for the construction industry

| Indicators                  | Percentage (%) | Ranking |
|-----------------------------|----------------|---------|
| Leadership                  | 91.3           | 1       |
| Planning strategies         | 78.3           | 2       |
| Internal resources          | 60.9           | 3       |
| Decision making             | 56.5           | 4       |
| Staff engagement            | 52.2           | 5       |
| Situation awareness         | 47.8           | 6       |
| Leveraging knowledge        | 43.5           | 7       |
| Roles & responsibilities    | 39.1           | 8=      |
| Breaking silo               | 39.1           | 8=      |
| Organisation connectivity   | 34.8           | 9=      |
Table 6 revealed that, in the event of a natural disaster, leadership was identified as the most important indicator for construction organisations. The interviewees, who consist of construction experts, stated that emphasis should be placed on the role of committed management and leaders to keep their organisations functioning throughout the post-disaster phases. Furthermore, communities rely on services provided by construction organisations in major restoration and reconstruction activities post-disaster [24]. In the first round of interview sessions, the respondents also were also asked whether the 13 resilience indicators developed by ResOrgs were related to organisational resilience within the construction industry. 32 per cent of the respondents agreed, while 24 per cent viewed the indicators as possibly related, and 44 per cent, the rest of respondents, were uncertain. The possible reason for the survey result can be the perception that resilience in the construction industry only focuses on physical properties [11] or hard resilience elements which consist of ‘robustness and redundancy’ [25]. Through the interviews, construction experts supported this view and suggested that the existing 13 indicators only cover the elements that measure how organisations manage or respond to disasters. Construction practitioners and experts have suggested a greater emphasis on the technical element when dealing with measuring construction organisational resilience towards natural disasters, supported by the existing organisational element. However, based on the five studies of organisational resilience, questionnaire surveys and in-depth interviews, this study presents key resilience indicators which help construction organisations to enhance their resilience. The majority of experts agreed that the top five indicators identified as most important for assessing resilience of the construction industry were, in rank order; 1) leadership, 2) planning strategies, 3) internal resources, 4) decision making, and 5) staff engagement. These indicators will be discussed briefly to demonstrate their significant for construction organisations and the industry as a whole.

6. Conclusion
This study provides an investigation into resilience of organisations within the construction industry. Based on the survey and interviews, it is clear that this is not currently achieved especially for construction SME’s. Consequently, there is a need for resilience management strategies and measurement tools to assess the resilience of organisations in the construction sector. In response, this study used a triangulation analysis method to identify the most important indicators which can help create a guideline or framework to enhance the resilience of construction organisations. A propose framework will developed and then validated in a follow-up interview involving a representative number of the same construction practitioners as part of further research. This study also noted that the indicators introduced by ResOrgs and MCDEM were difficult to use by construction practitioners which need a framework and measurement tool particularly for construction organisation in assessing their organisational resilience. The results from this study identifies that the leading and dominant indicators can help enhance the resilience of construction organisations. While the decision makers and the industry are concentrating on finding a suitable framework for post-disaster recovery and reconstruction, critical indicators of resilience within organisations should be understood by leaders and construction practitioners. These key indicators can be used to develop, evaluate, and execute plans or strategies for pre- and post-disaster for a successful disaster recovery.

Acknowledgement
This paper detail study funded by the Ministry of Higher Education Malaysia and Universiti Teknologi MARA Malaysia. Their support is gratefully acknowledged.
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