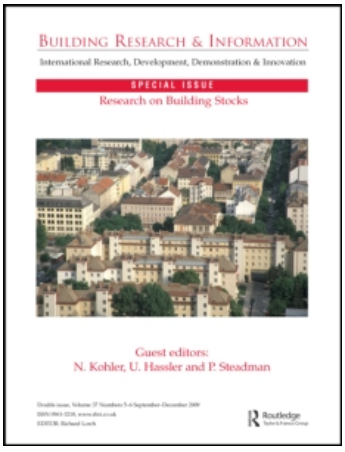

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Resourcing challenges for post-disaster housing reconstruction: a comparative analysis

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RESEARCH PAPER

Resourcing challenges for post-disaster housing reconstruction: a comparative analysis

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Post-disaster housing reconstruction is likely to suffer project deficiencies in relation to the availability of resources. Inefficiencies in dealing with resource shortages in the aftermath of a catastrophe can trigger economic and environmental impacts on the affected areas. Based on data collected from field research in China, Indonesia, and Australia, three types of resource-led reconstruction strategies are compared: government driven, donor driven, and market driven. Conventional interventions from the Chinese government (*e.g.* price restrictions and discouraging profiteering to regulate the market) were unable to meet the long-term reconstruction needs after the Wenchuan earthquake (2008). Complexity inherent in both internal and external environments in Indonesia compromised donors' efforts in post-tsunami (2004) resource procurement. Market-oriented resourcing processes in Australian bushfire (2009) reconstruction are unlikely to succeed without facilitated solutions from the government and institutions. The answer to effective resource management for post-disaster reconstruction lies in the appropriateness of the responses and improvements to address resourcing challenges. The success of resourcing depends on multi-stakeholder collaboration and the development of polices, plans, and tools to allow market flexibility, donor management, and government intervention.

Keywords: emergency preparedness, housing, non-governmental organizations (NGOs), post-disaster reconstruction, resource availability, resource management, resourcing, sustainability

Il est probable que la reconstruction de logements après une catastrophe se trouve confrontée à des insuffisances liées à la disponibilité des ressources pour les projets de construction. Le manque d'efficacité dans le traitement des pénuries de ressources suite à une catastrophe peut déclencher des répercussions économiques et environnementales sur les zones affectées. En se fondant sur les données tirées d'études de terrain en Chine, en Indonésie et en Australie, trois types de stratégies de reconstruction impulsées par les ressources sont comparés, mettant l'accent respectivement sur les gouvernements, les donateurs et le marché. Les interventions classiques du gouvernement chinois (par ex. limiter les prix et dissuader de faire des bénéfices excessifs pour réguler le marché) n'ont pas permis de répondre aux besoins de

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reconstruction à long terme après le tremblement de terre de Wenchuan (2008). La complexité inhérente aux environnements intérieurs aussi bien qu'extérieurs en Indonésie a mis en péril les efforts des donateurs concernant l'approvisionnement en ressources après le tsunami (2004). Il y a peu de chances que les processus de sourcing privilégiant le marché lors de la reconstruction suite aux incendies dans le bush australien (2009) puissent réussir sans des solutions facilitées par le gouvernement et les institutionnels. La réponse à apporter pour qu'une gestion efficace des ressources permette la reconstruction après une catastrophe réside dans la justesse des réponses et des améliorations faites pour relever les défis du sourcing. La réussite du sourcing dépend d'une collaboration entre les diverses parties prenantes et du développement de politiques, de plans et d'outils qui assureront la flexibilité du marché, la gestion des donateurs et l'intervention gouvernementale.

Mots clés: préparation aux situations d'urgence, logement, organisations non gouvernementales (ONG), reconstruction après une catastrophe, disponibilité des ressources, gestion des ressources, sourcing, durabilité

Introduction

Post-disaster reconstruction, if not well planned and implemented, can create further vulnerabilities in a disaster-affected community. According to Schilderman (2004, p. 415), whilst the number of hazard events does not appear to be increasing greatly, their impact on people is increasing. The underlying implications of disasters for longer-term reconstruction are not fully understood by policy-makers and recovery practitioners. After a large-scale disaster, housing reconstruction projects are susceptible to numerous resourcing bottlenecks inherent in post-disaster circumstances, such as resource shortages (Steinberg, 2007), price escalation (Nazara and Resosudarmo, 2007), and supply chain disruption (Zuo *et al.*, 2009), which significantly impede the reconstruction process in disaster-affected countries. As Jayasuriya *et al.* (2005) observed in Sri Lanka, the impacts of the 2004 Indian Ocean tsunami intensified resource shortage, fuelled inflation, constrained government's fiscal capacity, and adversely affected housing reconstruction.

A real impact after a high-profile disaster is the 'socio-economic displacement' manifested in forms of inflationary chaos (Jayasuriya *et al.*, 2005; Nazara and Resosudarmo, 2007), 'Dutch Disease'[1] (Adam and Bevan, 2004), and cost surge (Jayasuriya and McCawley, 2008). These adverse market conditions, if occurring in underdeveloped countries, tend to contribute subtly to a 'vicious circle' between disaster and development, hindering external recovery assistance (United Nations Development Programme (UNDP), 2006), exacerbating local poverty (Steinberg, 2007), and reducing people's capability to cope with post-disaster reconstruction (Kennedy *et al.*, 2008).

Where academics and non-governmental organizations (NGOs) have focused attention on exploring what makes the implementation of reconstruction programmes peculiarly difficult and advocating a community participatory approach,[2] the inadequacy of resources and capacities to rebuild has been largely overlooked. Four predominant resourcing approaches are adopted in the contemporary reconstruction practice: government driven, donor driven, market driven, and owner driven. The questions that form the theme of this paper are:

- Which resourcing approach is effective in post-disaster housing reconstruction?
- Which is not?
- What improvements can be made to address the inherent resource constraints under each approach?

The researchers took part in disaster field trips to China, Indonesia, and Australia. Using case studies in the three countries, they sought to understand their respective resourcing approach – government driven, donor driven, and market driven – for housing reconstruction. The study examines resourcing efforts and identifies challenges in each specific disaster reconstruction context. The empirical data are analyzed, and a comparative discussion is presented with a view to informing the thinking and actions of practitioners. Most significantly, the insights and perspectives captured through in-depth interviews in the field are provided to draw attention to the need to plan and manage resources for post-disaster reconstruction.

Importance of resource availability

Following a major disaster, the majority of local production facilities and supply systems in manufacturing industries are likely to be damaged and the construction market tends to be in disorder, contested, and highly adversarial (Nazara and Resosudarmo, 2007). This, if combined with disruption of transportation and energy supply (Cho *et al.*, 2001), and pre-existing historical problems of the local industry (Singh and Wilkinson, 2008), could significantly exacerbate the difficulty in procuring building expertise and materials (Jayasuriya and McCawley, 2008), leading to project failure and rework such as project suspension, quality

defects, cost overruns, and delivery delay (Boen, 2006; Steinberg, 2007).

