A systems approach to managing human resources in disaster recovery projects

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Abstract

Lack of construction resources and capacity has always presented difficult challenges to the construction industry following a major disaster. In the case of the Canterbury earthquakes that took place in 2010 and 2011 in Christchurch, New Zealand, a number of factors combined to influence the post-disaster recovery environments and increase the demands for better approaches to managing human resources for reconstruction projects. By using a systems approach, this study identified the dynamics that have changed construction companies' resourcing behaviours in relation to the employment demand and supply in the Canterbury recovery. Research findings show that the limited technical capability available nationally, lack of motivation among new entrants, combined with high turnover rate, had accounted for socially produced skills shortages in Christchurch. This shortage was further compounded by factors such as the shortage of temporary accommodation, time lags of training and a lack of information about reconstruction workloads from the recovery agencies. The study suggests that the design of policy instruments in managing human resources in Christchurch should be informed by a detailed understanding of the dynamics that mediate between policy objectives and outcomes over time. A systems approach should be applied to increase the efficiencies in resource management in the continued reconstruction.

Keywords: Systems dynamics, Human resources, Disaster reconstruction, Construction firms, Christchurch

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1. Introduction

The gradual shift in modern concept of 'building resilience' that has occurred over the past decade is having far-reaching implications for the construction industry who plays a pivotal role in disaster risk reduction and carrying out the post-disaster reconstruction tasks. In many countries, disaster recovery projects are given equal or even more priority over other development projects. Compared to conventional construction projects, disaster recovery construction projects are seen as requiring different management and delivery systems [1, 2]. In particular, disaster recovery construction projects following a large disaster tend to have resource challenges [3, 4] and capability issues [5].

When the Darfield earthquake struck Christchurch in 2010, the New Zealand construction industry was going through a recessional period of low activity caused by the 2008 global financial crisis. Many construction businesses had managed to come from the bust of economic cycle and aiming for a reviving opportunity in post-earthquake reconstruction [6]. Nevertheless, the shortage of skills is a recurrent problem in the New Zealand construction industry [7, 8]. And there was a limited pool of professionals in the country who had the experience of seismic assessment and design. The Canterbury region subsequently suffered a sequence of aftershocks. The earthquake of magnitude 6.3 on 22 February 2011 was the most severe, taking the lives of 185 people and causing buildings to collapse, further damage to infrastructure and widespread liquefaction [9]. High pressures of skills needs in undertaking the reconstruction following the earthquake events raised questions concerning how these skills needs can be met given the limited resource pool in New Zealand construction sector [10].

A number of factors such as the change of the building standards [11], insurance pay-out [12] and the decisions made by the Immigration New Zealand on Canterbury Skills Shortage List[1], combined to influence the post-disaster recovery environments and increase the demands for better approaches to managing human resources for reconstruction projects. By using a systems approach, this study aims to identify the dynamics that have changed construction companies' resourcing behaviours in relation to the employment demand and supply in the Canterbury recovery. The study was undertaken longitudinally with 15 construction organizations over an extended period. Research findings from this study is hoped to provide insights into future disaster response with respect to addressing the problem of rebuilding capability.

[1] The Canterbury Skills Shortage List (CSSL) highlights occupations in shortage that are needed during the rebuild in Canterbury region (area of South Island), and facilitates the grant of temporary work visas for those occupations. For more information, see http://www.dol.govt.nz/immigration/knowledgebase/item/4551

2. The construction industry skills shortage

Having a skilled, well-trained and productive workforce has always been central to the construction sector's growth and success [13-15]. The literature reveals a number of factors which have impinged upon the construction skills problem (See Table 1).

Table 1: Contributing factors that shape the skills problem in the construction industry

Category	Contributing factors
1) Contextual factors	• Workforce aging and demographic downturn • Reduced numbers of young people entering the construction sector • Technological changes • A lack of investment in skills development
2) Structural factors	• Absence of human resource management strategies at a project level • A lack of partnership between sector employers and training bodies • Low levels of training • Increased casual self-employment and sub-contracting • Rigidity of skills divisions
3) Inherent factors in the construction industry	• Poor image of the industry • Poor perception of pay and workplace conditions • Working practices • Cyclical labour demand • Fragmented, transient and heterogeneous workforce structure • Fragmentation between training provision and employment

Context-specific factors included such as workforce aging and demographic downturn [13, 16], reduced numbers of young people entering the construction sector [17, 18], technological changes [19, 20] and a lack of investment in skills development [21]. Structural factors causing construction skills shortfall included the absence of human resource management strategies at a project level [22], a lack of partnership between sector employers and training bodies [23, 24], low levels of training [7, 25], increased casual self-employment and sub-contracting [26, 27] and the rigidity of skills divisions [28].

