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Effects of a major disaster on skills shortages in the construction industry

Lessons learned from New Zealand

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Abstract

Purpose – The purpose of this paper is to empirically investigate the effects of a major disaster on the management of human resources in the construction sector. It sets out to identify the construction skills challenges and the factors that affected skills availability following the 2010/2011 earthquakes in Christchurch. It is hoped that this study will provide insights for on-going reconstruction and future disaster response with respect to the problem of skills shortages.

Design/methodology/approach – A triangulation method was adopted. The quantitative method, namely, a questionnaire survey, was employed to provide a baseline description. Field observations and interviews were used as a follow-up to ascertain issues and potential shortages over time. Three focus groups in the form of research workshops were convened to gain further insight into the feedback and to investigate the validity and applicability of the research findings.

Findings – The earthquakes in Christchurch had compounded the pre-existing skills shortages in the country due to heightened demand from reconstruction. Skills shortages primarily existed in seismic assessment and design for land and structures, certain trades, project management and site supervision. The limited technical capability available nationally, shortage of temporary accommodation to house additional workers, time needed for trainees to become skilled workers, lack of information about reconstruction workloads and lack of operational capacity within construction organisations, were critical constraints to the resourcing of disaster recovery projects.

Research limitations/implications – The research findings contribute to the debate on skills issues in construction. The study provides evidence that contributes to an improved understanding of the industry's skills vulnerability and emerging issues that would likely exist after a major disaster in a resource-limited country such as New Zealand.

Practical implications – From this research, decision makers and construction organisations can gain a clear direction for improving the construction capacity and capability for on-going reconstruction. Factors that affected the post-earthquake skills availability can be considered by decision makers and construction organisations in their workforce planning for future disaster events. The recommendations will assist them in addressing skills shortages for on-going reconstruction.

Originality/value – Although the study is country-specific, the findings show the nature and scale of skills challenges the construction industry is likely to face following a major disaster, and the potential issues that may compound skills shortages. It provides lessons for other disaster-prone countries where the resource pool is small and a large number of additional workers are needed to undertake reconstruction.

Keywords Skills, Human resource management, Construction industry, Earthquakes, Strategic planning, Labour force

Paper type Research paper

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1. Introduction

Having a skilled and productive workforce has been central to the construction sector's growth and success (Agapiou *et al.*, 1995; Chan and Dainty, 2007; Construction Skills, 2005). Literature has revealed a number of factors which can create a shortage in construction skills. In particular, cyclical changes in construction demand has been recognised as a major challenge facing construction firms and their workforce (Bennett, 2005; Fan *et al.*, 2011). This has manifested as large boom periods where there is more demand for labour than can be met, followed by bust periods where significant numbers of partially trained and fully trained construction workers are often lost to other industries and rarely return (McGrath-Champ *et al.*, 2011).

The nature of demand within the construction industry is often fraught with uncertainties, leading to pronounced fluctuations (Hua, 2012), adding instability and uncertainty in workforce planning for the industry at all levels (PWC, 2011). For example, as construction demand fluctuates, employees in the construction sector often face uncertainty in regard to their employment, which has a detrimental effect on their social well-being (Allan *et al.*, 2008). The cyclical nature of the industry deters young people from considering the industry as a future employer (Briscoe, 1988; Hillebrandt, 2000). The "gains" in the booms and "losses" in the busts also challenge sustainable development of construction firms (Fox and Skitmore, 2007).

In the past decade, to counteract the effects of economic cycles on construction workforce development, considerable effort has been put into developing various methods, tools and techniques to improve forecasting of labour demand and supply (e.g. Sweeney, 2004; Wong *et al.*, 2007; Ho, 2010; Sing *et al.*, 2014). The basic rationale underlying many of these tools is the use of a limited amount of data at the project or firm level to achieve a similar degree of accuracy to that of other statistical forecasting models. Wong (2006) emphasised the fact that workforce forecasting is a key strategic managerial practice for construction organisations. Such a viewpoint sees human resource management as a critical factor in enhancing the performance of construction businesses.

Other solutions to address vulnerability to economic cycles in regard to construction skills have also been used, primarily in such areas as the training of transferable skills (Clarke, 2006; Clarke and Wall, 1998), multi-skilling (Burleson *et al.*, 1998), promoting the construction industry as an attractive workplace (Agapiou *et al.*, 1995; Chan and Dainty, 2007), employing temporary workers or outsourcing (McGrath-Champ *et al.*, 2011) and developing new technologies and construction techniques that substitute manpower (MacKenzie *et al.*, 2000). Despite the achievements in construction skills research, Dainty *et al.* (2005) suggested that workforce planning needs to take account of a wide range of factors determining both labour supply and demand. There remains a paucity of empirical research into the nature of a highly complex and dynamic labour market (Pearce, 2003). In particular, very little attention has been paid to the effects of external shocks, such as major natural disasters, on the construction sector in terms of skills profile and capacity (Chang *et al.*, 2011b).