A lack of suitable resources and alternatives (Russell, 2005; Zuo and Wilkinson, 2008), the disruption of access to available resources (Green *et al.*, 2007), and limited ways of procuring resources (Brunsdon *et al.*, 1996; Oxfam Australia *et al.*, 2007) would further intensify competition among implementing agencies. If there are procurement limitations intrinsic in those organizations such as ineffective resourcing (UNDP, 2005; International Federation of Red Cross and Red Crescent Societies (IFRC), 2006) and poor resource management (Steinberg, 2007; Kennedy *et al.*, 2008), the competition for scarce resources would further compound inflation, profiteering, and 'Dutch Disease' affecting reconstruction, undermining market function, and obstructing longer-term economic development.

In addition, the availability of resources, combined with a series of economic and cultural shifts, would influence how assistance is targeted and materials and techniques are selected, and eventually contribute to a reconfiguration of local approaches to housing. For instance, the housing culture of the territory of Aceh, Indonesia, traditionally utilized organic building materials such as timber, thatched grasses, and bamboo (O'Brien *et al.*, 2008). Local contractors stripped indigenous forests before the tsunami and the higher timber prices were linked with deforestation, industrialization, urbanization, overpopulation, and corruption (Dauvergne, 1997; Food and Agriculture Organisation of the United Nations (FAO), 2001). As a result, the shortage of traditional resources largely curbed the community's ability to rebuild their homes successfully after the 2004 Indian Ocean tsunami. As noted by O'Brien *et al.* (2008, p. 369), the lack of a sustainable local timber industry within Aceh, coupled with the local demand for westernized 'modern' housing, required reconstruction housing to be reliant on external aid agencies with imported industrialized materials such as cement, steel, concrete, and mass-produced products.

The availability of resources has been recognized by a number of scholars as a driving force necessary for a successful construction project (Tukel and Rom, 1998; Chua *et al.* 1999; Bassioni *et al.* 2004, 2005). Park (2005, p. 585) claimed that 'construction management is nothing but resource management'. Poor-quality materials can directly cause the failure of physical connections between construction elements (Belassi and Tukel, 1996) or interrupt such connections when defective materials are replaced (Love *et al.*, 1999). Material delays, especially long-lead items, are a well-known cause for construction delays and can also trigger other relevant resourcing issues (Manavazhi and Adhikari, 2002). In addition, Yeo and Ning (2006) pointed out that appropriate plant, equipment or tools being unavailable also lower the efficiency of physical construction.

In post-disaster reconstruction research, Singh (2007) concluded that five factors influence the availability of resources for reconstruction, including the prioritization of works, the ability to pool resources, the lead time of procurement, existing contractual relationships, and transportation into and around the disaster zone. According to Singh and Wilkinson (2008), the availability of resources is also governed by the policies and strategies put in place by the authorities to deal with the reconstruction phase. Barenstein and Pittet (2007) stressed that the selection of materials for rebuilding houses must be in line with local aspirations. And it is important to consider the economic and environmental implications of different types of building materials (Barakat, 2003; O'Brien *et al.*, 2008).

The pressure to acquire resources for post-disaster reconstruction is even higher for poorer countries where natural resources are indigenously lacking. Post-disaster reconstruction in countries such as Indonesia and Sri Lanka relied on external assistance from, for example NGOs, international non-governmental organizations (INGOs), and The World Bank for imported skills and materials (Jayasuriya and McCawley, 2008), or the reallocation of resources from existing projects to meet rehabilitation and reconstruction needs (Freeman, 2004). Consequently, the dependence on external aid is likely to suppress local production capacity and reduce the likelihood of success of the reconstruction programme (Jayasuriya *et al.*, 2005). Likewise, resource reallocation tactics disrupt markets and economic order (Makhanu, 2006), adversely affecting sustainable productivity layout and economic and social development goals in the long-term (World Bank Operations Evaluation Department, 2005).

Moreover, construction activities and raw material exploitation constitute a threat to the sustainability of natural environments in disaster-impacted countries. Timber logging, as Shaw (2006) proposed, both legal and illegal, contributed to the incidence of flooding and landslides. A comparative study conducted by O'Brien *et al.* (2008) in Banda Aceh, the provincial capital of Aceh, demonstrated that the level of greenhouse gas emissions of new housing types with industrialized materials in Aceh post-tsunami was 50 times higher than traditional types and the ecological footprint was triple. Similarly, Roseberry (2008, p. 4) pointed out that the materials needed for construction may be harvested or extracted well beyond the renewable rate of the local ecosystem, possibly tipping the balance beyond its capacity to recover in a suitable timeframe.

Many NGOs, INGOs such as IFRC (2006), and United Nations agencies such as the UNDP (2005, 2006) highlighted the importance of resource availability in post-Indian Ocean tsunami reconstruction projects. There are also a range of role models that illustrated that post-disaster reconstruction practitioners benefited from proactive resourcing strategies and planning (Mitchell, 2004) and from addressing potential vulnerabilities and bottlenecks when sourcing resources (Singh and Wilkinson, 2008). Despite this, the added value of framing resourcing activities and strategies into the post-disaster reconstruction arena has not been demonstrated, for three main reasons:

- difficulties in translating experiences and lessons learned from disaster-impacted countries into other specific contexts and actions
- a limited understanding along with an absence of mechanisms in linking resource availability with local economic, social, and environmental settings
- resource availability for post-disaster reconstruction is often construed as a procurement responsibility for construction professionals rather than an integral issue in disaster recovery

This paper considers three representative resourcing models applied in past and current disaster reconstruction practice. Field-based case studies and a comparative analysis are provided showing improvements in solving the identified resource constraints under different recovery systems.

Resourcing approaches for post-disaster reconstruction

Resourcing broadly encompasses a wide range of activities that have a bearing on resource management for post-disaster reconstruction projects, embracing pre-event resource planning and preparedness, resource procurement, resource delivery, and the development of resource alternatives. Conventional measures have been employed in past reconstruction practice to address the resourcing problems, such as new investment in production (Jayasuriya and McCawley, 2008), and importing resources from outside of the affected areas (Walker, 1995; Zuo *et al.*, 2009). These *ad hoc* arrangements after a disaster seem to be unable to perform well to alleviate resource shortages in the long run (Jayasuriya and McCawley, 2008). In addition, the absence of pre-event planning and preparedness (Alexander, 2004; Orabi *et al.*, 2009), the inadequacy of efficient and flexible institutional arrangements (Sullivan, 2003), and the lack of proactive engagement of the construction industry into disaster management (Lorch, 2005; Pheng *et al.*, 2006; Bosher *et al.*, 2007) are underlying contributors to undermining resourcing performance in a post-disaster environment.

The empirical research conducted by Chang *et al.* (2010) recognized that in order to arrive at a resilient and sustainable built environment after a disaster, resourcing efforts should be made around four components – a resourcing facilitator: legislation and policy; a resourcing implementer: the construction industry; a resourcing platform: the construction market; and resourcing access: the transportation system.

