

Interpreting resourcing bottlenecks of post-Wenchuan earthquake reconstruction in China

Abstract

Post-disaster reconstruction is likely to suffer resource shortages and supply disruptions. The devastating Wenchuan earthquake on 12 May 2008 in China served as a typical example. After the catastrophe, resource problems such as soaring price escalation and short-term inflation strain posed a significant challenge to Chinese policy makers and reconstruction team. Based on filed surveys, the study attempts to examine the Wenchuan earthquake reconstruction practice and identify the most vulnerable resources along with resourcing impediments inherent in the reconstruction process. It is found that labour and materials such as brick, cement, steel and aggregate were the most needed yet vulnerable resources at the early stage of reconstruction. Resource procurement was mainly hindered by (1) reconstruction schedule and speed, (2) the impacts of the 2008 global financial crisis, (3) inadequate local transportation capacity, (4) dysfunction of the construction market, and (5) insufficient engagement of local construction industry. While the interventions and measures Chinese government adopted after the earthquake seem to be able to deal with resourcing bottlenecks in a short time; more policy innovations and key stakeholders' participation are needed with a view to fully addressing resourcing challenges confronted in the future.

Keywords: post-disaster reconstruction, resource availability, resourcing constraints, Wenchuan earthquake, China

1. Introduction

The massive earthquake on 12 May 2008 in China brought about severe damage to infrastructure, industrial production and economic sectors in the earthquake zone. The large-scale post-earthquake reconstruction in China, however, was not immune to inflation of resources required. Compounding the economic desolation in the disaster-hit region was the local mounting demand for construction necessities such as skills, materials, and machinery. The disproportionate imbalance between the reconstruction demand and the real supply capacity led to soaring price escalation and intensive inflation strain in the earthquake impacted areas.

The availability of resources allows for the rapid and cost-effective delivery of a construction project. For rebuilding programs after a natural disaster, the need for a better understanding of resourcing bottlenecks in post-disaster reconstruction process and their impacts on post-disaster reconstruction performance can be of crucial importance. The aim of this paper is to contribute to the limited understanding of resourcing practice in post-disaster reconstruction. It does this in the following two stages. First, the overall resourcing context of post-disaster reconstruction is investigated. In particular, resourcing situations in the aftermath of the Wenchuan earthquake in China are presented. This part is hoped to highlight the significance of resource availability in the hierarchy of project management. Second, perceptions and perspectives of 21 practitioners and researchers involved in post-Wenchuan earthquake reconstruction are reported with a view to deepening our understanding of contemporary resourcing practice post-disaster and opening up the potential prospects of resourcing channels for rebuilding projects.

The remainder of this paper will present the research methods and then address the following four questions based on the in-field survey data:

- (1) What were the most vulnerable resources in post-Wenchuan earthquake reconstruction?
- (2) What initiatives had been taken to address resourcing difficulties in China?
- (3) What were constraints to contractor-led resource procurement?
- (4) What need to be addressed in the future to enhance resource availability for post-disaster reconstruction?

2. Research Methods

In attempt to address the above research questions, we adopted empirical-based qualitative methods including field interviews along with desk review of policy documents and media publications. Given the exploratory nature of the study, the interview survey was semi-structured, allowing us to probe areas that open during the discussion (Hussey and Hussey, 1997; Fellows and Liu, 2003). The interview sessions were voice recorded, at the interviewee's discretion, transcribed and coded.

The interviews were conducted in the earthquake-impacted areas in China's Sichuan Province between December 2008 and February 2009. A varied sample was selected containing:

- 13 reconstruction contractors (coded C1-C13) who have been operating in Post-Wenchuan earthquake reconstruction in China and registered with Construction Bureau of People's Government of Mianzhu, China;
- 4 businessmen (coded B1-B4) retailing building materials in the earthquake affected areas;
- 4 academic researchers (coded R1-R4) in areas of construction material and technology, as well as construction procurement; and
- 4 government officials (coded G1-G4) involved in post-Wenchuan earthquake reconstruction administration.