Adding to the list are factors in relation to the very nature of construction industry, including the poor image of the industry [29, 30], especially regarding the pay and workplace conditions [31]; working practices [32]; cyclical labour demand [33, 34] and often fragmented, transient

and heterogeneous workforce structure [35, 36]. Above all, Dainty et al. found that fragmentation that flows from the structure of training provision and employment is likely to narrow the industry's skills base and reduce innovation within the sector [17].

By comparing construction industry concerns 50 years apart, O'Donnell et al. concluded that how to attract and develop apprentices and graduates remained to be a major industry concern [37]. Chan and Dainty [14] suggested that genuine skills improvement requires a sustained effort to understand the practical realities of skills provision at a project level. Lobo and Wilkinson [7] advocated a focus on examining the efficiency of skill level in the existing workforce, rather than quantity of skills. In practice, there has been a shift of emphasis from top-down labour market policy measures towards demand-led skills development systems [35, Dainty et al., 38]. This shift, however, calls for employers and employees to play a more proactive role in formalising the industry's training and employment practices if improved performance and productivity is be achieved [39, 40].

There is a growing awareness of the importance of skills development among construction organisations as a means of improving productivity [35, 41, 42]. Research points towards a direct correlation between skills, productivity and employment. Enhancing labour productivity was proposed by Chan and Dainty [14] as one of the solutions to alleviating the problem of skilled labour shortages in construction. This view, however, emphasised the efficacy of skills utilisation and development, rather than increasing their supply. Other solutions to addressing skills crises have been used in the past, primarily in such areas as training [25, 31], multi-skilling [43], industry promotion [13, 14], employing migrant workers or outsourcing [28], and the development of new technologies and construction techniques [44]. However, as Dainty et al, suggested such measures are difficult to sustain unless backed by a bespoke regional labour market approach [17, 45].

3. Resource issues faced by construction organisations post-earthquake in Christchurch

Past disaster events have shown that in the aftermath of a major disaster where the operational environment is often uncertain, complex and dynamic, the "business as usual" way of managing resources may not be fully applicable [46, 47]. In a post-disaster environment, there is strong pressure to act quickly to get back to normal [48]. Under the pressure of limited time, the need to replace lost housing, building and infrastructure facilities often generates a demand surge for labour [49, 50].

According to Dainty et al. [51], workforce planning models need to take account of a wide range of factors determining both labour supply and demand. However, the complexity of the post-earthquake situation has rendered accurate forecasting of skills needs extremely difficult. Variations in the size, speed and scope of reconstruction had a marked effect on the employment practice which further influenced skills demand [52]. In the case of New Zealand,

despite a relatively brief hiatus created by the global financial crisis, significant skills shortages have re-emerged from the earthquakes. The construction sector has moved from bust to boom and the employment situation in construction has dramatically changed [53].

Construction organisations, largely being labour-intensive, are more influenced by human resource effects. Following the 2010/11 earthquakes, construction organisations in Christchurch experienced major resource shortages for both post-quake damage emergency response and reconstruction stages [54]. Ongoing aftershocks caused structural and land inspection professionals to be constantly diverted from existing jobs to new damage [55, 56]. A questionnaire survey commissioned by the Resilient Organisations between October 2011 and January 2012 revealed that resource pressures experienced by the construction organisations in Canterbury region were primarily from human resources associated with structural, architectural and land issues. And the three most frequently reported 'problematic' human resources were: structural engineers, geotechnical engineers, and draughtsperson [54].

A follow-up survey in 2013 showed that as the reconstruction progressed, many construction organisations started encountering difficulty in finding suitable project management expertise such as site engineers, project managers and quantity surveyors [57]. Some engineering consultancies have reported ongoing issues with sourcing workers of high skill levels [53]. Since the September 2010 earthquake, young engineers and mature project management skills from Europe continue to be the largest inbound demographic group involved with the rebuild in Christchurch [56, 58]. At the same time, there has been an inflationary impact which flows through to higher property rents, and makes attracting tradespeople from other parts of New Zealand harder [59].