The dynamic resourcing process for post-disaster reconstruction reveals that resource availability depends on how relevant stakeholders address resource constraints including resource cost, quality, quantity, environmental concerns, and cultural acceptance. In 1974, Cyclone Tracy destroyed the City of Darwin in north Australia, killed 71 people, caused AUD$837 million in damage, and destroyed more than 70% of Darwin's buildings, including 80% of houses (EMA Disasters Database, 2005). According to Walker (1995), the post-Darwin cyclone reconstruction was a protocol of government-oriented resourcing. The Australia government initiated restrictions on building projects in order to control resource prices. However, post-cyclone inflation was about 75% and this impact even extended to Townsville (Walker and Minor, 1979). In contrast, the 1989 Newcastle earthquake in Australia was different because the government only controlled building standards and post-disaster inflation was about 20% (Shephard *et al.*, 1997). The main reconstruction cost inflation at Newcastle was due to the differing views of clients' engineers and insurers on what remedial work was required (Walker, 1995).

The 1994 Northridge earthquake in the United States shows that resource availability can be further enhanced by the government commitment to improve its environment and to help facilitate the procurement and development of resources. Wu and Lindell (2004) pointed out that having a pre-impact recovery plan in Los Angeles facilitated housing reconstruction and allowed local officials to manage the reconstruction process more effectively. Other cases such as post-disaster reconstruction in New Zealand (McIvor and Paton, 2007), India (Winchester, 2000), and Iran (Omidvar *et al.*, 2009) indicated that the support provided by the government enhanced the market players' capacity in coping with large-scale disaster reconstruction demand.

Donor-driven resourcing occurs when NGOs or other designated organizations are tasked with housing rebuilding projects for beneficiaries, often in underdeveloped countries where the indigenous resources and capability are unlikely to cope with large-scale

disasters. The post-Indian Ocean tsunami recovery highlighted significant contributions of donor communities; nevertheless, it also demonstrated NGOs' capability limitations in resourcing for attaining desirable reconstruction. A number of researchers such as Boen (2006), Dercon (2007), and Ahmed (2008) called for continuous learning, commitment, and improvement from NGOs for such an approach to be successful. This resourcing innovation also necessitates thinking ahead (Kennedy *et al.*, 2008) and an ethos of trust and commitment from governments (Pandya, 2006).

In comparison with donor-driven resourcing, the owner-driven/community-driven approach is empowering and participatory, and thus was popular in post-tsunami reconstruction in Indonesia among NGOs, such as the United Nations High Commissioner for Refugees (UNHCR) (2006), the United Nations Children's Fund (UNICEF) (Jaspars *et al.*, 2007), and World Vision (Bailey *et al.*, 2008), which consider community redevelopment and participation as being among their main objectives. The UNDP (2007), in conjunction with UN-HABITAT, designed the Aceh Nias Settlements Support Program (ANSSP) in which self-construction with a combination of funding support from aid agencies in forms of cash grant or transfer was adopted, and appropriate technical assistance with regard to material selection and procurement was advocated in some affected rural areas in Aceh. UN-HABITAT (2007) also introduced 'People's Process' in Aceh to allow a fully empowering community-organized reconstruction to make the best use of local resources and capabilities.

From the above discussion, the type of resourcing approach can be defined in terms of the way and extent to which the stakeholders leverage their influence and value into resourcing activities. Four main resourcing approaches have been widely applied in past disaster reconstruction practice:

- *government-driven resourcing approach*: post-disaster reconstruction resource availability is mainly driven by governmental agencies and other authorities
- *donor-driven resourcing approach*: donors play a dominant role in resourcing efforts for a post-disaster reconstruction project
- *market-driven resourcing approach*: the instruments, forces, and rules in the construction market have a major influence on resource availability for post-disaster reconstruction
- *owner-driven approach*: house owners are responsible for rebuilding their own houses through self-maintenance with limited external financial, technical, and material assistance

The four models work holistically and are essentially transferable under a specific reconstruction circumstance. The government may control the supply of cement which is purchased by a contractor or an NGO for construction work with or alongside a community constructing its own houses. Hence, there is a continual shifting between these models in post-disaster resourcing for reconstruction. It is when this balance is distorted that resourcing issues appear. For example, there were cases in which local governments restricted the supply of cement in Sri Lanka (*The Sunday Times*, 2007) and the supply of timber in Simeulue, Indonesia, after the 2004 Indian Ocean tsunami (Jayasuriya and McCawley, 2008; Zuo *et al.*, 2009), and the supply of roofing in Pakistan after the 2005 Kashmir earthquake (Mumtaz *et al.*, 2008). INGOs imported these resources from outside the affected areas where local contractors and communities were unable to cope with resource shortages, and longer-term resourcing problems appeared.

Furthermore, the four types of resourcing approaches can overlap or combine in the same recovery operation. For instance, both government- and NGO-driven resourcing practices were observed by the authors in Banda Aceh. Government-driven resourcing does not necessary imply that the government gets involved in actual resource procurement for housing reconstruction projects, but that the authorities retain full control over the resource provision and supply process. The success of market-oriented and donor-led resourcing in post-disaster housing reconstruction also requires continual government participation and lies largely in the way and extent to which the authorities provide facilitation.

During post-Indian Ocean tsunami housing reconstruction, the donor-led resource approach was predominant in Aceh, whereas in China the government-led resource management was key to the housing reconstruction after the Wenchuan earthquake, and in Australia bushfire reconstruction resource availability was mainly led by the construction market. The remainder of this paper focuses on comparing these three resourcing models in Indonesia, China, and Australia in terms of the resourcing challenges under each approach, the differences and similarities pertaining to their specific recovery context.

Research methodology

A comparative case study method was adopted for this research due to its explanatory nature (Yin, 2003). Major disasters such as earthquakes and tsunamis are infrequent events, so it is impossible to plan everything or to be perfectly prepared in a disaster zone. Three study sites were selected in terms of disaster impacts, types of resourcing approach, and field accessibility.

Their disaster impacts and resourcing approaches were analyzed. Between March and June 2008, the first and third authors were tasked with post-tsunami housing seismic assessment in Banda Aceh, working with CARE International, and they gained the opportunity to interact with a range of stakeholders such as governmental officials, construction professionals, and donor representatives engaged in post-Indian Ocean tsunami reconstruction in Indonesia. During this time, the researchers came to understand how a donor-driven system affected resource allocation and management for housing reconstruction. Six weeks after China's devastating earthquake on 12 May 2008, these two authors went to the earthquake-impacted zone and set up a baseline for a longitudinal case study to understand post-disaster resource management. Between December 2008 and January 2009, and between June and July 2009, the four authors conducted follow-up field trips to China. An extensive understanding about the resourcing approach Chinese reconstruction teams adopted was obtained through field-based observations,[3] a focus group, interviews, and other qualitative records. In August 2009, the first three authors visited the Victoria Bushfire disaster zone in Australia (the bushfire was on 9 February 2009) and undertook a grounded survey, assessing resourcing problems faced by governmental officials, implementing construction corporations, and people affected. The research background data and a profile of three case studies are presented in Tables 1 and 2, respectively.