The global financial crisis of 2008 and the earthquakes which occurred in Christchurch, New Zealand in 2010 and 2011, however, created a unique economic cycle affecting the construction industry. The research reported in this paper seeks to fill the knowledge gap by empirically investigating the effects of a major disaster on the management of human resources in post-disaster recovery projects. To attain this goal, two research questions were formulated:

RQ1. What skills challenges were faced by construction organisations in post-earthquake Christchurch?

RQ2. What factors influence the availability of critical skills for longer-term post-disaster reconstruction?

The paper begins by presenting an overview of skills issues faced by the construction sector in New Zealand, followed by a review of the effect of the external shocks on construction employment. The methods for examining the recovery experience after the 2010/2011

earthquakes in Christchurch are presented in the research method section, followed by the research results section. The interplay of factors that combine to impinge upon the prevailing skills issues in Christchurch will be discussed. The paper's conclusion suggests the types of policy solutions and associated supporting measures needed to address the skills challenges faced by the New Zealand construction industry. Findings from this research, including skills challenges and factors affecting their availability identified in a major disaster setting, provide insights into the development of a collective workforce plan for disaster-affected areas to align the industry and organisational workforce strategies with real-time demands.

2. Literature review

2.1 Skills shortage faced by the New Zealand construction industry

The New Zealand construction sector plays a large role in driving economic growth; however, it is subject to boom-bust cycles (PWC, 2011). As in countries such as the UK (e.g. Agapiou *et al.*, 1995; MacKenzie *et al.*, 2000; Dainty *et al.*, 2005) and the USA (Srour *et al.*, 2006), skills shortage is a lingering issue faced by the construction industry in New Zealand (Lobo and Wilkinson, 2008; Wilkinson, 2001). There are specific engineering skills that have been continuously listed on the Long Term Skill Shortage List[1]. These skills include civil engineers, geotechnical engineers, structural engineers and transport engineers. In the construction and building sector, a survey undertaken by The Department of Labour (2004) identified genuine skill shortages[2] in 15 trades. Of these, electricians, brick layers and plumbers were skills which construction employers found it increasingly difficult to recruit. In recent years, another skill that has been reported by the construction industry as being in high demand is construction project manager (Productivity Partnership, 2012).

Le Masurier and Hodgkinson (2006) and Lobo and Wilkinson (2008) have identified the factors causing skills shortages in the New Zealand construction industry. These factors included erratic apprenticeship schemes, poor public image of the industry, and an emphasis on a high-tech knowledge economy by the government to the detriment of construction industry training. In parallel with research initiatives, the New Zealand Government has made efforts in aligning the requirements of construction skills development with a national skills agenda. The agenda primarily focussed on reforming training schemes (Constructing Excellence, 2008; Productivity Partnership, 2012), reinforcing health and safety (Department of Labour, 2011) and standardising "best practice" for human resource management for construction firms (Edgar, 2002; Klein, 2004).

There were changes in construction skills requirements as the national skills agenda rolled out. In 2009, the Ministry for the Environment emphasised the need to achieve greater sustainability in the built environment. The call for sustainability has led a demand for more eco-friendly and sustainable design, standards, products and processes in construction. In addition, technological changes in the past decade have also affected the New Zealand construction industry in relation to prefabrication (Chris, 2009), energy efficiency (Hoque, 2010; Kestle and Rimmer, 2010) and the management of construction projects (Wilkinson, 1998, 2001). As a result, a need for a range of new skills in relation to such changes has emerged.

2.2 Effects of external shocks on construction employment

In a report commissioned by the World Bank, Marzo and Mori (2012) described how different external shocks, including economic crisis, pandemic, natural disaster and conflict, impact local communities. An investigation into the effects of natural disaster on labour markets shows that disasters differ from other shocks and disturbances to a local economy and workforce. A labour market can be fundamentally changed due to the restructuring of economic activities as a consequence of the disaster itself or by the reconstruction process (APEC, 2013). In the aftermath of a major disaster, where the operational environment is

often uncertain, complex and dynamic, the "business as usual" way of managing labour resources may not be applicable (Chang *et al.*, 2011a, b).

Unlike an economic crisis, a major disaster often causes significant damage to buildings and infrastructure. The construction sector may also be directly affected by natural events in terms of staff casualties, damage to premises and loss of revenue (Craigie *et al.*, 2012). While disasters may directly affect some economic sectors, post-disaster reconstruction can create employment opportunities in construction (Venn, 2012). In a post-disaster environment, there is strong pressure to act quickly to get back to normal (Johnson and Olshansky, 2013). Under such pressure, the need to replace lost housing, building and infrastructure facilities often generates a demand surge for labour (Chang *et al.*, 2012; Olsen and Porter, 2013). Depending on its pre-existing labour capacity, however, post-disaster skills shortages may arise or escalate during post-disaster reconstruction (Chang *et al.*, 2012; Jha *et al.*, 2010; Moe and Pathranarakul, 2006).

During the Queensland floods in Australia in late 2010 and early 2011, for example, the construction sector sustained a 12 per cent revenue loss which was among the highest when compared to other industries (CCIQ, 2011). The industry also faced severe competition from the mining sector for skilled workers in undertaking post-flood reconstruction (Queensland Reconstruction Authority, 2011). This is also the case in other disaster-affected countries such as Indonesia and China, where competition for limited manpower was a major issue that compounded skills shortages post disaster (Chang *et al.*, 2010, 2012). Consequently, the construction labour market becomes less efficient in matching skills required by employers and those of job seekers (Craigie *et al.*, 2012).

