Input Paper

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INVESTMENT IN THE CONSTRUCTION SECTOR TO REDUCE DISASTER RISK MANAGEMENT

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1. Introduction

Construction organisations are often called upon to manage the post-disaster environment. In addition to having to recover their own business functionality, construction organisations must operate to assist with the post-disaster recovery and reconstruction such as providing the physical resources, people, material supply, logistics expertise and rebuilding processes needed for recovery. Communities rely on services provided by construction organisations to enable them to recover from emergencies and crises. Pre-disaster construction company resilience impacts on the ability of construction companies to function post-disaster. The research discussed in this paper shows the role of construction companies in a disaster. This input paper for the 2015 Global Assessment Report advocates for investment in pre-disaster risk reduction at a construction organizational level to improve post-disaster recovery outcomes. The paper presents key indicators of organisational resilience in the construction sector. Resilience indicators set a benchmark for enhancing business risk reduction measures so that organisations can survive a crisis. Organisations that invest in pre-disaster risk reduction are more likely to be able to recovery their business functionality quicker than those with no pre-disaster risk reduction investment. This paper uses the construction sector organisations as a case study of the impact of disaster risk reduction on business functioning after an event. In order to ensure that the disaster recovery and reconstruction programs are successfully implemented, it is necessary for construction organisations to be resilient and able to respond, and recover from an event. The construction sector needs to understand the critical role they have to play in both disaster risk reduction, and in recovery post-disaster. Developments in the understanding of the critical role of the construction sector post-disaster, and the solutions to improving construction sector resilience can be incorporated into the industry sector risk reduction and resilience in the successor framework to the HFA.

The main questions guiding this research are:

- What is the role of the construction sector post-disaster?
- What are the challenges faced by construction organisations post-disaster?
- How can the construction sector improve its resilience?
- What changes are required to the HFA to improve construction sector resilience?

2. What is the role of the construction sector post-disaster?

The construction sector is a significant part of an overall economy. Construction industries tend to account for between 4–10% of an economy's Gross Domestic Product (GDP). In New Zealand, the building and construction sector contributed around 4% of the GDP in 2010, representing 7% of GDP in Australia, 8% of GDP in the UK and 9% of GDP in the USA (Building and Construction Productivity Partnership 2012). Construction organisations play key roles

within our society pre-disaster and post-disaster. All buildings and engineering infrastructure have been planned, designed, built, operated and maintained by organisations involved in the construction sector. Post-disaster, construction organizations are critical to the recovery and reconstruction programmes. The construction sector is not only a key component of the nation's economy, it is also a primary factor in the quality of communities' lives and the ability of the government to achieve their policies (Bosher et al., 2007).

Recent studies show that in many countries construction organisations are characterised as small organisations or small to medium enterprises (SMEs) (PwC, 2011; Hatton et al., 2012). Participation of these SMEs is critical for the successful operation of most international construction sectors. These organisations have the potential to create disruption to the construction and rebuild activities, not only in the construction sector but also to the supply chains of other industries and economies. The resilience of construction organisations against disasters is of significant importance to the construction organisation's themselves, the construction sector as whole and other reliant industries. Construction organisations have a significant role to play in contributing to a community's improved resilience (Haigh et al., 2006; Bosher, 2008; Haigh and Amaratunga, 2010). Communities rely on services provided by construction organisations in pre-disaster and post-disaster to improve their resilience. To improve community resilience, construction organisations must first be resilient and able to respond to, and recover from, a disaster (Lee et al., 2013). Dalziell (2005) suggests the ability of organisations to be resilient and continuously functioning during a disaster or crises will have a large influence on the ability of the community to recover from such events.

Reconstruction can be considered in the wider context of an ongoing and fluctuating recovery. Governments have attempted to plan for recovery and to develop policies which incorporate increased resilience into recovery frameworks. The reconstruction of the built environment is seen as one of the key elements within recovery. According to Quarantelli (2008) reconstruction refers to the post impact rebuilding of the physical structures destroyed or damaged in a disaster. The relationship between reconstruction and community recovery has been summarised by Quarentelli (2008) as "The longer the reconstruction process, the slower the recovery of the community since recovery in other dimensions is also slowed". By understanding the role of the construction sector at the different stages of reconstruction, opportunities can be found for improving and increasing the speed of the overall recovery,

including community recovery. The five stages of reconstruction, as discussed by Wilkinson (2013), are identified as: chaos, realisation, mobilisation, struggle and new normal. The role of construction organisations during these critical stages is a first step to developing an efficient recovery programme.