During the field visits to the three affected areas, a set of semi-structured interviews were conducted covering the topics of resourcing activities and associated problems in the aftermath of the disaster. The interviewees[4] were selected in terms of their experience and position with regard to resourcing in post-disaster reconstruction work. Qualitative data on perspectives and insights of these participants were captured, including:

- pre-existing and post-disaster problems and challenges to resource procurement

Table 1 Background data on studied disasters and impacts

Country	Date of the occurrence	Disaster	Number of casualties	Economic losses (US$, billions)	Resourcing model
Indonesia	26 December 2004	Earthquake and tsunami	126 900	4.50	Donor driven[a]
China	12 May 2008	Earthquake	69 266	123.66	Government driven
Australia	7 February 2009	Bushfires	173[b]	n.a.	Market driven

Notes: [a]Typical donors include international and regional development banks, bilateral donors, and multilateral donors such as the United Nations agencies, the European Commission, and non-governmental organizations.
[b]By the time the fires were contained.
n.a., Not available.
Sources: RMS (2006), Paterson *et al.* (2008), State Planning Group (2008) and VBBRA (2009).

Table 2 Profile of field-based case studies

Country	Date of the field trip	Places visited	Main interviewees
China	June 2008 December 2008–January 2009 June–July 2009	Mianzhu Dujiangyan Beichuan	Sixteen construction contractors (C1–C16) Five academic researchers (R1–R5) Five governmental officials (G1–G5)
Indonesia	March–June 2008	Banda Aceh	Twelve project managers from six NGOs[a] (P1–P12) Four donor representatives/reconstruction coordinators (Co1–Co4) Four governmental officials from BRR (BRR1–BRR4)
Australia	August 2009	Marysville, Flowerdale and Kinglake	Eight governmental officials (V1–V8) Two academics from CRC and two researchers from RMIT (A1–A4) Three contractor company representatives (Cr1–Cr3)

Notes: BRR, Agency for Rehabilitation and Reconstruction for Aceh and Nias, Indonesia; CRC, Australian Bushfire Co-operative Research Centre; and RMIT, Royal Melbourne Institute of Technology.
[a]International Federation of Red Cross and Red Crescent Societies (IFRC), CARE International, Canadian Red Cross, United Nations Development Programme (UNDP), Australian Red Cross, and British Red Cross.
NGOs, non-governmental organizations.

- initiatives adopted to improve resource availability for reconstruction projects
- likely measures and alternatives to address the resourcing constraints

The average interview for each interviewee in three study sites was 60 minutes. In addition, the focus group method was applied when interviewing the 12 contractors (C1-C12) involved in post-earthquake reconstruction in China in order to elicit information that illustrates combined local perspectives (Krueger and Casey, 2000). Follow-up telephone calls and e-mail and mail correspondences to a number of interviewees ensured the validity and accuracy of the research findings. The interview records were transcribed, coded, and analyzed using NVivo 8 qualitative data analysis software.[5] Through NVivo 8 coding comparison of queries, similar comments, and quotations from interviewees under a same question are analyzed and synthesized. The presence of data such as examples, comments, and suggestions in the paper was approved by the related respondents. In what follows, the resourcing models adopted by agencies in the disaster-affected countries are presented in terms of different interventions: government driven, donor driven, and market driven. The effectiveness, or otherwise, of each case studied is assessed.

Case study 1: Government-driven resourcing approach in China

Post-Wenchuan earthquake resourcing context and practice

China is an example of a government-led reconstruction and resource management post disaster. The response of the Chinese authorities to an earthquake that struck the province of Sichuan and its neighbours on 12 May 2008 was described by Chang *et al.* (2009). The Wenchuan earthquake, as it is commonly known, measuring magnitude (M) 8.0,[6] killed 69 266 people, injured 374 643, left 17 923 missing,[7] and caused widespread destruction to buildings and infrastructure. More than 15 million housing units collapsed during the earthquake, which resulted in direct losses to buildings and infrastructure of over US$150 billion (Paterson *et al.*, 2008). The damage experienced by structures in the Wenchuan earthquake was largely contingent on the construction type.[8] In the mountainous terrain of Sichuan Province, most residential buildings were one- or two-storey masonry structures composed of bricks or concrete blocks. These structures did not possess seismic-resistant elements such as reinforced concrete or were reinforced improperly and thus made highly vulnerable to earthquakes. Many houses of this type collapsed during the Wenchuan earthquake.

As the overall earthquake reconstruction unfolded in August 2008, shortages of building materials posed a significant obstacle to the housing sector. Labour scarcity was another problem leading to precipitous wage increases. Much of the resource shortage for reconstruction came from large-scale and intensive rebuilding demand. In addition, the inadequacy of local production capacity, raised transportation fees, and the scarcity of local raw minerals contributed to the subsequent supply disruption and inflationary chaos in disaster-affected areas.

In particular, brick supply pressure in some impacted areas of China was intensified by a monetary incentive from the local government and people's traditional value on celebrating the New Year. In pursuit of reconstruction speed, a number of local governments granted a subsidy RMB5000 (approximately US$750) to households who commenced rebuilding before 12 May 2009. This financial incentive combined with people's desire to welcome the traditional Chinese spring New Year in their new house led to competition among house owners and construction agencies for limited resources and thus pushed up the price of building materials. The costs of labour and main building materials in impacted rural areas of Sichuan Province during mid-2008 to mid-2009 are tabulated in Table 3.

Following the Wenchuan earthquake, the national government of China took swift legislative action to establish a multi-governmental management framework for recovery. In conjunction with local municipal

Table 3 Costs of labour and building materials in rural areas of Sichuan, from mid-2008 to mid-2009

Resource	Unit	Mid-2008	End of 2008	Early 2009	Mid-2009	Change (%)
Labour	RMB/day	30	60	100	80	167
Brick	RMB, each	0.33	0.53	0.55	0.35	6
Cement	RMB/ton	390	460	550	480	23.1
Aggregate	RMB/m^3	25	50	55	75	200
Steel	RMB/ton	5400	3800	3600	4200	22.2

Note: RMB, Chinese currency.
Source: Authors' own market investigation.

and county governments, the national government, through a variety of programmes, made 'sponsoring' its watchword. In spite of different forms of these initiatives, the key element in common was to stimulate and promote the use of resources both nationwide and locally.

The *Regulations on Post-Wenchuan Earthquake Restoration and Reconstruction* (The State Council of the People's Republic of China, 2008b) set guidelines for reconstruction and provided important legal ground for various departments and government agencies to assist with recovery and reconstruction. As a supplementary policy to aid the full implementation of the regulations, the *One-on-One Assistance Program for Post-Wenchuan Earthquake Restoration and Reconstruction* (The State Council of the People's Republic of China, 2008a) became a key constituent of China's post-disaster recovery management framework. The earthquake-stricken areas of Sichuan, Gansu, and Shaan-xi provinces were divided into 24 districts and twinned with 24 relatively developed localities across China. Sister localities were tasked over the next three years with funding 1% of their annual gross domestic product, provision of human resources, and temporary housing units, and in-kind support from planning institutions and other departments in association with disaster reconstruction.

