Identifying factors affecting resource availability for post-disaster reconstruction

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Abstract: The availability of resources allows for the rapid and cost-effective delivery of a construction project. For rebuilding programs after a disaster, the need for better understanding of factors affecting resource availability and their potential impacts on resourcing outcomes can be of crucial importance to desirable reconstruction performance. This research attempts to empirically identify the critical factors affecting resource availability for post-disaster reconstruction projects. The results show that the top ten factors with significant influence on resource availability in post-disaster situations are: legislation and policy, project schedule, competency of resourcing manager, qualification of contractor, project resourcing plan, quantity of resources required, resource procurement lead time, general economic environment and resource transportation cost and method. This ranking hierarchy helps draw attention to areas in which policy makers and reconstruction practitioners should make efforts to ensure resource available for post-disaster rebuilding projects.

Keywords: Disasters, post-disaster reconstruction, resource availability, construction projects, China

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Introduction

Resource management in construction projects has been subject to improvements in the last decade, with numerous techniques, algorithms and models incorporated to cater for various requirements of resource procurement, scheduling, optimization and allocation (e.g. (Padilla and Carr 1991; Khattab and Soyland 1996; Hegazy and Kassab 2003; Liu and Wang 2007)). However, these outcomes are not easily applied to reconstruction work after a disaster, because in most cases of post-disaster rebuilding, resources required for a project are no longer easy to secure in comparison with pre-event situations.

Many factors contribute to this difficulty such as the variety and severity of disaster impacts, including physical, economic, social and psychological (IFRC 2006; William L. Waugh and Smith 2006), the diversity and multiplicity of tasks that each working unit is to execute (Berke et al. 1993), and volatility and instability of the market in disaster-stricken areas (Jayasuriya and McCawley 2008). All these factors are highly dynamic as a result of the unpredictable situation post-disaster. Such dynamics make it mandatory for reconstruction planners and project managers to have the capability to continuously adapt themselves to the evolving conditions to cope with emerging problems in the aftermath of a disaster.

Amongst a number of contributors to successful post-disaster reconstruction, resource availability has increasingly drawn attention from practitioners and researchers in disaster management area. Some scholars such as Xie (1994), Ye and Okada (2002), Singh and Wilkinson (2008) have recognized the significant role of resource availability in post-disaster reconstruction. Engaging in post-Indian Ocean tsunami reconstruction programs, many NGOs, INGOs such as IFRC (2006) and the UN agencies such as UNDP (2005) have suggested general lessons and highlighted the importance of resource availability in reconstruction projects.

The post-disaster field observations by Russell (2005) and Zuo et al. (2008) also provided examples in rework or disruption of reconstruction projects, as a result of failure to procure resources required for projects post-disaster. On the other hand, a range of role models demonstrated that post-disaster reconstruction practitioners gained the reward from proactive resourcing strategies and planning (Mitchell 2004) and from good command of potential vulnerabilities and bottlenecks when sourcing resources (Singh and Wilkinson 2008). As costs incurred by disasters continue to rise throughout the world, the onerous reconstruction task could only be achieved through ensured resource availability (Masurier et al. 2008) and prudent allocation of limited resources (Freeman 2004).

Despite the inherent links between resource availability and reconstruction performance, little research and practical effort has been made to show the limitations on resource availability after a disaster or provide solutions to address this issue. The need for an in-depth investigation on factors affecting project resource availability in post-disaster rebuilding environments is, therefore, imperative for better resource-ensured reconstruction. To fulfill this need, this paper aims to develop a ranking hierarchy for post-disaster reconstruction by identifying the determinants affecting project resource availability in such an environment.

Resourcing of Post-disaster Reconstruction: Theory and Practice

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 projects. In the wake of a disaster, the majority of manufacturing-supply facilities and operational systems in up-stream industries in disaster-stricken areas are likely to be damaged and the construction transaction market tends to be in disorder, contested and highly adversarial. This, if combined with disruption of transportation and energy supply, and historical problems of 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 the 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 (Work Bank Operations Evaluation Department 2005).

In response to market disorder caused by speculative behaviors, regulatory authorities normally turn to ‘hard intervention’ solutions by directly interfering in manufacturing and circulation (Hirshleifer 1956). Herein lies another problem, that of generic restrictions posing a major disincentive to other suppliers from actively getting engaged in post-disaster reconstruction resourcing efforts (Chang 2008). According to McGee (2008), price controls cause resources to be allocated inefficiently and could only serve to delay disaster relief. Therefore, the tradeoff 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 lies in 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; logging, for example, both legal and illegal, contributes to the incidence of flooding and landslides (Shaw 2006).