Against this backdrop, this research attempts to investigate the dynamic factors that influence the resourcing behaviours of construction organisations operating on post-earthquake projects in Christchurch. By capturing perspectives from construction organisations, this study provides an understanding of how companies are responding to a looming skills and labour shortage for the Canterbury rebuild and how their resourcing approaches might affect the environment where they operate. The research methods used, the findings from this research along with a discussion are presented in the remaining sections. This paper concludes by reflecting on the implications of research findings for future studies.

4. Research Methods

4.1 Case study method

A case study method was adopted for this research due to its theory-building nature [60, 61]. As proposed by Yin [62], the case study design develops an empirical approach to research of a contemporary phenomenon within its own context. Longitudinal case studies of construction

organisations can provide insights into how hiring strategies across the construction industry and their strategies for workforce development will change as the landscape of Christchurch changes. The selection of case study organizations was based on criteria such as: the type of organization, size2, business characteristics, and involvement in the earthquake recovery process.

The key strategy used for selecting the sample was that all organisations would come from a spectrum of areas of the New Zealand construction industry. The case study 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. In December 2012, 15 case study organisations were selected to participate in the research. The chosen case studies collectively provided a reasonable overview of current experience with regard to the resourcing of skills for building activities [57].

In April 2014, the researchers conducted a second series of case studies with previously selected organisations. The focus of the second case studies was to examine the dynamics that influence their experiences of resourcing in Canterbury and changed business strategies since. Of 15 organisations, 10 participated in the second case studies. The reasons for the other 5 organisations not being able to participate included unavailability at the time of the case studies and absence from Christchurch operations. 3 additional organisations took part in the case studies. A total of 16 interviews were undertaken across 13 organisations in Christchurch in April 2014 (See Table 2).

Table 2: Description of organisations used for case study data collection

Types of construction organisations	Characteristics
2 Engineering consultancies	1 large size and 1 medium size (E1 and E2)
7 Contractors/builders	3 large civil contractors, 2 subcontractors, 1 home builder, 1 large construction company (C1-C7)
2 Building supplies companies	2 large concrete product manufacturers (M1 and M2)
2 Project Management Offices	Horizontal infrastructure rebuild & EQC's residential repairs (P1 and P2)

The research design and data collection methods complied with the requirements of the Human Ethics Committee of the University of Auckland (Reference number 7520). The interview records within case studies were recorded, transcribed, coded, and further analysed using NVivo 9 qualitative data analysis software. NVivo 9 coding comparison of queries allowed for

[2] The size of the organization was pre-defined in the survey in terms of the number of employees. A large organization has more than 100 employees; a medium sized organization has more than 50 but less than 100 employees; a small organization has 50 or fewer employees; and a micro-sized organization has less than 10 employees.

similar comments and suggestions being synthesised under common themes. A case study report that relates to individual organisations was sent back to interviewees for data validation.

4.2 Qualitative systems dynamics

System dynamics is a method to enhance learning in complex systems [63, p4]. Based on the findings from the interviews, further analysis was conducted by using causal loop diagrams to describe the dynamics and how they have influenced the behaviours of case study construction organisations in resourcing for disaster recovery. This paper only reports the qualitative system dynamics, often referred to as system thinking. The quantitative system dynamics which is based on quantified simulation will be reported in future published works.

The System Dynamic modelling approach was first introduced by Jay Forrest [64]. It offers a rigorous method for the description, exploration and analysis of complex organisational system comprised of organisational elements and the environmental influence. In the security world, systems thinking is a powerful tool for analysing and interpreting risks, and for developing control or intervention options [65]. While systems methods are not yet widely used in disaster management, experience in related disciplines, such as earthquake mitigation decision making [66] and planning for disaster recovery [67], indicates that they will be an increasingly useful tool for addressing complex issues in the aftermath of a large disaster.

We approached the analysis with the intent of exploring the critical dynamics of organisational resourcing process following the Canterbury earthquakes. By aggregating the findings from the case studies, the issues and processes that were relevant across a range of case study organisations can be identified. Those dynamics and how they have influenced the resourcing behaviours of case study organisations are presented in the causal loop by using Vensim modelling technique. In the following section, the generalised thematic findings will be presented and discussed, with illustration of dynamics identified in case studies.