There are three main reconstruction approaches widely applied in the past disaster reconstruction practice: contractor-driven, donor-driven, and owner-driven. During the Wenchuan earthquake, the builder/contractor-led resourcing approach was dominant. The focus of this study, therefore, is focused on contractor-led resource procurement for Wenchuan earthquake housing reconstruction. The selected interviewees were positioned in different specialization areas concerning the resourcing issue post-disaster. The profile of the interviewees is shown in Table 1.

Table 1: Profile of the interviewees

<i>Interviewee Code</i>	<i>Description</i>
<i>Group1</i>	<i>Specialization</i>
<i>C1-C4</i>	<i>Project managers</i>
<i>C5-C13</i>	<i>Resource procurement managers</i>
<i>Group2</i>	<i>Source of resource supply</i>
<i>B1-B4</i>	<i>Construction material retailers</i>
<i>Group3</i>	<i>Research Area</i>
<i>R1-R2</i>	<i>Construction material</i>
<i>R3-R4</i>	<i>Construction procurement</i>
<i>Group3</i>	<i>Main Responsibility</i>
<i>G1</i>	<i>Construction market transaction regulation</i>
<i>G2-G3</i>	<i>Post-quake reconstruction supervision</i>
<i>G4</i>	<i>Transport planning</i>

Within the interviews, qualitative data was captured around the following three issues:

- the most vulnerable resources during post-Wenchuan earthquake reconstruction;
- resourcing initiatives that have been taken to address resource vulnerability; and
- specific resourcing bottlenecks and challenges in the reconstruction process

3. Resource availability for post-disaster reconstruction

According to Shaw (2006), the recovery and reconstruction process will depend on the administrative, political, social, economic and cultural context. Lack of attention paid to these factors, coupled with other unforeseen events will bring about problems such as ‘Cost Surge’ (Rodriguez et al., 2007) and ‘Dutch Disease’ (Corden, 1984; Adam and Bevan, 2004), affecting the speed and effectiveness of resourcing efforts for reconstruction. In the wake of a disaster, the majority of manufacturing-supply facilities and operational systems in up-stream industries in the impacted areas are likely to be damaged and the construction market tends to be in disorder, contested and highly adversarial. This, if combined with disruption of transportation and energy supply, and historical problems of the local industry, could significantly exacerbate the difficulty in project sourcing within the construction industry (Cho et al., 2001; Singh, 2007; Jayasuriya and McCawley, 2008).

The pressure to acquire resources for post-disaster reconstruction is even higher for poorer countries as they have to rely on external assistance, such as NGOs, INGOs, World Bank, etc.; or reallocate resources from existing projects to rehabilitation or reconstruction to meet their recovery needs (Freeman, 2004; Jayasuriya and McCawley, 2008). Consequently, dependence on external aid is likely to suppress local self-production capacity and reduce the likelihood of the reconstruction program succeeding (Cuny, 1983). These resource reallocation tactics disrupt markets and economic order (Makhanu, 2006), adversely affecting sustainable productivity layout and economic and social development goals in the long run (World Bank Operations Evaluation Department, 2005).

In response to market disorder caused by speculative behaviours, regulatory authorities normally turn to ‘hard intervention’ solutions by directly interfering in manufacturing and circulation (Hirshleifer, 1956). According to McGee (2008), price controls could cause resources to be allocated inefficiently and could only serve to delay disaster relief. Therefore, the trade-off between levels of macro control and market self regulation poses a great challenge for policy makers to settle different and conflicting interests of stakeholders without detriment to the disaster-affected areas.