The interplay between the pricing mechanisms and industry pooling of resources also influences the capacity of the construction industry to respond to major disasters (Wein and Rose, 2011). Revised building codes and standards, regulatory requirements, construction innovation, environmental concerns, an altered housing culture and budgetary constraints tend to combine to require new skills sets for building a more resilient built environment (Chang-Richards *et al.*, 2013; Chang *et al.*, 2010). All of these changes which occur in the wake of a major disaster present resource challenges which require a coherent, overarching strategy of the construction sector (Bosher, 2014).

A study into the cyclical performance of the New Zealand construction industry revealed that with almost full employment levels coupled with net migration effects, it is difficult for construction companies to undertake workforce planning (Allan and Yin, 2010). Previous economic cycles have had a particular impact on the New Zealand construction labour market. In boom conditions, skilled workers were usually attracted to other industries or overseas to countries such as Australia and the UK, which had closely coupled economic cycles. In recession periods, however, skilled workers were also attracted overseas for better job opportunities (Bollard and Hunt, 2008; PWC, 2011). The New Zealand construction industry has a labour turnover rate of over 20 per cent on average (CIPD, 2007). High turnover creates further difficulty in workforce planning and increases the costs of recruitment and training.

During the 2008/2009 global economic crisis, the New Zealand construction industry was amongst the hardest hit, with employment down by 5 per cent from 190,000 to 181,000 by June 2009 (Department of Labour, 2009). The downturn had an impact on the number of construction apprentices which is vital to the productivity of the sector. According to the New Zealand Building and Construction Industry Training Organisation (BCITO, 2008), construction employment peaked in June 2007 and experienced a significant fall in the number of new apprentices as a result of the financial recession in 2008.

The 2010 and 2011 earthquakes in Christchurch and the subsequent high demand for labour presented an opportunity for the construction sector to revive itself from the global recession. However, the complexity of the post-earthquake situation has rendered accurate

forecasting of skills needs extremely difficult (CESB, 2011). It was estimated that reconstruction might challenge the industry's already strained labour capacity (PWC, 2011).

Against this backdrop, the research reported in this paper uses an empirical approach to investigate the skills challenges faced by construction organisations in Christchurch. The study was undertaken longitudinally over an extended period with a view to tracking the changes in skills requirements post-earthquake. Empirically, the purpose of this research is to provide an improved understanding of skills issues that likely face the construction industry in a large disaster event, thus enabling better resource planning in response to future events.

3. Research method

A mixed method approach, namely, triangulation, was adopted for this research due to the nature of the inquiry. Creswell (2003) suggested that triangulation suits research that involves collecting data either simultaneously or sequentially to best understand research problems. The methods used for data collection in this study were an online questionnaire survey of construction organisations, field observations, interviews, and focus groups. According to Chang (2010), basic quantitative descriptions can provide a valuable baseline background to help identify issues for a more in-depth, qualitative or quantitative study for a particular event. Therefore, the quantitative method, namely, a questionnaire survey along with statistical analysis, was employed at the first stage to identify the skills challenges faced by construction employers in Christchurch and the critical factors they perceive have affected their skills availability.

By undertaking a series of field visits to Christchurch, observations and interviews were used as a follow-up to ascertain issues and potential shortages over time. Three focus groups in the form of research workshops were convened to gain further insight into the feedback provided by the survey and interview sessions. Selected representatives from the construction organisations interviewed and from the reconstruction-related agencies were invited to participate in the focus groups. The workshops allowed the researchers to meet research participants, ask questions of them and identify the changes in capacity reserves and shortages in relation to the earthquake recovery. Focus groups were also used as an instrument for clarifying conclusions reached from prior study sessions and validating research data (Krueger and Casey, 2000). The research was approved by the University of Auckland Human Participants Ethics Committee in October 2011, reference number 7,520. To maintain confidentiality, the organisations interviewed were coded. Details of the data collection methods for this research and the codes of organisations interviewed are shown in Table I.

Between October 2011 and January 2012, an online questionnaire survey was conducted to assess the skills needs of construction organisations in Christchurch. The questionnaire classified skills sets according to the Australian and New Zealand Standard Classification of Occupations (Australian Bureau of Statistics and Statistics New Zealand, 2006). The occupations selected for use in the questionnaire were further examined by a senior economist based with the Building Research Association of New Zealand. Survey respondents were asked to select and rank the types of human resources that were in short supply. Semi-structured questions were designed to investigate other labour resource challenges faced by construction organisations and the factors that affected their ability to acquire the desired skills.