5. Results and Discussion

5.1 Changed business operational model

Case studies in April 2014 show that there is a general trend for the workforce that were involved in the Canterbury earthquake reconstruction to move away from disaster recovery projects, as shown in Figure 1. In particular, the medium to large-sized infrastructure contractors were experiencing some human resourcing pressure as they have lost expertise to the new subdivision sectors. Case study organisations reported a renewed interest in moving

back to their business-as-usual market, driven by the development of new subdivisions in Canterbury and New Zealand Government's housing and transport commitments.

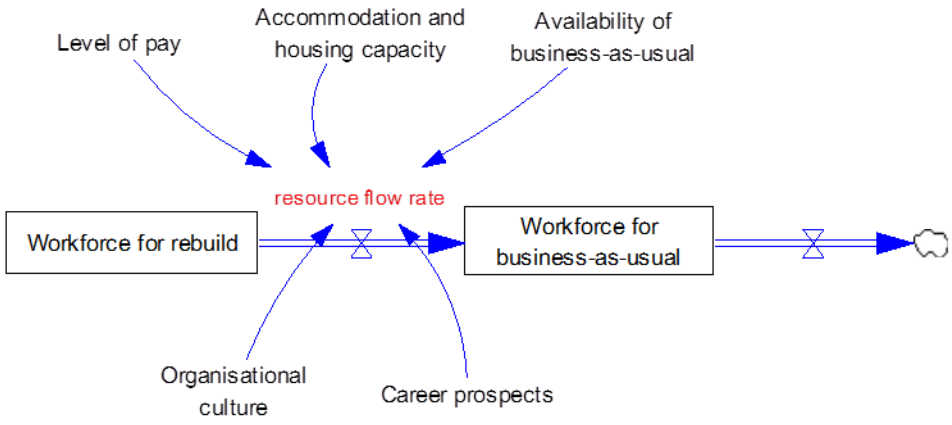

Figure 1: Dynamic factors that influence workforce flows between sectors

Lifestyle and cost factors are the dominant determinants of workforce migration patterns [68]. Such labour demographic-related factors play a major role in a workforce's decision-making and changing directions of resource flows [35, 36]. Case study organisations reported that the phenomenon of moving away from reconstruction to other sectors was most prominent among those who entered the reconstruction sector following the earthquakes, including overseas immigrants and those entrant people from outside Canterbury. Anecdotally, it appears that some new entrants tended to pursue better career opportunities in other places with their Christchurch reconstruction experience. This tendency, however, will likely be moderated somewhat by rebuild-related organisations providing needed support with organisational culture and certainty of career development playing a central role [59].

Small-to-medium sized businesses have seen work levels in non-reconstruction sectors rise over 2013 and were optimistic about development prospects in buildings and infrastructure industry. Large engineering and construction companies, however, remained to be focused on the reconstruction projects, in the meantime, dealing with high rate of staff turnover and the challenge of staff retention. As reported by interviewee C6,

> *'This year (2014), we start seeing a significant resource pinch on our external subcontractors. For instance, we sent 100 invitations for tender, only a third got back to us as those subcontractors are busy and their resources got tied up. It will be difficult for us to find compliant tenders and keep us competitive.'*

General changes in the demand landscape for different sectors of reconstruction and new developments were also affecting business operational behaviours. For example, as shown in Figure 1, the change in demand and higher rates in other places meant that those who established local operations in Christchurch and secured reconstruction projects following the earthquakes had now moved back to housing and building markets in Auckland or Wellington. As one interviewee E2 put it,

> '*As the Auckland market picks up whereas the Christchurch market raised but not super busy, some of those companies had pulled out their presence from Christchurch as they can survive now in other markets.*'

This finding bears resemblance to the situation following the 2009 Victorian 'Black Saturday' bushfires [69] and the situation in Queensland' flood-affected areas in Australia [70]. Comerio [71] stressed that with prospects of economic development and growth pressures in other areas, the impact of their competing demands for construction skills should not be underestimated. Some case study organisations were concerned that escalating accommodation costs may discourage some construction workers from outside Christchurch. Case study organisations highlighted the importance of Government's investment in temporary housing for additional out-of-town workers as a strategy to retain these resources for the reconstruction projects.