Availability of resources has been recognized by a limited number of scholars as a driving force necessary for the successful performance of construction projects (Tukel and Rom 1998; Chua et al. 1999; Bassioni et al. 2004; Bassioni et al. 2005), and few of them, in part, mentioned potential factors affecting resource acquisition outcomes. Belassi and Tukel (1996) suggested that resource availability is a system response to organizational, environmental and project management-related factors, such as top management support, project manager's negotiation skills, the general economic situations and the organizational type of project. They also highlighted that a number of environmental factors such as political, economic, and social factors might to a great extent influence the resource availability and thus the project manager's performance on the job. Morris and Hough (1987) illustrated political influence with examples as a crucial environmental factor affecting resource availability of construction projects.

Manavazhi and Adhikari (2002) identified main causes of material and equipment unavailability induced by procurement delay: organizational weaknesses, suppliers' defaults, governmental regulations and transportation delays. In addition, inadequate planning may delay the project resource supply due to material shortages (Tserng et al. 2006). Singh and Wilkinson (2008) suggested proper scheduling of resource utilization and pre-planning whereas Liu and Wang (2007) advocated 'project duration compression' to ensure resource availability.

A more integrated project procurement mode is more likely to be able to secure resources required, such as in engineering-procure-construct (EPC) projects. Closer cooperation between procurement and construction functions enables direct receipt of materials from suppliers to a construction site (Yeo and Ning 2002). The design phase is usually followed by a process where the successfully selected project team is mobilized and resources are procured to deliver the project. This is where sub-optimal procurement choices can have a profound impact on project delivery value (Walker and Rowlinson

2008). From this perspective, detail drawings (Tatum 2005) and construction method (EI-Rayes and Kandil 2005) seem to carry connotations of the availability of different types of resources to be utilized.

Pryke (2004) underlined the important role of the social network of project stakeholders, especially large contractors in resource acquisition. On account of their purchasing power, large contractors are able to deal directly with manufacturers and wholesalers thus acquire resources easier than small and medium units (Agapiou et al. 1998). In addition, site location also affects lead time of procurement which directly determines resource availability (EI-Rayes and Khalafallah 2005).

In post-disaster reconstruction research, Singh (2008) concluded that five factors influence availability of resources for reconstruction including prioritization of works, ability to pool resources, lead time of procurement, existing contractual relationships and transportation into and around the disaster zone. According to Singh and Wilkinson (2008), availability of resources is also governed by the policies and strategies put in place by the authorities to deal with the reconstruction phase.

Research Methods

The research approach, namely statistical analysis with aid of questionnaires and SPSS, was employed to determine the key factors affecting resource availability in post-disaster reconstruction situations. The questionnaires were sent by post, email or personal delivery in our field trip to 90 randomly selected building contractors involved in reconstruction work after China's Wenchuan Earthquake (2008). In questionnaire, we asked the respondents to rank the importance of each factor in achieving resourcing outcomes of post-disaster reconstruction projects on a five-point Likert scale from 1 to 5, where 1 symbolizes 'not important at all' and 5 represents 'very important'. The questionnaire also requested the informants to add any other potential factors and rate them accordingly.

Pilot Study

Apart from the factors identified from literature above, a pilot study was undertaken in a manner of independent interviews with experienced personnel involved in post-disaster reconstruction to supplement the questionnaire. These people consist of three NGOs construction coordinators of post-tsunami housing reconstruction program in Indonesia, two academic researchers in reconstruction procurement at Sichuan University, China and three project managers in charge of resource procurement in post-Wenchuan earthquake rebuilding projects.

One Sample T-test

The statistical analysis was conducted by using SPSS 15.0 software package. One sample t-test of the mean was used, based on the sample's ratings, to check if the factors identified within the questionnaire were significant in affecting project resource availability in post-disaster reconstruction situations.

Descriptive Mean Rank

By using descriptive statistics in SPSS, a ranking of the factors perceived by respondents was carried out to identify critical ones which bear significantly on resource availability of reconstruction projects after a disaster.

Research findings

Pilot Study Result

The additional factors recognized in pilot study are shown in Table 1. Employing content analysis, we categorized the potential variables into five groups with the following headings: market-related factors, logistics-related factors, project-related factors, organization-related factors, and environment-related factors.