Another major factor adding to the difficulty of post-disaster resourcing is concerned with the environmental impact. Several disasters in recent past pointed out the issue of environment-disaster linkages (Shaw, 2006; Budidarsono et al., 2007). Two specific problems are becoming increasingly prominent environmentally. Firstly, raw material exploitation for making building

components and products poses a great threat to the natural environment system. Secondly, inappropriate sourcing approaches are likely to induce secondary hazards; timber logging, for example, both legal and illegal, contributes to the incidence of flooding and landslides (Shaw, 2006).

In spite of the above propositions, the issue of resourcing for post-disaster reconstruction has not been adequately debated in academic and practical forums. This paper aims to contribute to fill this gap by examining a contemporary case study. An empirical analysis, based largely on China's Wenchuan earthquake (2008) rebuilding experience, of the resourcing practice and outcomes during post-quake reconstruction is presented. Specific resourcing-related constraints that obstructed the post-disaster reconstruction along with the vulnerable resources were identified to inform further thinking and actions of reconstruction stakeholders and of those involved in a similar post-disaster situation. The remainder of the paper presents the research findings in terms of (1) the most vulnerable reconstruction resources in the wake of the Wenchuan earthquake, (2) the measures adopted by the Chinese government in order to address resource bottlenecks, and (3) resourcing constraints inherent in the post-earthquake reconstruction process.

4. Post-Wenchuan earthquake resourcing in China

4.1 Most vulnerable resources

At the early stage of post-Wenchuan earthquake reconstruction, most material production facilities were still in a paralyzed state. The inadequate production capacity and the market disorder created disproportionate imbalance between construction material demand and supply, resulting in soaring price escalation. The most needed construction materials were brick, cement, aggregate with 127%, 30%, and 125% price increase respectively and steel with 30% price decrease thus farⁱ. The price escalation curves of brick, cement, steel and aggregate are presented in Figure 1, Figure 2, Figure 3, and Figure 4 accordinglyⁱⁱ. Although the fall of steel price to some degree eased the tension of steel supply in the earthquake-affected areas, the quantity of the reconstruction demand was, however, sufficient to play a dominant role in posing difficulty to reconstruction practitioners in procurement of steel products. Furthermore, the rebuilding tasks were incommensurate in scale with the available construction labour in the earthquake impacted areas. This led to a precipitous wage increase of local labour, undermining the sustainability of local construction market. The estimated supply shortfalls of main construction materials for a three-year reconstruction period are tabulated in Table 2.

Table2: Supply shortfalls of cement, brick and steel in earthquake-stricken areas

Items	2008-2009	2009-2010	2010-2011
Cement (million tons)	53	39	31
Brick (billion pieces)	35.5	17.8	3
Steel (million tons)	3-3.6	3-3.6	3-3.6