5.2 Shifted focus from recruitment to retention and up-skilling

The skills issue in terms of resource quality is one of the most reported problems – so to a certain extent was viewed by small-to-medium-sized organisations as their top concern. This is not surprising as Mahamid [72] argued that a lack of labour experience is among the top-five factors negatively affecting construction business performance. A range of terms, such as 'lack of competency', 'lack of experience', 'low level of skill', 'absence of work ethics' and 'incorrect work attitude', were used by studied employers as a reason, in part, to explain their reluctance to recruit young workforce which does not seem to have a sufficient skills set for work elements of the reconstruction. A continuing low unemployment rate (3.2 per cent for the December quarter of 2013) in Christchurch will make sourcing appropriate labour more difficult [73]. This is an issue that may become more prominent once more construction works get underway.

Prolonged lead time from planning for forward work programmes to their eventualisation was another key resourcing barrier identified by case study organisations. This is also intertwined with an inconsistent work flow issue. For construction businesses, there is added instability and uncertainty in planning, particularly human resources which causes waste and increased costs [74]. According to Hua [75], firms are more likely to invest in physical assets if they expect demand to remain high and long-term economic conditions to be good. If the economic prospects are unfavourable, they tend to be conservative about their investment due to potential fiscal risks.

Some interviewees noted that slow reconstruction of commercial buildings was capping the rate of the cash flow and the rate and number of people coming in. This is in line with the findings of Ng et al. [76] which emphasised that private construction investment is more sensitive to general economic conditions, creating uncertainty in the future levels of construction workloads. Contractors and suppliers also reported some of their spare capacity was a result of the inconsistent workflows, affecting their workforce demand. One contractor C2 in the infrastructure rebuild sector shared its particular concern:

> *'In 2014, we are particularly concerned that the new subdivisions as a result of the earthquakes and the vertical rebuild will be sucking a lot of our subcontractors. What's gonna happen next might be they are going to suck our own staff, our engineers and project managers.'*

Case studies opened up a discussion about a focus in 2014 for skills retention and up-skilling. Strategies already implemented included changing from annual to quarterly reviews, touching base on a regular basis, increasing the focus on staff development and staying competitive in the market in terms of pay rates. It appears that the high turnover rate among newly recruited workforce undermines the skills retention and in-house up-skilling strategies adopted by case study organisations. As one interviewee (C4) highlighted:

> *'Finding the right people who are willing, able and motivated has been problematic. The more frustrating is you take on new people and spend a lot of time and money training them up. Once they have gained that experience, they move to another company. This is certainly not good for apprenticeship with fewer companies willing to invest in youth training.'*

This is not supervising given that the New Zealand construction industry has a labour turnover rate of over 20 per cent on average [77]. It in turn increases recruitment and training costs. With the higher turnover rate, construction business owners will need to secure key people who maintain the core competency of the business [26, 27]. The need to effectively 'self-insure' for human resource loss, and escalating competing demand from the business-as-usual sectors, will potentially lead some businesses to rethink their resourcing strategies.

5.3 Changing dynamics and relative nature of hiring

Some construction businesses of small-to-medium size indicated that it may be uneconomic to hire wage workers, partly due to quick turnover and some of the work ethics issues of their recruits. This is similar to the findings in the European construction sectors, which lead to the increased sub-contracting [24]. One studied organisation C5 reported that they had to re-assessed their business development strategies and opted to re-structure the company by using sub-contractors to reduce operational costs. The interviewee acknowledged that this change of staffing approach had increased its revenue in terms of improved productivity and work efficiency.

As mentioned above, the change in business resourcing behaviour brought about by staffing experience through a rapid growth cycle post-earthquake will in turn affect the in-take of new staff and buy-in of industry training programmes. If a growing number of construction businesses choose to cancel or reduce the pipeline of their recruitment, it is less likely that a skilled workforce will be delivered to Christchurch in the long term. Figure 2 shows that three critical dynamics – staff turnover rate, competency of hired workforce and business operational capacity – play out together to have an impact on company's ability to work efficiently. The more difficulties a company finds in achieving work efficiency, the lower the productivity [78, 79]. This will in turn make hiring less desirable and less affordable, causing more businesses not to hire.