Table 1 Additional factors identified by pilot study

No.	Additional factors identified via pilot study
1	Resource price fluctuation in market
2	Local production capacity
3	Competition for resources from other reconstruction projects
4	Competition for resources from other existing construction projects
5	Competition for resources from other industries
6	Location of depot
7	Quantity of resources required
8	Contractor resource database system
9	Supplier inventory
10	Contractor inventory
11	Communication with local authorities
12	Physical impact of the disaster
13	Community influence

Questionnaire Survey Result

The sampling frame contained 218 building contractors registered with Construction Bureau of People's Government of Mianzhu, Sichuan Province, P.R. China. Out of 90 questionnaires sent out, 29 responses were returned with response rate of 32.2% within three months. The composites of these informants were construction coordinators (21%), project managers (17%), and procurement managers (62%) responsible for material and equipment sourcing operations. The average working experience of the informants in the construction industry is 16 years. The maximum and minimum working experiences are 3 years and 36 years respectively. Only one respondent proposed 'policy execution/enforcement capability' as a necessary factor to be added. The profile of the respondents is shown in Table 2.

Table 2 Profile of the questionnaire respondents

Reconstruction Project		Frequency	Percentage
Project Type			
Residential		12	41.4%
Public Facilities	School	4	13.8%
	Hospital	2	6.9%
Industrial		7	24.1%
Civil Engineering		4	13.8%
Project Duration			
Up to 12 months		21	72.4%
13-24 months		5	17.3%
>24 months		3	10.3%
Contractor Size			
Large		12	41.4%
Medium		6	20.7%
Small		11	37.9%
Respondent Experience			
Up to 5 years		6	20.7%
5-10 years		4	13.8%
>10 years		19	65.5%

T-test result in Table 3 indicates that only 2 factors, namely competition for resources from other industries (sig. 0.115) and social public attitude (sig. 0.281) fall in the rejection range of the alternative hypothesis H_1 due to their significance level greater than 0.05. It seems that they are not important with regard to resourcing efforts while the other 35 attributes indentified have an influence on project resource availability in post-disaster reconstruction.

The ranking hierarchy of significant factors affecting project resource availability in post-disaster reconstruction is tabulated in Table 4. The top ten determinants were legislation and policy, project schedule, competency of resourcing manager, qualification of contractor, project resourcing plan, quantity of resources required, resource procurement lead time, general economic environment, transportation cost and transportation method.

Table 3 One sample t-test result

No.	Factors affecting project resource availability in post-disaster reconstruction	Mean	*t* -value	SD	Significance (2-tailed)
	(I) *Market-related factors*				
1.	Resource price fluctuation in market	3.97	6.009	0.865	0.000
2.	Local production capacity	4.24	9.040	0.739	0.000
3.	Competition for resources from other reconstruction projects	4.07	8.844	0.651	0.000
4.	Competition for resources from other existing construction projects	3.59	3.829	0.825	0.001
5.	Competition for resources from other industries	3.34	1.625	1.143	0.115
	(II) *Logistics-related factors*				
1.	Local transportation capacity	4.38	9.581	0.775	0.000
2.	Transportation method	4.48	12.602	0.634	0.000
3.	Transportation cost	4.55	12.183	0.686	0.000
4.	Resource procurement lead time	4.59	12.520	0.682	0.000
5.	Location of depot	4.10	7.697	0.772	0.000
	(III) *Project-related factors*				
1.	Project design drawings	4.21	8.401	0.774	0.000
2.	Quantity of resources required	4.59	13.607	0.628	0.000
3.	Project type	4.00	5.203	1.035	0.000
4.	Project schedule	4.66	18.427	0.484	0.000
5.	Project budget	3.90	5.617	0.860	0.000
6.	Type and method of construction	3.66	4.118	0.857	0.000
7.	Project procurement method	4.00	6.075	0.886	0.000
8.	Resource procurement contract type	3.52	3.057	0.911	0.005
9.	Project resourcing plan	4.59	9.034	0.946	0.000
10.	Location of construction site	4.38	11.945	0.622	0.000
	(IV) *Organization-related factors*				
1.	Qualification of contractor	4.59	10.360	0.825	0.000
2.	Selection of suppliers	3.41	2.268	0.983	0.031
3.	Partnership and supplier management	4.14	8.250	0.743	0.000
4.	Contractor resource database system	4.48	13.899	0.574	0.000
5.	Supplier inventory	3.97	7.112	0.731	0.000
6.	Contractor inventory	4.14	7.353	0.833	0.000
7.	Cooperation of parties in construction	3.86	5.073	0.915	0.000
8.	Coordination among parties in construction	3.69	4.170	0.891	0.000
9.	Communication with local authorities	4.34	6.717	1.078	0.000
10.	Contractor top management commitment	3.62	3.186	1.049	0.004
11.	Competency of resourcing manager	4.59	9.855	0.867	0.000
	(V) *Environment-related factors*				
1.	Legislation and policy	4.83	25.601	0.384	0.000
2.	General economic environment	4.55	13.229	0.632	0.000
3.	Local pre-event economic condition	4.10	7.697	0.772	0.000
4.	Physical impact of the disaster	4.14	8.250	0.743	0.000
5.	Social public attitude	3.21	1.099	1.013	0.281
6.	Community influence	2.62	-2.262	0.903	0.032