The key strategy used for selecting the sample was that organisations came from a spectrum of areas of the New Zealand construction industry. Therefore, the survey sample was selected from the New Zealand Construction Industry Council (NZCIC) membership database. Sample organisations were all based and operated in Christchurch and registered with regional industry bodies under the umbrella of NZCIC. Invitations to

Objectives	Data collection methods and codes of interviewed organisations
(1) To identify the skills challenges faced by construction employers in Christchurch and the critical factors that affect their skills availability	(1) Online questionnaire survey of construction organisations in Christchurch between October 2011 and January 2012 (sample size 155, 61 organisations responded to the survey with a response rate of 39%) Respondents consisted of: 4 building supplies companies (i.e. equipment supply, material supply) 17 contractors (i.e. builders, trades and sub-contractors) 31 consulting companies (i.e. engineering, architecture, quantity surveying and project management) 9 earthquake-related project management organisations (i.e. Housing recovery projects and infrastructure recovery projects)
(2) To understand the effects of earthquakes on the construction sector in terms of skills shortages (3) To ascertain emerging issues and potential shortages over time	(2) Interviews with 33 key stakeholders from 24 Christchurch recovery agencies and large construction companies during 3 field visits in May, November and December 2012, including: 3 design organisations (D1-D3) 5 structural engineering consultancies (E1-E5) 1 large geotechnical engineering company (G1) 5 construction contractors and builders (C1-C5) 2 building supplies companies (Bs1 and Bs2) 5 Project Management Offices (PMOs) (PMO1-5) 1 Building Industry Association (Bi1) 2 Government departments (Building and Housing Group & Labour Group in the Ministry of Business, Innovation and Employment) (G1 and G2)
(4) To consolidate and verify interview and survey data and gain insights into the skills issue in Christchurch	(4) Focus group with 9 representatives from Christchurch recovery agencies and construction organisations during 3 field visits on 12 September 2012, 13 November 2012 and 23 July 2013, consisting of (coded Fr1-Fr9): 1 representative from the Building Research Association of New Zealand (BRANZ) 1 representative from the infrastructure reconstruction project office 1 representative from the housing recovery and repairs project office 2 representatives from building supplies industry 1 business manager from a local construction company 2 project managers from two large contractors 1 representative from the Canterbury Earthquake Recovery Authority (CERA)

Note: Canterbury Earthquake Recovery Authority (CERA) was established by the New Zealand Central Government to manage the overall recovery and reconstruction in Christchurch following the 2010 and 2011 earthquake events (http://cera.govt.nz)

Table I.
Methods of data collection

participate in the survey were sent via the NZCIC internal mail system, targeting NZCIC member organisations in the Canterbury region. Of a sample of 155 NZCIC Christchurch construction organisations, 61 responded to the survey with a response rate of approximately 39 per cent.

Of 61 surveyed organisations, 24 were selected for follow-up interviews. In 2012, interviews with 33 key stakeholders from Christchurch construction companies and recovery agencies were conducted over three field visits in May, November and December 2012, respectively. Qualitative data from the perspectives and insights of these participants were captured, including:

- impact of the earthquakes on the skills shortages and wider construction industry; and
- emerging issues and potential resource shortages over time.

In September 2012, November 2012 and July 2013, focus groups in the form of research workshops were organised by the researchers in Christchurch, investigating the validity and applicability of the research findings. In general, focus groups provided a practical perspective on what the implications of the research findings were, and how the participants could actively use the information. Discussions with these industry representatives were important in terms of establishing the value and relevance of this research. Secondary data provided by the government and the construction industry were also studied to supplement research data in order to draw an in-depth picture of how the issue of skills shortages was handled, as well as its effects on wider recovery. The questionnaire survey results were analysed using Excel's statistical descriptive tool, whereas the interview records were transcribed, coded and analysed using NVivo 9 qualitative data analysis software.

In this paper, data analysis was undertaken at two levels. The first level dealt with the results from the questionnaire survey. This analysis answers the research question as to the skills challenges posed by the earthquakes to the construction industry and the factors that affected their resource availability. The second level dealt with the assessment of changes over time in order to capture the effects of longer-term reconstruction on construction skills needs. The analysis focussed on the longitudinal qualitative data generated from interviews and focus groups. The diachronic analysis of the conditions and emerging issues reveals the changing dynamics in organisational resourcing practice during post-earthquake reconstruction. The presence of data such as examples, comments and suggestions in the paper was approved by the related respondents. In what follows, the research results are presented in the form of a synthesis of quantitative and qualitative results using coding as shown in Table I.

4. Research results

4.1 Skills challenges faced by construction employers

The respondents to the questionnaire survey represented a range of organisations of varied type and size (Table II). The size of the organisation was pre-defined in the survey in terms of the number of employees. Approximately 41 per cent of respondents were from large

Construction organisations	Frequency	Percentage
Business category		
Design company	2	3
Consulting company	28	46
Construction company	17	28
Consenting organisation	1	1.5
Building supplies organisation	4	6
Construction project client and project manager	9	15.5
Organisational size		
Sole trader	10	17
Micro-sized (Ep $\leqslant$ 10)	11	18
Small-sized (Ep $\leqslant$ 50)	13	21
Medium-sized (50 $<$ Ep $\leqslant$ 100)	2	3
Large-sized (Ep $>$ 100)	25	41
Number of construction projects		
Reconstruction	70	29
Repair	86	35
Demolition	23	9
Non-quake related, business as usual	66	27

Note: Ep denotes the number of employees

Table II.
Profile of the questionnaire respondent organisations

organisations with more than 100 employees. 21 per cent of the organisations represented were small organisations with 50 or fewer employees, and 18 per cent of respondents were from micro-sized organisations with ten employees or fewer. 17 per cent of respondents were self-employed sole traders. Each organisation was asked to list the types of construction projects in which they were involved at the time of the survey. This was to measure the level of their existing work commitments and the level of earthquake-related work. It was found that a large proportion of projects undertaken by the surveyed organisations were earthquake-related (73 per cent) with the rest being non-quake related, business-as-usual building projects (27 per cent).