In addition to the legal support, the national government, the Provincial Government of Sichuan Province, and local authorities took a series of measures in order to solve resource constraints during reconstruction process. Based on the interviews, the key interventions introduced were presented as follows:

- a range of temporary price restrictions
- directing resource supply to the most severely earthquake-stricken areas
- assigning inspectors on the ground to monitor the selling price of resources
- enhancing supplementary subsidies for transportation cost and exempting highway tolls for vehicles that deliver materials to the earthquake-affected zone
- sanctioning the building of 75 cement-production plants, 760 brick factories, and two large-scale high-performance steel factories[9]
- establishing a transparent supply-demand information platform embracing databases containing demand of construction materials, directories of 95 cement- and steel-production companies in neighbouring provinces, and detailed daily prices of steel, cement, and brick in 51 affected counties

Analysis of resourcing challenges in China

China's post-disaster resourcing strategies are in line with the findings of Hirshleifer (1956), who found that to deal with market disorder, profiteering and inflation, regulatory authorities normally turn to 'hard interventions' by directly interfering in manufacturing, supply and transaction. The cornerstone of this philosophy is that legislation and policy decisions can have positive consequences in a complex post-disaster system. As McGee (2008, p. 547) explained:

> government officials often succumb to public pressure to place controls on the very goods and services that are most needed after a natural disaster.

However, within China's specific context, the market regulations after the earthquake enabled public institutions to orient resource production and supply for the most vulnerable communities. Innovative public-private partnerships were also developed in order to capitalize widely on domestic strengths and encourage other sectors' participation. The following quotes highlight the views from a range of interviewees on the effectiveness of such a government-driven resourcing approach:

> China's efforts to improve resource availability and to ensure the priority needs in the most vulnerable communities provided the government with the credibility to 'campaign' for long term reconstruction nationwide.
> (Synthesis of views from a Focus Group with C1-C12)

However, as the post-earthquake reconstruction proceeded, some underlying problems surfaced, as the interviewed reconstruction practitioners C12, R3 and G1 reported that:

> These government-driven resourcing actions, focusing on the supply side to stimulate the construction market, to some degree, eased the temporary tension of inflation in the earthquake-affected areas.
>
> (C12)

> However, the generic restrictions also pose a major disincentive to other suppliers to actively get engaged in post-disaster reconstruction resource supply.
>
> (R3)

> Another problem with these mandates is that the superficial ease of inflationary tension in the short term would make authorities underestimate the disaster-economic impacts without a careful assessment of community needs.
>
> (G1)

In addition, in light of the authors' longitudinal research, the on-going activities of housing reconstruction in China showed a restricted market mechanism for balancing reconstruction demand and supply. Additional vulnerabilities in the local economy were created as a result. As the interviewee G2 commented during the interviews in June 2009:

> As could be seen in the field that the majority of housing reconstruction (80%) in rural areas was completed one year after the earthquake, the local brick production industry had already suffered 'crisis of excessive production'.
>
> (G2)

These comments reinforced the point raised by McGee (2008, p. 551), who claimed that any sort of price controls will cause resources to be allocated inefficiently and could only serve to delay disaster relief. Any input into the construction market and material production needs to be grounded in an understanding and continual monitoring of community needs during reconstruction process. Local government should pay attention to the evolution of local economy and social requirements on resource availability in post-disaster situations. As two interviewees C14 and R1 proposed:

> Policy makers should understand the resource supply vulnerabilities from the demand side.
>
> (C14)

> The public rules should not aim for settling different and conflicting interests of stakeholders but for what can be improved to facilitate resource supply in a given context.
>
> (R1)

Furthermore, as observed, other important stakeholders, especially the construction industry, appeared to rely passively on policies and administrative interventions from governmental authorities. The reason, according to the present investigation, is that in China there is a misunderstanding in the disaster-impacted areas that the government is the most significant institution the nation could utilize for dealing with disasters (interview with G1, Focus Group with C1-C12). The construction industry in China has not been sufficiently prepared for, and involved in, the changing built environment after a disaster; and the awareness to engage in disaster prevention and management is poor. Some of the interviewees claimed that:

> We just do what we normally need to do in the construction process according to the requirements of the regulatory agencies and house owners.
>
> (C3)

> We really didn't realise we are contributing to reduce vulnerability of potential disaster risks.
>
> (Synthesis of views from C7, C10, and C14)

and both C12 and C15 mentioned that:

> Even we knew our significant role in future disaster prevention, disaster management and construction still appear to be separate subjects.
>
> (Synthesis of views from C12 and C15)

This disjointed situation bears a resemblance to that of other countries such as Indonesia (Pribadi *et al.*, 2003), Iran (Gharaati, 2006), Sri Lanka (Pheng *et al.*, 2006), and the UK (Bosher *et al.*, 2007), and manifests itself in aspects such as in education, planning, operations and daily activities, and to a great extent hinders the inclusion of professionals from the built environment into hazard mitigation.

The analysis of resourcing challenges Chinese authorities encountered during post-Wenchuan earthquake reconstruction demonstrated that while government interventions into the market could cater for reconstruction requirements of the most vulnerable communities in the short-term, they also undermined the longer-term sustainable development of the local economy. The key aspects of a successful resourcing approach including input requirements, market linkage, infrastructure settings, and key stakeholders interactions are not being addressed in China's case. It seems that this government-driven resourcing is unlikely to achieve a favourable result without pre-event resource planning and preparedness, flexible market adjustments, and proactive engagement of the construction industry.

Case study 2: Donor-driven resourcing approach in Indonesia

Post-Indian Ocean tsunami resourcing context and practice

In the aftermath of the tragic event of the 2004 Indian Ocean tsunami, a large number of NGOs became involved in the implementation of reconstruction. However, as some scholars such as Steinberg (2007), Jayasuriya and McCawley (2008), Kennedy *et al.* (2008) and Lyons (2009) pointed out, the influx of aid money to tsunami-affected areas was inflationary and the construction sector was a notable example. A number of the respondents during the interviews also acknowledged that:

> Most of NGOs' housing interventions were planned and implemented rapidly, and in isolation from the local political, economic and social environments.
>
> (Synthesis of views from BRR1, P3-5 and P11)

As a result:

> local skills, preferences and needs tended to be marginalised in preference for speed, and little effort was made in knowledge management during the reconstruction processes.
>
> (Co3)

In addition:

> pressures for housing numbers from government and donors caused aid agencies to rush the procurement of resources regardless of their limited capability, shortages of qualified staff, and inadequate development plan for long term projects.
>
> (P8)

The additional expectations from local communities and government for modern housing generated a tendency in tsunami-impacted Aceh for masonry and concrete house construction rather than traditional wood-based dwellings (Boen, 2006; Steinberg, 2007; Kennedy *et al.*, 2008; Zuo *et al.*, 2009). Heightened construction activities and the need to import construction materials, along with increasing energy prices, led to material cost escalation. Shortages of qualified construction labour, experienced professionals and supervisory staff, and the need to bring over such human resources from other locations in Sumatra and Java, or even further afield, also contributed to overruns in construction cost and time. For instance, the BRR initially estimated that the cost of building a 36 m^2 house was around US$3000. By the end of 2005, it was reported that the cost of building such a house had increased to around US$5000 (BRR and Partners, 2006). Table 4 illustrates the significant cost increase of building materials and labour in comparison with that of before the tsunami.

According to Steinberg (2007, p. 156), as central government ministries had limited operational capacity, international and national NGOs became the real drivers of emergency aid, rehabilitation and reconstruction. The difficulties contractors faced in terms of procuring building expertise and materials were shifted to NGOs which eventually had to turn to international construction professionals for remedial solutions. Aid agencies overlooked the time these specialists need to establish locally and be familiar with reconstruction activities. A number of houses in Banda Aceh with donor-procured materials of poor quality were not earthquake resistant and had to be demolished and rebuilt.