Note: Scale ranges from 1 = 'not important at all' to 5 = 'very important'. The null hypothesis is H_0: $\mu=\mu_0$ and the alternative hypothesis is H_1: $\mu>\mu_0$, where μ is the population mean, μ_0 is the critical rating at 3. The level of significance for the one-tailed test is 0.05.

Table 4 Ranking hierarchy of significant factors affecting project resource availability in post-disaster reconstruction

Rank	Factors affecting resource availability in post-disaster reconstruction	Mean
1	Legislation and policy	4.83
2	Project schedule	4.66
3	Competency of resourcing manager	4.59
4	Qualification of contractor	4.59
5	Project resourcing plan	4.59
6	Quantity of resources required	4.59
7	Resource procurement lead time	4.59
8	General economic environment	4.55
9	Transportation cost	4.55
10	Transportation method	4.48

Note: Sig. of these factors is 0.000, less than 0.05

Discussion

Legislation and Policy

Legislation and policy are concerned with a portfolio of legislative and regulatory provisions pertaining to post-disaster reconstruction operations. This result is consistent with the findings of two studies (Lowndes and Skelcher 1998; Considine and Lewis 1999) that in the hierarchical governance model, 'legitimate' authority provides the means of integrating and regulating the relationships between actors into a functional system of operation. Invariably, legislation and policy package has been regarded by a number of researchers as an overarching imperative to allow effective coordination and delivery of reconstruction work (Godschalk 1999; McEntire et al. 2002; Birkland 2006; Masurier et al. 2008). However, the reconstruction facts in Indonesia and Sri Lanka after Indian Ocean tsunami (2004), and in New Orleans after Hurricane Katrina (2005) revealed that existing legislation and policy seemed to be unable to cope with post-disaster situations (Zuo et al. 2008), especially after a large-scale disaster (Masurier et al.

2006); and inappropriate legislative and governmental system could substantially limit the recovery progress (Burby 2006; Nazara and Resosudarmo 2007; Lyons 2009) and hinder reconstruction resource procurement and utilization (Hanaoka and Qadir 2005).

To be more certain of fulfilling resourcing needs of post-disaster reconstruction, a specific legislative and regulatory system is required. Legislation and policy, as a powerful confluence, needs to be revamped prior to future disasters in order to facilitate effective resource acquisition and utilization for long-term sustainability in disaster prone countries. An effective enforceability of legislation and policy is essential to formulation of an overall resourcing system and its outcomes after a disaster.

Project Schedule

Project schedule was thought of as the second significant factor influencing resource availability during reconstruction. This result agrees with Belassi and Tukel's study (1996) which proved that the urgency of a project, as one of project attributes, plays an important role in post-disaster reconstruction. Much of such urgency comes from livelihood recovery, notably residential reconstruction, often as the top priority for disaster-affected communities. The role that reconstruction can play in long-term community redevelopment is often overlooked. For instance, there was an imperative to complete rebuilding of permanent residences before winter for people affected by Great Pakistan Earthquake in North Pakistan (2005) and people impacted by Wenchuan Earthquake in China (2008). In these situations, no enough time was allocated to reconstruction planning and scheduling (Schwab 1998) and normal planning procedures and construction legislation were frequently bypassed (Silva 2007). As a result, the project is more likely to suffer resourcing bottlenecks (Resilient Organisations 2006), exceed budgets (Davidson et al. 2008) and overrun schedules (Steinberg 2007). Given tight schedules in some of reconstruction projects, fast-track (Rowland 1995; Masurier et al. 2008) was introduced to expedite recovery and reconstruction; yet conversely, it often resulted in poor decision making (Silva 2007), poor reconstruction quality (Zuo et al. 2006) and to a great extent intensified the shortage of resources and rate escalation of major building materials in the construction market (Jayasuriya and McCawley 2008).