Source: <http://www.sc.gov.cn>

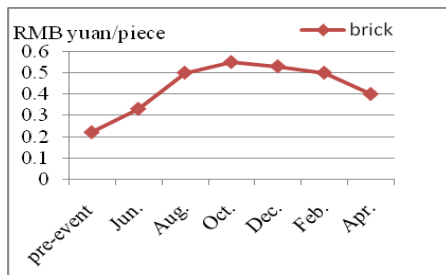


Figure 1: Brick price trend

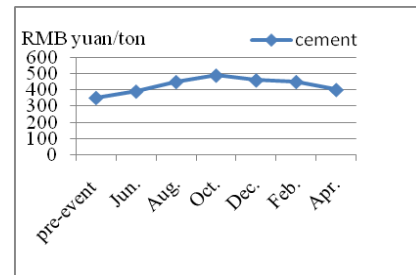


Figure 2: Cement price trend

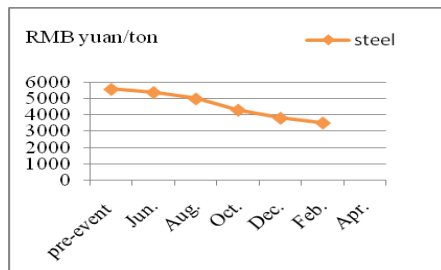


Figure 3: Steel price trend

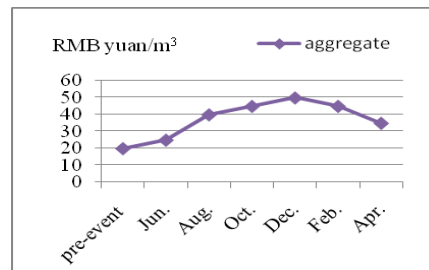


Figure 4: Aggregate price trend

4.2 Current practice to ease resource strains

4.2.1 Government interventions

Against the resourcing background discussed above, the Chinese authorities enforced tight yet flexible price control and market regulatory interventions to push forward price restructuring in brick, cement, aggregate and other building materials. These interventions included a series of temporary price regulations, designating production supply, and assigning inspectors to monitor the selling price. In line with the top priority of reconstruction, there was a specific provision mechanism designed by the municipal local government for rural residences in the earthquake-

hit areas. Furthermore, a cost-monitoring system was set up in a number of manufactories to ensure effective implementation of these temporary price restrictions.

According to the interviewee G1, the temporary price regulations rightly focused on the supply side to directly contain the speculative behaviours in the construction market, limited the growth of price, and prevent all-out inflation in forms of setting maximum rates and profit control over material retailers. For instance, in earthquake impacted Mianzhu city, the local governmental agencies manipulated the selling prices of the specific materials in the following way: the maximum selling price of brick was set to be RMB \$0.36 yuan/brick, the retailing price for C15 concrete was RMB \$315 yuan/m³ containing the transportation fee and the price for C20 concrete was RMB \$345 yuan/m³; In addition, the maximum profit could not access 20% for construction glass and 3% for construction steel (Price Bureau of The People's Government of Mianzhu City, 2008). In the meantime, government provided subsidies in support of material transportation and exempted highway tolls for the vehicles which deliver materials to reconstruction areasⁱⁱⁱ. Additionally, RMB \$0.1 billion of financial subsidies was assigned to the corporations tasked with material production and delivery to the government-designated areas.

4.2.2 Increasing production facilities

According to interviewees G2 and G3, there were 75 cement production lines, 760 brick factories and 2 large-scale steel manufactories approved by the authorities concerned and under construction in Sichuan Province to satisfy three-year reconstruction demand. The transparent supply-demand information platform was established in the provincial government embracing a variety of databases such as demand quantities on construction materials, directories of 95 cement and steel production companies in neighbouring provinces, detailed daily prices of steel, cement and brick in 51 affected counties.

4.2.3 Advocating new building materials

In order to solve the shortages of common building materials, local government encouraged the use of environment-friendly, energy saving and seismic-resistant materials by providing relevant preferential policies. According to interviewees R1 and R2, research on alternatives of construction materials in universities and academic institutions recommended local people affected to construct a wooden house to replace the conventional brick masonry structure. Some sample wooden houses were built up in the affected villages to strengthen the local people's knowledge of seismic-resistant construction technology and materials. Furthermore, local government attempted to formulate policies to recycle construction wastes produced by the earthquake in a combination of government providing land, enterprise investment and market-oriented operation.

4.2.4 Expanding transportation network

As alluded to earlier, lack of access was a critical problem with regard to delivering resources required for reconstruction projects. During our reconnaissance trip to Mianzhu, we had witnessed all kinds of transport for delivering building materials to the construction sites,

including manual and animal carrying methods. When interviewed, G2 introduced that The Transport Ministry of P.R. China approved four river-land joint routes for large cargo delivery by fully capitalizing on the comprehensive transport system nationwide (see Figure 5).