Another important issue affecting resource availability in post-tsunami Aceh is the past conflict regarding the 'Aceh Free Movement'. During decades of conflict, construction and development activities were limited. Skilled workers had to be brought in to meet the demand of construction work. As some interviewees claimed:

> The construction industry in Banda Aceh, particularly after decades of civil conflict, was insufficient for large-scale reconstruction. Nearly 95% contractors, solutions, materials and expertise were imported from outside Banda Aceh, mainly from Java.
> (Synthesis of views from P4, P6-8, Co2, and Co4)

Moreover, donor organizations did not have a tacit support from BRR for their supply chain management and, as was observed, the infrastructure system, especially transportation, was inadequate for post-tsunami material and equipment delivery. Some interviewees reported that:

> There is only one major highway which is a dirt track road, leading along the east coast of Sumatra from Java via Medan to Banda Aceh.
> (Synthesis of views from P1, P3, P8, P10-12, and Co1)

> Poor roads and telecommunications made it difficult to provide labour and materials from other parts of Indonesia to many villages along the coast of Aceh.
>
> (Co3)

The salient problems of legally procuring treated timber in post-tsunami reconstruction in Aceh were elaborated by Zuo *et al.* (2009). The new timber

Table 4 Estimates of costs of labour and building materials in Aceh, late 2004 – 2006

Resource	Unit	End of 2004	Mid-2005	Early 2006	October 2006	Change (%)
Labour	Rp, thousands/day	30	40	50	50	67
Wood	Rp, millions/m^3	1.0	1.5	1.9	2.2	120
Cement	Rp, thousands/50 kg	20	26	34	37	85
Sand	Rp, thousands/3 m^3	150	300	300	300	100
Brick	Rp, each	250	580	700	700	180

Note: Rp, Indonesian currency.
Source: Nazara and Resosudarmo (2007, p. 40).

administration rules issued by the Indonesian government on 1 January 2007 significantly reduced the possibility for donors to procure local timber in Indonesia. A number of NGOs resorted to donor countries or other producing countries for timber resources. Additional pressures imposed on NGOs were environmental concerns over timber use, difficulties in purchasing construction timber of suitable quality, and logistics for importing timber from overseas. As some interviewees raised that:

> The lead time of imported timber from overseas, such as Australia, Canada and New Zealand, was three to four months. Once landed in Indonesia, customs and other inspections held up delivery to the construction site, as did road bandits in northern Sumatra.
>
> (P11)

As a result:

> some NGOs ended up with new houses that incurred cost and time overruns.
>
> (Synthesis of views from P6 and Co4)

Assessment of donor-driven resourcing efforts in Indonesia

The resource availability for donor-driven post-tsunami housing reconstruction in Aceh is connected with the internal context of the aid agency itself, including the mandate, capacity and skills to procure resources for reconstruction programmes. Local knowledge (Thanurjan and Seneviratne, 2009), in-house capability (Meding *et al.*, 2008), and social networks (Winchester, 2000) are important components for INGOs' successful resourcing. According to the interviewees from BRR and the INGOs in Aceh:

> apart from basic historical, social and economic stories, the necessary local knowledge for NGOs' resourcing includes the traditional construction materials and techniques, construction knowledge and disaster mitigation technologies, local traditions and housing cultures, physical resource conditions, productivity, and other social development issues.
> (Synthesis of views from BRR1, BRR3, P6, P11, and Co1)

Post-disaster reconstruction requires NGOs to extend their capability from humanitarian relief to physical construction. It is the failure to change their role and the failure to communicate and coordinate with the local affected communities that made NGOs subject to resourcing difficulties which commonly face construction practitioners. Lyons (2009, p. 387) pointed out that NGOs' approach to post-disaster reconstruction is often at odds with their day-to-day work in developing countries. Often, they operate with inexperienced staff and in unfamiliar conditions (Harris, 2006), and sometimes undertake unrealistic commitments (Pandya, 2006).

> The fact, that the 'window of opportunity' of post-tsunami reconstruction turned out to be a 'competition arena' for NGOs to showcase their capability and competencies in the humanitarian course, is however, a major contributor to resource shortages during post-tsunami housing reconstruction.
> (Synthesis of views from P2, P5, P10, and Co2)

On the other hand, resourcing difficulties in Aceh are also external to the implementing aid agencies, and lie with the specific local context. In Aceh, insufficient reconstruction capability in the local construction industry, transportation system, and government institutions handicapped resource provision and supply after the catastrophe and also inhibited the donor community's ability to acquire available resources. A respondent commented that:

> The conditions in Aceh were not conductive for NGOs to maximize the utilization of local resources and even complicated and reduced the effectiveness of NGOs' reconstruction endeavours.
>
> (Co3)

Moreover, limitations on Indonesia's ability to absorb and utilize local market forces such as social capitals from local communities, the construction sector, and other institutional instruments were apparent and resulted in reliance on assumed support from NGOs. It is also important to note that:

> The Master Plan,[10] formulated by the Indonesian National Government as the 'blueprint' to guide tsunami reconstruction operations, received a 'cold welcome' at the local level despite the widespread consultation with NGOs, local governments and communities. As a conciliatory way, the Master Plan was put aside by BRR and replaced by an evolutionary approach with an emphasis on providing opportunities for communities to participate in the process of reconstruction.
>
> (Synthesis of views from P4, P7 and Co4)

The lack of consistency in mandates, operations and leadership from the government authorities in Indonesia gave a 'free hand' to NGOs involved in post-tsunami housing reconstruction. These NGOs, without appropriate resourcing capabilities, tended to pass a 'free hand' to local unqualified construction

practitioners. Given this, a variety of resourcing problems during post-tsunami reconstruction thus arose.

Indonesia's case raised concerns about whether the international aid agencies and donor society are adequately prepared for post-disaster reconstruction, in particular for resource procurement in a post-disaster situation. The resourcing problems are mainly attributed to the internal capability of NGOs and other issues in the external built environment such as legislation and policy, coordination with other stakeholders and infrastructure conditions. However, all these internal and external aspects were not recognized and addressed by international aid agencies before a rebuilding project commenced. Donor-driven resourcing, with available funding and NGOs' commitment, could be more effective if these aspects are sufficiently understood, resolved and blended into an organizational culture.

Case study 3: Market-driven resourcing approach in Australia

Bushfire reconstruction resourcing context and practice

The 2009 Victorian bushfires in Australia were devastating. The fires affected nearly 80 communities across the state, destroyed more than 2000 homes, and damaged around 430 000 hectares of land. By the time the fires were contained, 173 people lost their lives and many others were seriously injured (Victorian Bushfire Reconstruction and Recovery Authority (VBRRA), 2009). While disaster and emergency relief services were activated immediately, the task of responding to a tragedy of this scale was onerously complex.

On 10 February 2009, the Commonwealth and Victorian Governments established the Victorian Bushfire Reconstruction and Recovery Authority (VBRRA) to oversee and coordinate bushfire recovery and rebuilding programmes. According to VBRRA (2009, pp. 14, 15), at the end of September 2009 insurance assessments had been completed for 99% of damaged residential properties and commercial properties and 80% of claims for destroyed homes had been settled.