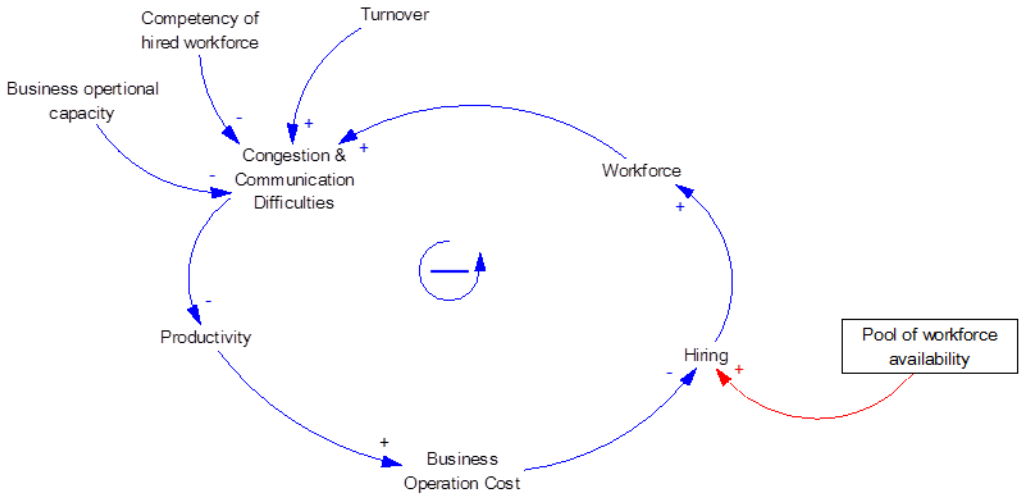

Figure 2: Changing business dynamics and relative nature of hiring

As mentioned earlier, the issues of rapid turnover and lack of competency are particularly found among the youth workforce. The implications from the dynamic model in Figure 2 are that the trend of recruitment is now moving to more temporary contracts on short-to-medium terms. However, there are economic and social consequences of the industry labour market in not delivering the supply of workforce at a rate to meet the required demand by employers [23, 80, 81]. In the meantime, construction organisations were understandably concerned about the risks of overcapacity in Christchurch. In particular, the risk of influx of a less experienced labour force and questions over the training buy-in from the industry were of concern.

6. Conclusion

The nature of reconstruction following a large disaster is often fraught with uncertainties, leading to pronounced fluctuations in its demand [50]. By using a systems approach, this study identified the dynamics that have changed construction companies' resourcing behaviours in

relation to the employment demand and supply in the Canterbury recovery from 2010/11 earthquakes. In particular, the limited engineering and project management capability available nationally, lack of motivation among new entrants, combined with high turnover rate, had accounted for socially produced skills shortages in Christchurch. This shortage was further compounded by factors such as the shortage of temporary accommodation, time lags of training and a lack of information about reconstruction workloads from the recovery agencies.

It is difficult to separate pre-existing contributing factors that influence construction skills problems from those of the effects of reconstruction demands. Comerio suggested that disasters do not completely change pre-disaster economic conditions; instead they simply magnify trends or conditions in place before disaster strikes [82]. As shown in this research, the Canterbury earthquakes and the reconstruction demand had brought about fluctuations in the economic cycle. However, the pre-event issues such as the high staff turnover rate, competency of hired workforce, organisational culture and company retention ability still played a dominant role impinging upon the practice of human resource management of construction organisations in disaster recovery projects.

The dynamic models developed in this research provide visual directions for decision makers and construction organisations to implement supporting measures for improved capacity and capability for ongoing reconstruction. The study offers an improved understanding of disaster effects on the construction skills needs and of changes in the skills requirements post-event, enabling better future industry preparedness for a similar event. It is suggested that the design of policy instruments in managing human resources in Christchurch should be informed by a continued investigation of the dynamics that mediate between policy objectives and outcomes over time.

More than that, the study makes the case for a new approach to looking at resourcing problems following a major disaster. Those methods that are based on neoclassical economics and deal mostly with the larger economy tend to consider resource availability as a consequential result of market processes. The systems approach used in this research demonstrates that for enhancing the reconstruction capability in complex post-disaster settings, an organisational perspective should be considered in the decision making, which explains both internal resourcing dynamics and the linkages between construction organisations and the wider recovery environment.

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