Development of the five stages of reconstruction (chaos, realisation, mobilisation, struggle and new normal) through the lens of recent disasters demonstrates the difficulty of disaster reconstruction. The experience of disasters confirm much of what is known about post-disaster recovery and reconstruction, including the importance of leadership, funding availability, participation of local communities and timing of decisions. Reconstruction is a complex and dynamic process, full of uncertainties and stress, requiring a significant level of coordination and innovation. Effective reconstruction of housing, infrastructure and commercial buildings requires an understanding of how the construction sector operates in a post-disaster environment. Although disaster reconstruction moves at different speeds, depending on the differing circumstances of the affected area, the reconstruction stages remain relatively static.

Wilkinson et al (2013) discussed the initial stages of recovery where there tends to be significant chaos and a general situation characterised by the question "what do we do?" The key reconstruction features found in this stage are the need for assessments to be done on buildings and communities. Brunsdon and Smith (2004) described the need for impact assessments requirements, similar to the World Bank's recommendations for assessing needs, identifying priorities, and planning recovery, where one of the first activities usually undertaken is the assessment of damage and the impact of the damage on the community. The World Bank's Rapid Damage and Loss Assessment (DaLA) methodology provides a way of undertaking the assessment activity, where DaLa incorporates physical damage, losses from that damage and assessments of social, economic, and environmental impacts. The construction sector is mostly called upon to develop and train the workforce to undertake these assessments. Qualified engineers, builders and project managers are the professionals required to both manage the assessment process and undertake assessments. The result of the impact assessment becomes the basis for future reconstruction works and recovery plans. To improve recovery pre-planning for damage assessment is required, which means that training for assessments in construction organisations. Damage assessment training and understanding should be an ongoing process; however, few construction employees are actually trained in

management of post-disaster environments, including training in damage assessment, even though they are expected to take on these roles.

Following on from the Chaos Stage is the Realisation Stage which is characterised by the common thought that "the disaster's impact is bigger than we thought" (Wilkinson et al, 2013). In this stage the common elements are around establishing agencies, planning, especially land-use and rezoning, new legislation, the introduction of quickly produced new building codes (which are usually designed to improve past building practices and are aimed at improving resilience) and demolitions occurs (Manakkarra et al, 2013). The construction sector is again required to play a pivotal role at this stage of recovery and reconstruction such as managing temporary accommodation requirements, repairs and retrofitting of buildings. Planning for new replacement buildings starts to take place. Newly established agencies often appear which require staffing. The construction sector should have an input into the newly established recovery agencies, for instance through planning for rebuilding, removal and disposal of waste, repair and rehabilitation of infrastructure. If the construction sector is resilient, then the involvement is strong. Brunsdon and Smith (2004) discussed the need for decisions on whether to repair, replace or demolish affected properties and also the need to produce restoration proposals to give an outline of the anticipated reconstruction needs. Proposals outline a range of options for reconstruction, and an attempt to put costs to the reconstruction are often made, and these are based on recommendations from construction sector organisations. The time period for complete reconstruction is relatively indefinite. It could last months, years or decades after the disaster event The sooner good organisational structures, staffed with qualified professionals, are in place the better for overall recovery. Ensuring a smooth transition from response through relief and recovery is critical to the effectiveness of post-disaster recovery activity (Smart, 2012). Davies (2006) points out that "…many [disasters] concern the relentless pressure for rapid recovery from all quarters which is set against the normal demands for prudent planning, detailed consultation, reviews of safety requirements etc. There is also the demand for reform to be balanced with another pressure for realism or a return to pre-disaster norms" The realisation stage of reconstruction brings this point into focus, as the debates of what to rebuild, where and when become more frequent. The construction sector, through assessment reports and capability is often asked to contribute to the ongoing debate.