The resourcing issue after bushfires in Australia significantly differs from that of developing countries. According to Freeman (2004), in recent years governments in developed nations have focused attention on the regulatory, institutional and infrastructure frameworks that enable the market to meet housing needs. For example, France, New Zealand and the US depend on insurance programmes to address the loss of private housing damaged by disasters (Spence, 2004). In Australia, building codes play a large role in reducing building vulnerability to bushfires (Blong, 2004). The major resource crisis for post-bushfires housing reconstruction primarily exists where there is no capacity to finance the repair or reconstruction of houses in a reasonable time frame. This is consistent with the findings of Comerio (1998) who recognized that housing repair and reconstruction in developed nations is fundamentally concerned with house owners' affordability.

In the wake of the devastating bushfires, the Victorian government introduced a new residential building standard to ensure that new homes, alterations and additions in Victoria are designed, constructed and located to a higher degree of fire safety. The changes in the building rules, however, incurred a huge increase of rebuilding costs. An interviewee estimated that:

> The construction cost for a house in compliance with the new building rules would be five times higher than that of the original one.
>
> (V3)

With the old standard, the costs of building depended on the type of construction and the property's level of bushfire risk. With the introduction of new residential building standards involving enhanced risk assessment, the construction requirements address the level of exposure that a building could face under bushfire conditions. However, this innovation brought about a resourcing difficulty for housing reconstruction:

> When the housing rebuilding commenced in May 2009, the non-combustible materials, such as masonry, brick veneer, aerated concrete, for constructing a new house located at BAL-29, BAL-40 and BAL-FZ level[11] (flame zone) were not available in the market, and material suppliers had not tested some of the materials for window and roof system.
>
> (V3)

The new standard did not allow for cost-effective selection of building materials at the early stage of the reconstruction and, rather, forced a number of house owners to purchase the available and expensive fire-resistant products, pushing up the construction cost. Meanwhile, as pointed out:

> [The] VBRRA had to dedicate a lot of time to getting the reconstruction technology and methodology correct and advising house owners to make decisions.
>
> (V6)

> It also took long time for social organizations to understand the vulnerabilities and to assess local capacities before commencing a project.
>
> (V8)

Other common challenges of resourcing for bushfire housing reconstruction in Australia were identified during the field observations and interviews:

- insurance payment shortfalls due to the higher building standards required for rebuilding of damaged dwellings
- non-synchronization of building code changes and material market development
- shortages of registered builders and a long lead time for them to commence housing repair or reconstruction
- logistics and accommodation for non-local builders, artisans and labour force
- provision of low-cost housing

Analysis of resourcing problems faced by Australian practitioners

The implementation of the overall bushfire reconstruction in Australia is primarily undertaken by local construction professionals. The availability of building resources after the event is mainly determined by market-based forces and their supply-chain capacities. Some interviewees pointed to the importance of the construction sector in the aftermath of bushfires:

> The building industry, for instance, the Victorian Building Commission, the Master Builders Association or Housing Industry Association in Australia played an important role in rebuilding facilitation such as organizing training programs for construction professionals, providing free site assessment for house owners, and introducing hazard mitigation and sustainable development into local government policy.
>
> (Synthesis of views from Cr1 and Cr2)

In spite of this, the resourcing problems in Australia after the bushfires posed a significant challenge to local construction industry with regard to how to provide compliant low-cost housing solutions. According to these interviewees:

> This requires the government to work closely with industry leaders and associations to consider and improve conditions in which the community could manage rebuilding on their own.
>
> (V3)

> it is also necessary to build capacity amongst vulnerable communities to make informed choices from the available options.
>
> (A3)

The interviewees' point of view concurs with that of Lorch (2005, p. 210) who suggested that policies that reward improved performance and innovation may be more effective than the planning and building regulations and the governance imposed by the insurance industry, if these are adequately monitored, enforced and embedded into an organizational culture. This sentiment may provide Australia with an insight into reconstruction affordability which could be addressed by a combination of local financial incentives and the development of low-cost building technologies.

It is clear that a market-driven resourcing approach for housing reconstruction differs from that of normal construction times due to the chaotic, dynamic, and complex nature of post-disaster environment. Successful resourcing implementation in the wake of a catastrophe requires a robust market base and facilitation from governments and construction professionals to assist with the task. Currently, as the above assessment showed, little motivation and reward exists in the Australian construction market to aid the resourcing process for the affected communities. Instead, the upgraded building standards imposed an obstacle to acquiring suitable resources. It would be appropriate for governments to forge strategies, tools and mechanisms in the market to ensure the built environment and communities can respond appropriately to a future disaster and its aftermath.

Comparative analysis of case studies

Which resourcing approach of the three is most effective? The discussions in the paper show differences and similarities between the three different types of post-disaster reconstruction models. The Chinese authorities' way of resourcing for the reconstruction after the Wenchuan earthquake is effective in meeting their rebuilding objectives, although it gives rise to an adverse impact on local economic development. The remedial alternatives by NGOs in countries like Indonesia are preferable where the natural resources are lacking and local institutions are unable to play a leading role in post-disaster reconstruction. However, local market and infrastructure settings in Indonesia are unlikely to assist poorly managed international aid agencies in coping with the logistical requirements of large-scale developments. Australia's case is in line with a common concern in developed countries that the disaster mitigation measures and building standards introduced post-disaster would cause resourcing problems for reconstruction.

The mandated legislation and policies from the Chinese government are a powerful vehicle which articulates both the outcomes of the stakeholder's resourcing efforts and the manner in which the resourcing activities are carried out. However,

government-driven measures could misguide people to improvisational and *ad hoc* tactics and handicap the sustainability and development of the local economy and market. Thus, it has been difficult for authorities to impose regulations of such a kind in countries like Australia where the market economy is dominant.

In Indonesia's case, there was an absence of a political and operational space where local recovery efforts could take a strong hold. The role of the national government through the BRR was limited to information sharing, implementation capability, and communication with aid agencies. The varied and inconsistent objectives among aid agencies, local government, and communities posed obstacles to coordinated resourcing efforts during post-tsunami reconstruction.

Both resourcing approaches in China and Indonesia are representative of situations in many developing countries where socio-economic and political conditions play a dominant role in shaping the nature of reconstruction programmes. The absence of an insurance culture in these two countries is a possible reason for their dependence on assistance from the government or aid agencies. Additionally, China's and Indonesia's cases also suggest that the local construction sector in these countries fell short of their resourcing duties in the wake of the disasters.

In contrast, in Australia, where the government's major role was the restoration of services and public infrastructure, the reconstruction of private housing was conducted by the affected house owners. Market-driven resource availability mainly hinges on developing a mechanism to capitalize on the market leverage for rebuilding affordable housing after a disaster. This is where a market-driven resourcing approach seems more effective than that of driven by government or donors. A realistic assessment of resource availability before and after a disaster combined with market-oriented government facilitation might provide an opportunity for reconstruction implementing agencies or communities to pursue cost-effective and sustainable resource procurement.