The shortage of human resources was determined by the questionnaire. Respondents were given a list of skills types required for the Christchurch earthquake reconstruction and were asked what the capacity shortages would be and the level of difficulty in acquiring such skills. Survey results show that the skills shortages appeared primarily in engineering and trades. The average shortfall was approximately 30 per cent of demand for the top ten "problematic" skills (Figure 1). The most-needed labour included structural engineers and geotechnical engineers with more than 10 per cent of respondents reporting such shortages. This was followed by draughtspersons, electrical engineers, mechanical engineers, resource and environmental engineers, carpenters, painting trades, electricians and building services engineers.

Interviews with construction organisations in May 2012 confirmed that the major issues noted in the questionnaire survey remained current. Discussions with interviewees further revealed that the skills shortages largely existed in the engineering sector which played a major role in structural and land assessment in the immediate aftermath of the earthquakes. Engineering employers specifically required personnel with engineering skills experienced in dealing with seismic-related damage. Shortfalls in structural and geotechnical engineers were expected to be met from imports from other earthquake-prone countries such as the USA, Chile and Italy. However, many questionnaire respondents (65 per cent) reported that "poaching" labour from other construction companies had intensified since the earthquakes. There was a consensus among the interviewees that quality control personnel, particularly site project management and supervisory staff would become "pinch resources" as Christchurch moved into the stage of long-term recovery and reconstruction. Field observations and the focus group in July 2013 confirmed that this concern had eventuated since early 2013.

Most organisations in successive interviews in 2012 reported that increased workloads from the earthquake-related repairs and rebuild had overwhelmed their

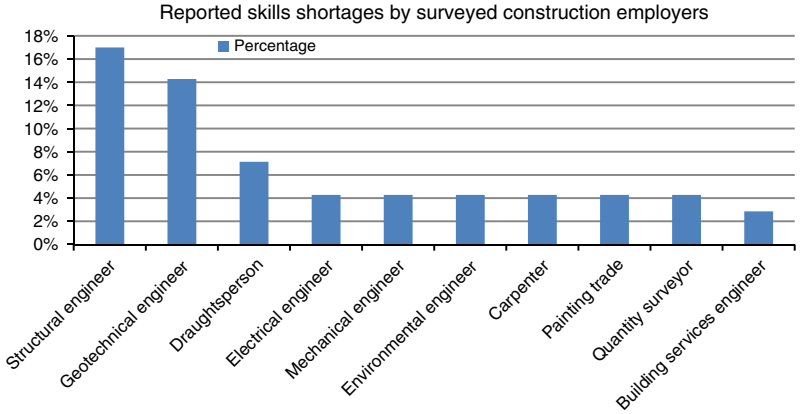

Figure 1.
Top ten construction skills with capacity shortages

existing capacity and they found it difficult in fulfilling their existing work commitments. As interviewee E2 described:

> A significant proportion of our resources was directed to the quake-related jobs. Most of our staff have been working overtime and juggling between our existing projects prior to the earthquakes and new projects as a result of the quakes. Our capacity was so much over-stretched that we had to turn away any new projects that came along.

Small to medium sized companies (E1, E2, D3 and C4) sensed that skills constraints may have limited the growth of their business. Other challenges consistently reported by the interviewees over three interviews included the well-being of their employees. According to some interviewees (D1-D3, E5, G1, Bs2, C1, C4 and PMO2), skills shortages, accompanied by increased workloads, had put more stress on the delivery of projects in terms of quality and timeline, and also impaired their staff morale. Some companies (e.g. E1, E5, C5 and D2) expressed their frustration at the need for repeated advertising for staff and time spent on filling vacancies. There was a sense of time and money being wasted finding the skills required both in terms of quantity and quality for their projects.

The focus groups in September and November 2012 further highlighted the fact that certain impacts of skills shortages, such as overtime and increased recruitment costs, have a negative impact on an organisation's growth and productivity. It seemed that construction employers in Christchurch were commonly faced with challenges posed by the disproportionately increased workloads relative to their operational levels in normal times. One focus group participant, Fr5, raised his concern over the staff well-being issues such as fatigue, stress and low productivity observed in his company. This situation, however, was compounded by the fact that some employees were themselves also affected by the earthquakes and were struggling with recovery demands at a personal level. Both interviews and focus groups that were conducted in 2012 indicated that managing staff well-being following the earthquakes was one of the biggest challenges facing construction organisations.

4.2 Critical issues that impinge upon post-earthquake skills availability

Questionnaire participants were asked what they perceived were the factors that affected the availability of skills. Respondents were also asked to rank the top-five factors. Results from the questionnaire showed that the top-five critical factors included limited technical capability in New Zealand nationwide, the shortage of temporary accommodation to house non-local workers, time needed for trainees to become skilled workers, lack of reconstruction workload information from recovery agencies, and lack of operational capacity within construction organisations to accommodate additional resources (Table III).