At realisation stage, information about the financial impacts of the reconstruction is clearer as reconstruction proposals and the apportioning of funding becomes a key issue. Reconstruction funds may be raised privately; through insurance companies; and from external donor agencies or charities. The outcome of funding and other statutory compliance applications may necessitate adjustments to initial restoration plans. Some other factors apart from economic considerations may impact on restoration programmes. These may include structural integrity, safety, and functional/historical/cultural significance of the property to the owner. Hasty reconstruction programmes have longer-term impacts that may be difficult to undo (Ingram et al., 2006). Reconstruction decisions should therefore be a trade-off between idealistic goals and expediency. When systems are established, there is a desire to see some action, mainly in the form of rebuilding. Pressure is therefore put on construction organisations to mobilise their workforce.

Often marking the start of the mobilisation stage is the one year anniversary of the disaster, and the increasing mood to get on with the reconstruction. Mobilisation is where the construction sector has its main impact, as this stage is characterised by the common thought "we're getting on with it". Often public building repairs become evident, especially schools and community centres, as a desire to make physical statements about the rebuilding progress are made. New buildings emerge, there is high activity in repairs, an elevated concern about the wider resourcing problems being encountered, leading to increasing costs and shortages of supply. In rebuilding, resilience to natural disasters is required, and the construction sector is key in developing novel ways of building back better (Manakkarra et al, 2012) Training for the construction sector to be able to manage the boom-bust cycles inherent in a disaster is needed. Housing repairs are a large component of the reconstruction process, which increases pressure on SMEs and individual builders who traditionally manage small repairs. The increased optimism of mobilisation is often followed by a struggle stage. The main mood of the struggle stage is one characterised by the feeling that "it's really hard, it's not going to plan". What appears in this stage is the realisation that there will be no fast recovery. Statutory application and documentation procedures have been known to slow down reconstruction programmes (Burby et al., 2006). The entire process is worsened by the absence of skilled professionals and skills needs mostly in the construction trades and professionals. Resourcing pressures occur in most disasters, as most countries are unable to cope with the large building requirements (Chang-Richard et al, 2012). At the struggle stage there is often costs escalating, materials hard to

procure; skilled professionals in demand; reduced housing stock and housing affordability problems. The struggle stage is very hard for the community, and more people start to reassess options, and there are population shifts from the region. In the pursuit of reconstruction objectives, it is usual for conflicts to occur between affected groups, government, and recovery providers. Auf De Heide (1989) gives three reasons for conflict after a disaster as: scarcity of information and or breakdown in communication among recovery stakeholders; challenges posed by the management of limited recovery resources; and excessive response and recovery provisions by external aid agencies and outsiders. The construction sector is often expected to solve some of the common problems that emerge at the struggle phase.

Conflict must be properly managed otherwise they could have lasting effects on individuals and the community and affect the reconstruction. The reconstruction process involves the application for consents, building approvals and adherence to building codes, many of which are newly created or revised (Manakkarra et al, 2012). Consenting processes are usually painstaking for both the party(s) seeking approvals, the approving authorities and the construction sector, causing delays to rebuilding. Approving authorities need to ensure that performance quality and safety provisions are not compromised. Skilled and adaptable construction organisations cope better with the changing legislative environments brought on by this phase of reconstruction (Manakkarra et al, 2012).

The New Normal stage, which starts many years after the disaster, is characterised by the feeling that "this is how it is, there's no going back". Disaster recovery and reconstruction do not recreate the same environments seen prior to the disaster. Where resilience has been introduced into the buildings and the construction sector has used resilience principles to enhance the reconstructed environment, there is a sense of buildings being better, newer, and safer. Chief amongst post disaster management objectives is to enable a community to recover from the event whilst also future-proofing the community and its physical facilities against similar disaster events. The construction sector is one of the sectors most likely to have faced changes during the disaster, as the sector has had to respond to changing business sizes and practices, new rules and regulations and a fluctuating market place. The role of the construction sector pre-disaster is to make sure they are sufficiently resilient to manage the increasing pressures call upon them in recovery.