It is important to keep in mind the fundamentally different challenges that these contexts present and, consequently, the different efforts they require. Both government- and donor-driven resourcing can be further enhanced by the government fostering an enabling environment and facilitating the procurement and development of resources. The materialization of potential benefits of a market-driven resourcing approach will depend on the particular design of implementing mechanisms, and on the legal and governance context. Therefore, the resourcing focus for post-disaster housing reconstruction should not be on finding suitable overarching frameworks, but on understanding opportunities and pitfalls of different resourcing approaches and what can realistically be achieved in a given context. Ultimately, the success of resourcing depends on multi-stakeholder collaboration and the development of polices, plans, and tools to allow market flexibility, donor management, and government intervention.

Conclusions

Post-disaster housing rebuilding priorities require special attention to be paid to the implications of resource availability for reconstruction performance and to underlying resourcing bottlenecks in the reconstruction process. Resourcing bears on a variety of issues inherent in the post-disaster reconstruction context. Little research has, however, been conducted to look into resourcing and its linkages with post-disaster reconstruction.

Based on in-field surveys, this paper examined and compared three contemporary resourcing approaches, government driven, donor driven and market driven, in post-disaster reconstruction in China, Indonesia, and Australia. Although interventions from Chinese authorities into the Wenchuan earthquake rebuilding operations paradoxically helped mask the pre-existing macroeconomic imbalances in the construction market for a time, inflation chaos and resourcing problems still persisted, hindering reconstruction process and adversely affecting the rehabilitation and development of local economy. Insufficient resourcing capability of the non-governmental organizations (NGOs) involved in post-tsunami housing reconstruction along with complexities inherent in the local context in Indonesia caused significant resourcing frustrations. While a market-driven resourcing method seems desirable, it is unlikely to attain a better outcome without unstinting facilitation and support from other stakeholders such as government and the local construction sector. By linking resourcing with broader plans for sustainable and equitable post-disaster reconstruction, more fundamental action both before and after a disaster can be taken to reduce socially and physically produced resource shortages.

The recommendations outlined below are suggestions for the involved agencies to incorporate into the current resourcing approaches for a potential reduction in their weaknesses and constraints.

Possible improvements to the studied resourcing approaches

- Given China's specific social system, government efforts need to be put into pre-event resource planning and preparedness, monitoring reconstruction needs, maintaining a functioning construction

market by forging strategies to utilize market forces rather than to substitute or restrain their abilities. As the main implementers in physical reconstruction and rehabilitation after a disaster, the construction sector needs to take proactive steps to improve resourcing capability by close interaction and communication with market suppliers in both pre-event and post-disaster situations. The supply chain maintenance and management after a disaster should be enhanced by a flexible blend of government facilitations and market-driven inputs.

- The emphasis of government authorities in Indonesia for alleviating NGOs' resourcing constraints should be on enhancing national capacity and legitimacy, strengthening infrastructure, and facilitating closer communication and coordination with aid agencies. The focus of the NGOs should be on extensively mapping construction capability and local material supply capacity at the early recovery stage, and based on the contextual reality, formulating resourcing strategies for longer-term recovery and reconstruction. Both local government and NGOs could make development efforts in enhancing the capacity of the local institutions and market supply by improving local economic circumstances for business investment.

- The priority of considerations for authorities in Australia should be in the development of market mechanisms and improvements in policy-making to enable a variety of post-disaster resource options for housing. The policy incentives along with a robust insurance system should play a major role in effective housing supply and provision in post-disaster reconstruction. Furthermore, there is a need to involve research institutions and construction-related stakeholders in the development of low-cost building materials and technologies; the training and education for new skills are also needed.

The research in this paper confirms many of the issues from previous studies associated with government-driven resourcing behaviours and the problems existing in a market-driven resourcing approach and donor-driven reconstruction process, and it highlights the importance of multi-stakeholder collaboration and policy innovations. However, through extensive case studies in three post-disaster countries – China, Indonesia, and Australia – this paper identifies the main challenges in each resourcing approach, and also recognizes differences and similarities between these resourcing models to habitat projects. Further, this paper extends many of these findings to other similar contexts to inform proactive thinking and actions in resource availability for reconstruction in a post-disaster situation.

The concept of resource availability for post-disaster housing reconstruction is not only a complement to housing recovery literature, but also a pragmatic endeavour to provide an overview for decision-makers and practitioners to locate their position in a resourcing system and to develop strategies for attaining a customized resourcing approach for reconstruction. The questions and answers in the paper draw attention to this often-overlooked area. The cross-cultural comparative study contributes to the philosophy of project management and encourages policy-makers and practitioners to exchange experiences from recent recovery operations. This research opens up broad channels for future research. Detailed operational aspects under each resourcing approach need to be investigated. Future studies regarding contractor-led resourcing under market-driven circumstances and resourcing for infrastructure reconstruction are likely. Successful resourcing practice in differing recovery contexts should be explored and encouraged.

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Endnotes

[1]Whenever a particular sector in a particular economy experiences a marked boom, the demand for inputs used in that sector tends to increase. This increased demand, in turn, tends to cause negative impacts for other industries that compete for the inputs used in the booming sector. The increased prices of inputs raise costs and reduce profitability in the competing (non-booming) industries. The resulting negative impact on the non-booming sectors is known as 'Dutch Disease', named after the experience in the Netherlands of de-industrialization in the wake of large inflows of export revenues from North Sea Oil in the last 1970s.

[2]For more references on post-disaster housing reconstruction challenges, see the i-Rec website (available at: http://www.grif.umontreal.ca/i-Rec.htm).

[3]The field-based observations by the four authors were recorded in the form of notes. The output based on authors' observations in China was published as a reconnaissance report, embracing the reconstruction progress, challenges and practice along with phenomena of resourcing problems in the market, and resourcing approaches and measures Chinese practitioners adopted to enhance resource availability during Wenchuan earthquake reconstruction. For more information, see Chang *et al.* (2009).

[4]Before the interview, each potential interviewee was advised by the researchers to subscribe the Participant Consent Form through which a number of the interviewees chose to be unidentified by name, gender, position, and status.

[5]For information on NVivo 8 software, see http://download.qsrinternational.com/Document/NVivo8/NVivo8-Introducing-NVivo.htm/

[6]M8.0 represents surface wave magnitude (Ms), the national standard used by the Chinese government for earthquake magnitude. M7.9 for the Wenchuan earthquake from The United States Geological Survey (USGS) reports represents moment magnitude (Mw).

[7]As of noon on 11 September 2008.

[8]A selection of the survey publications on the Wenchuan earthquake is available from the websites of the organizations: Earthquake Engineering Field Investigation Team, Earthquake Engineering Research Institute, Multidisciplinary Center for Earthquake Engineering Research (MCEER), USGS, and National Center for Research on Earthquake Engineering.

[9]The appropriateness of building materials produced by the newly built factories for reconstruction after the Wenchuan earthquake will be investigated by further longitudinal research in China.

[10]The Master Plan was released through the President Regulation (Perpres) No. 34/2005 in April 2005.

[11]For further information, see *A Guide to Assessing your Property's Bushfire Attack Level (BAL)*, and *A Guide to Building in Victoria After the Bushfires, Building Commission Victoria* at: http://www.wewillrebuild.vic.gov.au/