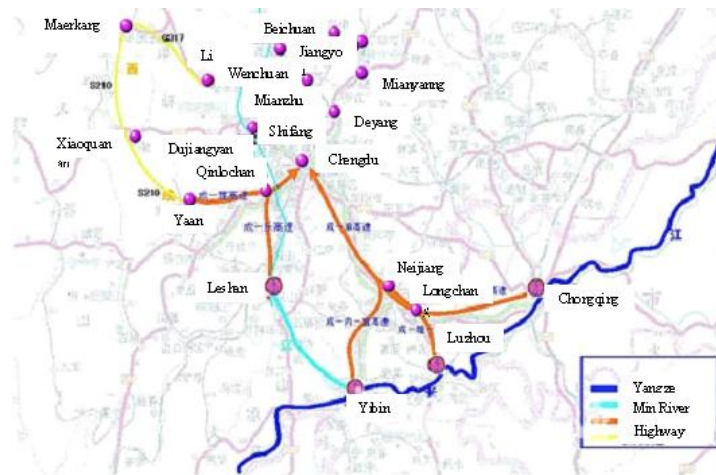


Figure 5: Four river-land joint transport routes after the Wenchuan earthquake

(Source: adapted from <http://www.moc.gov.cn>)

From Figure 5, we can tell that one of the four lines was from Shanghai via Chongqing to Chengdu. The recovery and reconstruction resources were shipped from Shanghai to Chongqing through Yangze River and then transferred to the earthquake affected areas through Chongqing-Suining highway (295 kilometers), Chengdu-Chongqing highway (339 kilometres) and Yuling highway (413 kilometers). These *ad hoc* transport capacity extending strategies for reconstruction to some degree eased the transportation pressure after the quake, it, however, according to interviewee G4, led to a potential transportation conflict between the normal delivery activities and reconstruction needs and added difficulty to the overall logistics coordination.

4.3 Resourcing constraints in post-earthquake reconstruction

In this research, we asked interviewees to indicate the impediments to the process of acquiring reconstruction resources in the aftermath of Wenchuan earthquake. Such a discussion would further reveal the root causes of resourcing problems inherent in the post-disaster context and deficiencies in the current reconstruction practice in China. The main constraints identified are discussed below.

4.3.1 Reconstruction time and speed

According to the material suppliers interviewed, supply shortages of resources required for Wenchuan earthquake reconstruction mainly come from large-scale and intensive demands of reconstruction. In addition, inadequate production capacity due to the earthquake impacts,

increased transportation fee and scarcity of local raw minerals were major reasons for the sky roaring price of bricks which is the most predominant construction material. Most interviewees pointed out that the imperative to complete rural residence reconstruction by the traditional Chinese New Year in 2009, to some extent, intensified the strain on key material supply. Material suppliers B1-B4 and G1 and G2, when interviewed, expressed their anticipation that the resource supply tension could be eased in 2009 with damaged production plants being restored and newly built ones being put into use.

4.3.2 Impacts of the economic crisis

The global economic crisis in 2008 was a less insidious, yet equally destructive calamity to China's construction market, with a great impact on the steel and cement industry in particular. According to China Iron and Steel Association (2009), in the second half of 2008, steel producers in China were cutting their production and dropping prices of steel. Nevertheless, the heavy overcapacity of the steel industry made steel makers in China stock the raw materials they purchased at a high price and unwilling to manufacture steel products. This profit-driven risk aversion to some extent exacerbated the steel supply shortage in the disaster impacted areas. In addition, some contractors (C5, C6, C8, C9, C11, and C12) reported that the financial crisis caused price increase of oil and raw coals in China, also contributing to the resource sourcing pressure in the earthquake affected areas.

4.3.3 Inadequate transportation capacity

The devastating Wenchuan earthquake highlighted the vulnerability of the transportation system in the affected areas. The transport planner G4 revealed that the highway and railway systems were mainly damaged and cut off by a large number of secondary hazards induced by the earthquake and aftershocks, such as landslides, mud-rock flow and 'quake lakes'. Reopening access was a slow process due to the local particular mountainous terrain topology. As the overall post-quake recovery and reconstruction unfolding, the numerous aftershocks constantly disrupted access to the disaster-impacted areas. Some contractor interviewees stressed that lack of access to a great extent inhibited the recovery and reconstruction process.