3 What are the challenges faced by construction organisations post-disaster?

The Canterbury earthquakes in New Zealand can be seen to illustrate the role the construction sector plays in a disaster. Canterbury was significantly damaged by two major earthquakes and thousands of aftershocks. In the first earthquake on the 4th September 2010, there were no fatalities but widespread damage to housing, infrastructure and public facilities throughout the city and surrounding areas. After the September earthquake, a large number of unreinforced masonry buildings in the Central Business District (CBD) were heavily damaged and large areas of the CBD were cordoned off from the public for approximately one week. Engineers were quickly mobilised throughout the country for building damage assessment and safety evaluation. The earthquake produced rapid response and assessment, and structures were quickly put in place to deal with the situation. However, the violent magnitude 6.3 earthquake that devastated Christchurch on 22 February 2011 was the most severe of all the events in the Canterbury earthquake sequence causing the deaths 185 people and many buildings were severely damaged including further damage to infrastructure and widespread liquefaction leading to a more complex response, recovery and reconstruction. The February earthquake also triggered land movement, the collapse of cliffs and rock falls. As a result of the Canterbury earthquakes, more than 60 per cent of Christchurch's CBD buildings were severely damaged (CERA 2012). Another 60 per cent of the 5,000 organisations in the CBD and 50,000 employees were displaced. More than one third of central city organisations were unable to operate, with another third relocating to makeshift premises (DoL, 2011). Over 150,000 homes (about three quarters of Christchurch's housing stock) sustained some damage from the earthquakes. The total number of individual buildings, land and contents insurance claims received in the first year exceeded 600,000 (EQC, 2011).

In terms of infrastructure damage, 1,021 kilometres of roading needed rebuilding, which is about 52 per cent of Christchurch's urban sealed roads. The earthquakes also damaged 51 kilometres of water supply mains and 58 kilometres of the sewer system within the city (CERA 2012).

In the need to act quickly, the initial earthquake assessment methods and protocols were not consistent and the quality of assessment was variable (NZSEE, 2011). There were different

assessment techniques being used by different agencies leading to different levels of quality and different information in the assessments. The level of training of the assessment teams varied, leading to the same buildings having different assessment outcomes. Reassessments were commonplace. Inaccurate and incomplete building assessments were used to make decisions, leading to fast-track demolition of buildings. Significant land-use reassessment was made to categorise land for rebuilding, but this again was initially characterised by inaccuracies and confusion (NZSEE, 2011). Since there was widespread water and waste water system failures, people had to use portable toilets and water tanks delivered water, a situation which continued for many months (Potangaroa et al, 2011). The requirement to rapidly repair systems and produce building assessments were seen to be the responsibility of the construction sector. When the construction sector is called upon to respond to a natural disaster, it needs to be clear on role it will be playing, and the resources that will be provided for the sector to undertake their role.

Successful post-disaster recovery depends on strong leadership, including leadership from the construction sector. In Christchurch, the recovery leadership was undertaken by CERA at the national level. However, in order to manage a large disaster rebuild, new structures in the construction sector emerged. Due to the scale of the February earthquakes, The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) was created to rebuild the horizontal infrastructure (roads, bridges, water systems) and be responsible for delivery of all asset assessments, project definition, concept and detailed design and construction delivery. SCIRT adopted an innovative alliance delivery system for the reconstruction of the horizontal infrastructure. The alliance model adopted by SCIRT was a collaboration between a client, consultant and contractor who mutually agreed to undertake the work to target levels of quality, cost and time. An additional rewards/sanctions mechanism is put in place to measure the performance of individual delivery contractors over time. The need to put in more collaborative structures for rebuilding, as demonstrated by SCIRT, has been recognised by Zuo et al (2006) and the system adopted by SCIRT takes the alliance model concept and applies it in a unique way. SCIRT is effectively a 'virtual organisation' which has a leadership team for governance and an Alliance Management Team (AMT) which looks after the Integrated Alliance Team (IAT) who are responsible for delivering the planning, design and management functions to enable the delivery teams to do the work. The delivery teams are responsible for the construction. The SCIRT model allowed for construction companies to join together to solve the large scale

reconstruction problems faced by significantly damaged infrastructure. The construction sector needs to be adaptable to changing requirements of the complex post-disaster environment, and the SCIRT model is an illustration of the structural solutions used to meet the changes the construction sector faced post-earthquake.