Interviews show that the major reason for the shortages of skills in undertaking reconstruction-relate work was a lack of technical capability and expertise in the country as a whole. Interviewee E5 suggested that:

> New Zealand has never had a large technical base in seismic design and in dealing with quake-related liquefaction, and this capacity strain already existed at the time of the earthquakes.

Table III. Critical factors affecting the construction skills availability

Rank	Factor	Frequency	Percentage
1	Limited technical capability in New Zealand nationwide	55	90
2	Shortage of temporary accommodation to house outside workers	49	80
3	Time needed for trainees to become skilled workers	45	74
4	Lack of reconstruction workload information from recovery agencies	40	66
5	Lack of organisational capacity to accommodate additional resources	32	52

Participants (Fr1-Fr2, Fr5, Fr7 and Fr8) in the focus group in September 2012 emphasised that, in spite of a strong desire to use local resources and skills, construction organisations had to turn to offshore recruitment for specific professional and managerial expertise.

When asked what initiatives were taken in response to skills shortages, there was a difference in the responses of large companies and smaller ones. Several large organisations (E3, E4, C1-C3, D2) reported they were supporting industry workforce planning by sitting on the Canterbury Employment and Skills Board and liaising with recruitment agencies, schools and other training bodies, and also with Immigration New Zealand. In comparison, small organisations preferred resource-sharing, setting up a partnership with other domestic or overseas companies. The potential benefits of this resource-partnering mechanism, according to some interviewed organisations (E1-E2, D3 and C4), were that:

> Small organisations were able to quickly gain the resources and capacity advantages by utilising existing capacity elsewhere, without worrying about the size of the company and the skills constraints.

The second ranked factor affecting skills availability (identified by 80 per cent of respondents) was the shortage of temporary accommodation for housing the construction workforce. This was a major concern among interviewees given the significant housing damage caused by the earthquakes. It was estimated that over 150,000 homes, or about three-quarters of Christchurch's housing stock, sustained some damage (Earthquake Commission, 2011). A projection of labour demand showed that around 24,000 additional construction-related workers would be required at the peak of the recovery (CESB, 2011). The sheer amount of housing needed to accommodate additional workforce posed a big challenge to the construction industry. Interviewee C5 emphasised that:

> The shortage of temporary accommodation in Christchurch was a major constraint for us (the company) to attract skilled people from outside. Many builders seeking work were reluctant to move to the region because of the accommodation problems.

Interviews in November 2012 also raised concern over the potential adverse effects of displaced homeowners and the construction workforce competing for limited housing resources. To accommodate the projected size of the workforce, the focus group in November 2012 suggested that approximately one community in eight would need a sizable lodge (workers village). The willingness of communities to absorb this inflow of workers, however, according to focus group participant Fr9, was the major issue that the local authority should consider in addressing the dual effects of housing crisis and skills crisis.

Another top factor accounting for the reconstruction skills shortage was the time required for trainees to become skilled workers. This was identified by 74 per cent of respondents. The government continued with its skills programmes after the earthquakes but the question raised during the follow-up interviews was, "Are we training enough people in the right sectors to address the skills shortages for the reconstruction?" Interviewee G1 lamented that these training initiatives may take too long to produce workers when the industry needs them most. This sentiment was echoed in the focus group held in November 2012. Representative Fr5 from a local construction company made the following statement:

> The skills learning process in the construction sector cannot be simply fast-tracked. People we need most in Christchurch are those who are senior and have had earthquake design experience before. It takes at least three years for a graduate structural engineer to become competent in building design and capable of communicating with clients. Skills training should've started three years ago before the earthquakes.

The fourth-ranked factor, by 66 per cent of questionnaire respondents, was a lack of reconstruction workload information from recovery agencies. Field observations and interviews made it clear that the delays caused by complexities around land zoning

decisions and insurance pay-outs created an information "vacuum" for the construction industry. It seemed that there were inconsistent workflow figures released by government and recovery-related agencies to the construction organisations operating on Christchurch reconstruction projects. Interviewees from smaller companies (E1, D3 and C4) noted that the slow pace of reconstruction was affecting their cash flow and further affecting the pace and number of people they could employ. The focus group in July 2013, in particular, highlighted that the lack of information as to when projects are going to market and the resources they may require had a detrimental effect on workforce planning in the construction sector.

A lack of operational capacity of construction organisations in response to workforce growth was another key resourcing barrier identified by more than half of surveyed organisations (52 per cent). Interviews in December 2012 suggested that this factor, combined with a high turnover rate in the sector, had an impact on companies' ability to work efficiently. The questionnaire survey also revealed that the majority of respondents who ranked this factor as critical were small to medium sized companies. Interviewee E2 explained:

> Most companies in the construction sector are relatively small in size. Many project opportunities in the reconstruction had somehow inspired SMEs to grow their businesses. But the capacity of these businesses was still limited, like they tend to have small or micro-sized financial systems, office facilities and HR (human resource) systems; this capacity couldn't match the growing number of staff.