4.3.4 Dysfunction of the construction market

Although a series of material price control policies and regulations were in place, resource procurement, as a number of contractor interviewees reported, was still a difficult issue to solve. As we observed on the ground, the on-going activities of housing reconstruction in China showed a restricted market mechanism for balancing reconstruction demand and supply. The interviewee G1 commented 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'. According to McGee (2008), price controls caused resources to be allocated inefficiently and served to delay disaster relief. Therefore, the policy interventions should fully activate and enhance the functions of the construction market rather than constrain or substitute the main role of the construction market.

4.3.5 Insufficient engagement of the construction industry

The construction industry in China has not been sufficiently involved in disaster planning and management. The reason, according to our 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). In spite of resourcing facilitation efforts made by the Chinese government, the local contractors and reconstruction organizations in the earthquake-affected areas appeared to be less proactive in reconstruction resource procurement. Except for a few large national construction companies which had resourcing contingency plans integrated into the overall project plan, there were no set schemes and strategies regarding post-disaster reconstruction, and the awareness of engagement into disaster management was poor. 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.

Furthermore, according to a number of the contractors interviewed, for the majority of materials purchased, the planning of deliveries was undertaken on an *ad hoc* basis rather than via a systematic thinking. This led to a prolonged lead time of procurement and the final delay of the rebuilding projects. C1 and C4 stated that some materials like cement could not be delivered to the construction site consistently, resulted in interruptions of the work, and the unfinished piles had to be demolished and rework.

5. Conclusions and future challenges

Construction resource shortage is a recurring problem after a natural disaster. This paper looks into the post-disaster resourcing issue by drawing on the literature and a contemporary reconstruction practice after China's Wenchuan earthquake. Based on empirical data, perceptions and insights of those participating in post-Wenchuan earthquake reconstruction were captured to present a comprehensive view of the most vulnerable resources, current measures adopted, along with bottlenecks of acquiring these resources.

The temporary price interventions on price of main construction materials were proved vital and worked well in a post-disaster situation. However, it, to some extent had been putting the Chinese authorities into a dilemma. On one hand, without tighten-up measures for price control, the construction trade market would tend to be in disorder after the earthquake and people affected would be unable to afford to rebuild houses on their own; on the other hand, the price control and instructions might cause frustration to tradesmen and suppliers, and at the extreme might lead to potential construction market dysfunction. Hence, there is a need for decision makers at higher levels and project planner and management involved to give a due cognisance to the real rebuilding needs and local capacity of material production in the earthquake-hit areas so as to map the reconstruction road in a reasonable way.

The lack of deep understanding of new types of construction materials put a damper on their wide use and application in earthquake affected areas. More channels need to be opened to

solicit communities' opinions and address their worries and concerns regarding the use of new construction materials. Legal efforts need to be made to develop the specific regulations for timber logging and reforestation in a sensible way to make the local wood resources accessible for people affected without detriment to the natural environment.

The outlook for material price in 2009 means that, looking forward, inflation would no longer be a concern for the longer term reconstruction. During the recent episode of building material inflation, new production facilities geared would allow earthquake affected region to absorb more local resources without leading to a price spiral. However, there's a concern that with supply gradually outpacing demand at the late stages of reconstruction, excess production is likely to have a negative contribution to the local economy. This means that a desired volume of investment on material production facilities may need to be adjusted as reconstruction proceeds.

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Endnote

ⁱ price contrast between in April 2008 pre-earthquake and in February 2009 post-earthquake

ⁱⁱ Source: authors' own investigation

ⁱⁱⁱ By the end of November 2008, the exempted highway tolls in Sichuan Province reached RMB \$0.18 billion.