The construction sector post-earthquake faced process challenges. There were vast numbers of construction process changes experienced during the recovery in Christchurch. Local councils' consenting processes changed as a result of the need to change building codes and regulations. This had an impact on the construction sector's ability to rapidly rebuild. Zuo et al (2013) reported on the initial stages of recovery showing that difficulties. Zuo et al (2013) reported that consents were taking a long time to obtain; there was fear of the Council being unable to cope; concern about impractical requirements; confusion; a business as usual process being used when a new systems was required; and the costs of consents increasing. New staff in Council positions and the lack of clarity around procedural requirements caused difficulty and were a concern for delays. Increased difficulty in recruiting skilled labour and qualified engineers for rebuild was seen as impacting the Canterbury reconstruction. Additional issues rose with skills and labour included the potentially incompatible labour skills with different build methodologies. Homeowner exhaustion was commented on as affecting the rebuild, including having to engage with reappraisal requirements or having problems getting the insurance resolved. Homeowner expectations needed to be better managed. Sorting out multi-event assessments, early assessment and later assessment differences were causing problems and slowing the rebuild process. Unresolved land issues, such as land zoning status and subsequently different building requirements for different types of foundation, were interconnected with insurance, local councils' consenting processes, and legislative changes. Unresolved land issues were a result of the legislative changes following the Canterbury earthquakes. Without resolution the Council could not issue consents and insurance could not settle claims.

In New Zealand, the Government appointed the largest local construction firm, Fletchers Construction Ltd, to coordinate the rebuilt for all residential housing, with SMEs involved as sub-contractors under the new organisation, called Fletcher EQR. In post-earthquake reconstruction the development of new subdivisions in affected regions faced shortages of building expertise and materials and the need for improved skills training and recruitment. Chang et al. (2012)

emphasised that limited capacity of the construction sector and the resources shortage in post-disaster reconstruction and recovery in Christchurch affected recovery in terms of construction delay.

Construction companies also faced internal organizational changes. Longer design and planning processes were experienced due to the increased volume of work and more reporting requirements expected during the post-earthquake rebuilding caused extra time requirements, and subsequently extra costs. With workload increasing, subsequently changes were experienced in the way a typical privately-owned construction firm operates its business. Changes such as: procedural changes, i.e. moving from chasing an inquiry to choosing work; dealing with different stakeholders, such as the insurers; more up-front costs; more time and more communication; better budgeting and more networking. The procurement methods used in the Canterbury recovery, especially on larger scale projects, changed from the traditional design-bid-build model to more collaborative and integrated arrangements, including partnering and alliance arrangements. The overall desire for more efficient procurement methods was reported (Zuo et al, 2012) and meant that the construction sector was required to manage both external changes and internal changes.

4. How can the construction sector improve its resilience?

In order to ensure that the disaster recovery and reconstruction programs are successfully implemented, it is necessary for construction organisations to be resilient and able to respond, and recover from an event. Improving the resilience of the construction sector demands an in-depth understanding of the expertise and knowledge needed to avoid and mitigate the effects of disasters. There are identified key indicators of organisational resilience which can be used by the construction sector. These indicators can be used in setting a benchmark for measuring the resilience of construction organizations and, hence, enhance their capability to increase their resilience in order to survive a crisis and thrive in a world of uncertainty. Past events demonstrate that the construction sector faces significant changes following a disaster. The sector is expected to lead reconstruction, as well as manage internal and external changes. These complexities create vulnerabilities for the construction sector.

As far as construction organisations are concerned, being resilient might well decide the survival or the failure of affected organisations, resulting in economic and community consequences. Seville et al., (2006) highlight that organisations deal with uncertainties and unexpected events all the time, and managing these present both opportunities and risks for the organisation. Resilient construction organisations are capable of maintaining function and structure in the face of major disruption. Communities rely on services provided by construction organisations in major restoration and reconstruction activities and improving resilience of construction organisations to the effects of disaster has become an important issue, with the increasing threat of disaster. To be resilient, construction organisations need strong leadership, an awareness and understanding of their operating environment, their ability to manage vulnerabilities, and their ability to adapt in response to change. These attributes need to be captured in organisational resilience indicators.