Interviews in December 2012 also revealed that workforce expansion across the interviewed organisations was 30 per cent on average above the pre-event level. In many cases, smaller companies increased their number of employees by more than 50 per cent. The focus group in July 2013 voiced the concern that such a growth was not sustainable. More and more companies encountered congestion and communication difficulties caused by having a larger workforce than they could efficiently deal with. As interviewee C4 reported:

> Rather than saying we have "gained" from workforce expansion, we actually have "lost" the ability to operate efficiently due to the space and communication issues. We were talking about the competence of people, but somehow lost the sight that, as a company, we need competency to manage our people.

5. Discussion

The types of skills that were subject to shortages during the Christchurch earthquake reconstruction were similar to those of normal times. According to Comerio (1998), disasters do not completely change pre-disaster economic conditions; instead they simply magnify trends or conditions in place before the disaster strikes. This was the case in Christchurch, where the pre-existing shortages for both structural and geotechnical engineering occupations, along with the specialist trades associated with housing and infrastructure construction, and project management professionals seemed to be intensified by the earthquakes. Research findings show that the earthquakes had changed the landscape of employment requirements and compounded the skills shortages in the construction industry.

An apparent challenge facing the construction industry was to do with the nature of damage caused by earthquakes (Bosher, 2014; Dainty and Bosher, 2008). In fact, the perennial paucity of skilled personnel with experience in seismic design and land liquefaction failed to draw sufficient attention prior to the earthquakes. This is perhaps due to the fact that New Zealand had had no event of this nature before which requires large numbers of seismic professionals (IPENZ, 2012). However, the resourcing challenges facing engineering companies, as identified in this study, created a sense of urgency to embrace an all-hazard educational element into the engineering programmes offered by tertiary education and training organisations.

It was found that earthquakes caused additional participation barriers such as the lack of accommodation and psychological well-being issues for individual workers. This result is in

line with the findings from an APEC-commissioned report which examined the effects of disaster events on labour market participation (APEC, 2013). Employee well-being issues, as highlighted in the interviews, including stress, fatigue, trauma from earthquakes, together with other family concerns which construction employees had, particularly affected the capability of construction organisations. Page (2004) suggested that the ability of the industry to respond to disaster events also depends on the level of existing work commitments throughout the country. In the case of the Christchurch earthquakes, however, a degree of resource priority appeared to have been given to reconstruction projects over business-as-usual projects. The low level of activities in the construction sector during the pre-earthquake recession might be a reason for organisations to increase their involvement in post-disaster recovery (PWC, 2011).

A basic assumption in neoclassical economics is that market forces will direct resources to the recovery zone (Hallegatte and Przyluski, 2010; McGee, 2008). Long-term observations in Christchurch show that government policy in providing assistance to the construction workforce is also critical in ensuring skills availability. As Chang *et al.* (2012) suggested, the effective resourcing for post-disaster reconstruction depends somewhat on the competence of construction organisations and government's facilitation in the reconstruction. The shortages in temporary accommodation, as shown in this research, exacerbated the local shortage of resources, imposing time and cost repercussions on reconstruction. Similar to the situations in Australia following the Victorian "Black Saturday" bushfires in February 2009 (Chang-Richards *et al.*, 2012) and in New Orleans, in the US post-Hurricane Katrina (Fletcher *et al.*, 2007; NAHB, 2005), few housing options in the disaster areas had limited Christchurch's ability to attract and retain the workforce that is essential for restoring the damaged built environment.

According to Jha *et al.* (2010), construction skills needed for disaster reconstruction can be met by giving priority to training, developing new entrants to the industry and using the existing workforce, balanced by importing appropriately skilled internal and external migration. However, it appears that training was not the panacea to solve the problem of skills shortages in post-disaster Christchurch. There was a tension between the time needed for training competent workers and the urgency for responding to the upswing in building and construction activity. Skills import, therefore, became a popular approach adopted by the construction organisations studied. This situation resembled that of Aceh, Indonesia when rebuilding its communities after the devastating tsunami in 2004. While there was a substantial number of contractors (95 per cent) from Java, the issues which emerged during the reconstruction in Aceh, such as differences in building standards, workmanship, lifestyle, climate and even language, added difficulty for construction organisations in managing their workforce effectively (Chang *et al.*, 2011a; Dercon, 2007; Zuo *et al.*, 2008). The impact of large skills migration after the earthquakes in Christchurch, however, remained untested and need to be further investigated.

Findings from this research showed that information asymmetry compounded the construction labour market problem. As opposed to normal circumstances, operating in an environment of considerable uncertainty often involves inadequate information sharing between the decision makers and construction professionals (Allan *et al.*, 2008; Howes, 2000; McGrath-Champ *et al.*, 2011). One of the main reasons for information delays in Christchurch concerned the decisions regarding land and structural assessment. This is consistent with findings by Wamsler and Lawson (2011) who recognised that timely demand information from recovery agencies (e.g. government and insurance companies) on repairs and reconstruction is critical to the response of the construction industry. Evidence in this research suggested that the time aspect of the reconstruction was a significant factor that affected the demand for recovery in Christchurch. When faced with "patchy" workflows, without having information about future construction workload, construction organisations faced difficulties in skills development and forward workforce planning.