Lee at al. (2013) states that if organisations are not prepared to respond to emergencies and crisis communities also are not prepared. The ability of organisations to continue to operate and to provide services and employment is critical to the ability of communities to be resilient. McManus et al. (2008) argue that the resilience of organisations directly contributes to the speed and success of community recovery. Without critical services provided by construction organisations in restoration and reconstruction of lifelines, building and infrastructure, it is difficult for communities to respond or recover.

Researchers in this area have come up with different definitions for resilience as well as what factors contribute to a resilient organisation. The definitions are dynamic and change with different perspectives, such as spatial, social, and scale or unit of analysis (Renschler et al., 2010), and according to the context in which it is being applied (Haigh and Amaratunga, 2010). Researchers also often meet difficulties in gathering data on resilience indicators for input into their models or frameworks (Cutter et al., 2008). ResOrgs (2012) 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 ready, to help measure the resilience of organizations, to monitor processes over time, and to compare resilience strengths and weaknesses against other organizations (ResOrgs, 2012). The 'Resilience Benchmark Tool' for improving organisations' understanding of resilience help

construction organisations to understand their ability to adapt and respond to a disaster. Construction organisations can use the tool to determine their levels of resilience under the areas of Leadership & culture: (with indicators on Leadership, Staff engagement, Situation awareness, Decision making, Innovation & creativity) Networks: (with indicators on Effective partnership, Leverage knowledge, Breaking silos, Internal resources); Change Ready: (with indicators on Unity of purpose, Proactive posture, Planning strategies, Stress testing plan). Because the construction sector is required to be proactive in a disaster environment, increasing their resilience will ensure a better recovery outcome. The Canterbury rebuild is presenting a test for the New Zealand construction sector resilience. Building the resilience of construction organisations is a key part of any overall resilience policy due to their role in restoration and reconstruction project delivery post-disaster. Improving the resilience of construction organisations minimises the negative consequences of disasters to the organisation, and also helps to improve long term community resilience.

5. What changes are required to the HFA to improve construction sector resilience?

The following suggestions are provided for discussion on how the HFA might use this input paper to understand the role of construction and to advocate for the construction sector to become a focus for enhanced resilience planning.

The paper has shown the significant role the construction sector could expect to play in a post-disaster environment. Achieving a highly responsive and resilient construction sector should be a HFA priority business area focus. Suggestions for improving resilience of the construction sector are:

- Improvements in the education of the pivotal role of the construction sector in recovery and reconstruction at multi-governmental and international levels.
- Improvements in the training for disasters for the construction sector, especially in relation to their essential role in recovery and reconstruction.
- Development and promotion of a resilience of organisations management tool targeted at the construction sector organisations, both large and SME's, to allow the sector to benchmark their resilience.
- Encouragement of strong leadership, partnerships and collaboration within the sector and across sector and government boundaries.
- Encouragement for the construction sector to be more adaptable to change. For instance encouraging the identification of business risks in a disaster and undertake scenario planning, using flexible networks and partnerships.

- Disseminate the understanding and management of the changes the construction sector will face post-disaster (for example dealing with revised building codes, changing regulations, changing consent processes, workforce changes)

6. Conclusions

In order to ensure that the disaster recovery and reconstruction programs are successfully implemented, it is necessary for construction organisations to be resilient and able to respond, and recover from an event. A resilient construction sector is responsive, adaptable and able to lead in a disaster. Resilience indicators help construction organisations with enhancing business risk reduction measures so that they can survive and be useful in a disaster.

This paper has shown that events directly impact on the ways in which the construction sector operates.

A key aim of the Hyogo Framework for Action (HFA) is the increase in the number of countries establishing a multi-sectoral National Platform to engage more stakeholders in disaster risk reduction (UN/ISDR, 2013). The construction sector, as a key recovery stakeholder, is one which requires more active engagement. Loss of functionality of the construction sector leads to slow, uncoordinated recoveries. There is a need to promote he resilience of the construction sector and provide advice, education, training and support to enhance construction sector resilience. The discussions in this paper shows the many challenges facing he construction sector, and provides suggestions to the HFA for better engagement to minimise disaster risks, and aid disaster recovery.

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