6. Conclusion and recommendations

Skills development is fundamental to the development of the construction industry (Fox and Skitmore, 2007). Based on a questionnaire survey and in-field investigations in Christchurch during its recovery from the 2010/2011 earthquakes, this study sheds light on the sorts of resource challenges faced by the construction industry responding to the demand for large-scale reconstruction. By surveying construction employers operating in Christchurch, this paper has focussed on identifying the factors that affected skills availability for disaster recovery projects in order to gain insights into the effects of a large earthquake event on construction skills development.

The research findings show that skills shortages post-earthquake existed in seismic assessment and design for land and structures, certain trades, project management and site supervision. Difficulties in acquiring these resources that were traditionally on the list of construction skills shortage were intensified due to the significant demand created by earthquake reconstruction. Growing work demands from the recovery, increased competition for skilled labour, and staff well-being issues were additional challenges faced by construction organisations. Despite various resourcing efforts, five top factors, namely, limited technical capability nationwide, shortage of temporary accommodation for housing additional workers, time needed for trainees to become skilled workers, lack of information about reconstruction workloads and a lack of operational capacity within construction organisations were identified as critical constraints to the resourcing of disaster recovery projects.

A triangulation method provides a multi-perspective view of the construction organisations on the skills issue in disaster recovery. Findings show that the "problematic" skills identified in this research were subject to shortages prior to the earthquakes. This means that post-disaster resource availability intrinsically links to the pre-planning and preparedness of the industry for disaster events. For countries such as New Zealand where there is a limited resource pool and a large number of additional workers will be needed after a major event, the housing needs of external reconstruction workforce should be considered by recovery agencies. The critical human resources required for reconstruction will inform workforce planning in the construction industry to establish appropriate retention and training arrangements. Factors that affected the availability of these critical resources serve as directions for reconstruction stakeholders to design supporting measures to reduce the impact of fluctuating demands on skills development.

The study of the earthquakes in Christchurch reveals most of what we know that distinguishes post-disaster recovery processes from similar processes in normal times. This paper also offers lessons to help academics and industry practitioners to think about how the effects of a large disaster can change their normal lenses when viewing skills development in the construction sector. The following recommendations are suggested based on the research findings:

- To facilitate proactive workforce planning within organisations and sustainable skills development in the industry, reconstruction demand data should be shared with the construction sector. Construction companies, especially those small- to medium-sized firms, should consider what level of business maturity they need to achieve and take steps to build their workforce base by increasing operational capacity and applying improved skills management and retention practice simultaneously.
- Construction organisations should work with government agencies to develop bespoke initiatives in support of reconstruction workers, in addition to staff retention strategies used by individual construction organisations. A collaborative campaign between recovery agencies and industry groups would be ideal, including initiatives

such as increasing awareness of the well-being of the earthquake-related workforce, identification and sharing of good practices for addressing the needs of the reconstruction workforce, community events to integrate migrant workers into local neighbourhoods and collective housing assistance for the external workforce.

- Industry training organisations should scope out the broad skills required for basic reconstruction (e.g. replace linings and claddings of a damaged house, re-piling and roofing) that could be undertaken by previously unskilled or semi-skilled people by providing a short training course. A coordinated approach across tertiary education institutes should be adopted to have targeted training courses for upskilling professionals in damage assessment, architectural and structural design and construction project management. The projected number of apprentices in the industry should be fed into recovery agencies and construction organisations for workforce planning purposes.
- When the boom starts to slow as reconstruction building work nears completion, it is imperative that non-earthquake-related growth is maintained. Planning for building of major sectors, such as an improved infrastructure and transport network, housing construction and building community facilities will provide this strength. The growth and retention of employment opportunities in the construction sector will also be essential in attracting people to Christchurch.

Although the findings reported are country-specific, this research provides learnings for other disaster-prone countries where the building and construction sector is especially vulnerable to boom and bust cycles. Evidence in this paper suggested that without appropriate facilitation from the government and industry, market forces are not able to direct resources to post-disaster recovery. Successful resourcing implementation in the wake of a disaster requires capacity building in the construction sector along with facilitation from the government (Chang *et al.*, 2012).

It is hoped that this study will encourage the development and application of a shared workforce demand model considering the complexities and issues reported in this paper. The research results highlight the changing skills requirements as reconstruction proceeds. The effects of earthquake events are likely to change over time. Continued longitudinal studies of skills challenges are therefore needed, with a view to better preparing the construction sector for future major disasters.

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Notes

1. The Long Term Skill Shortage List is a list used by Immigration of New Zealand to show the occupations for which New Zealand has a sustained and ongoing skill shortage. The list is updated annually. Immigrants who are qualified and skilled in an occupation on the list may be eligible for a work visa under the Long Term Skill Shortage List Work Category. For more information, see www.immigration.govt.nz

2. Genuine skills shortages are distinguished from recruitment difficulties. Skill shortages are genuine when there are not enough skilled employees to meet demand. Recruitment difficulties, on the other hand, can mean there are enough skilled employees, but they are not willing to take on jobs at the pay and conditions offered.

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