It seems that the impact of project schedule on resource availability is overlooked in conventional construction management practice, though they are intrinsically linked with project resourcing outcomes. This becomes more significant particularly in post-disaster situations and can serve as a very important factor taken into account during reconstruction project resource planning.

Competency of Resourcing Manager

Competency of resourcing manager is defined as the ability of resourcing managers to procure resources needed for project construction in a timely, economical and environmental manner. This result demonstrates that though much attention is given to the competency of project managers in construction projects (e.g. (Edum-Fotwe and McCaffer 2000; Pheng and Chuan 2006)), resourcing responsibility mainly falls to a functional manager in charge of resource procurement. Spekman (1985) highlighted the important role of the procurement sector within a construction company in monitoring, gathering and dissemination of material-purchasing related information. Similarly, Singh and Wilkinson (2008) and Zuo et al. (2008) accentuated a more proactive stance needed for resourcing managers in efficient procurement/material management under post-disaster reconstruction circumstances where the broader social aspects are required such as environmentally responsible behaviour (Chang et al. 2006), and maintaining the right relationships with stakeholders (Edum-Fotwe and McCaffer 2000).

To achieve this, capacity enhancing for those responsible practitioners in post-disaster reconstruction is needed through the provision of training, expert advice, or funds (Kenny 2005). Targeted education and technical assistance programs should be provided (Yoshida and Deyle 2005). We suggest that large-scale construction companies provide procurement expertise to assist small and medium-size corporations with training in basics of resourcing procedures, assessing quantities of resources required and strategic procurement skills to reduce lead time and cost; local construction governmental agencies play a coordinative role in facilitating such technical assistance by providing financial or in-kind support to launch a series of training initiatives.

Qualification of Contractor

Qualification of contractor not only refers to the scale, financial and technical capability of a contractor, but also their industrial influence and social network. It was highly regarded as a key element to pool and source resources required during an emergency. This finding is in line with the study result of Zuo et al. (2006) who found that large-scale contractors are more likely to procure resources needed for disaster reconstruction. One of the reasons is that many large contractors have maintained a long-term relationship with their subcontractors and suppliers, and it is this stable connection that determines the priority of large contractors in resource acquisition in the hierarchy of post-disaster reconstruction.

Another possible reason for superior resourcing ability of large contractors is that, in comparison with those of small or medium size, they are likely to have more competent professionals in resourcing. In this research, amongst 29 respondents, out of 19 with more than ten-year working experience in procurement, 12 were positioned in large construction companies, 5 in small-size construction companies and 2 in medium-size construction companies. These professionals contribute to the organization enabling the contractor to better handle the resourcing tasks in post-disaster situations.

In this regard, large-scale contractors, as the leading players in the industry, should advocate the collective promoting programs with other counterparts of smaller size, including synchronizing interdependent processes, integrating information systems and organizing distributed learning. A range of '*fit-for-purpose*' contractual relations and well-tailored *ex ante* resourcing strategies, when appropriate, could be linked with positive measures to foster resourcing capability of small or medium size contractors.

Project Resourcing Plan

Apart from basic plans, project resourcing plans should involve proactive and preventive schemes to address potential sourcing bottlenecks. The significance of this variable is in accordance with findings in the previous study showing that a well-organized plan rooted in good factual detail can make the process manageable (Schwab et al. 1998). In a disastrous situation, this plan is essential and will be dependent on knowledge of available resources for an initial response to the emergency and subsequent restoration phases (Alexander 2002).

However, resourcing is always decided after the disaster which prevents the construction sector from being ready against disasters, and potential resources being used efficiently. Against this background, Yeo and Ning (2002) advocated that suppliers could contribute to improving contractor's planning efficiency by providing more accurate and timely information inputs into the resourcing plan. In addition, planning attention should be focused on critical resources with long lead time from overseas manufacturers (Zuo et al. 2006). Detailed planning also needs to be decentralized to the level responsible for the execution of the works (Winch and Kelsey 2005), because focusing on details of implementation is at the heart of preparing the elements of the plan for long-term post-disaster reconstruction (Schwab et al. 1998).

From the perspective discussed above, project resourcing plan to a great extent determines the success of post-disaster project resourcing. It is important to incorporate as much resource-associated information into the plan as possible by network building among stakeholders. The construction planning should be made through a proactive approach that is cognizant of the actual resource availability situations.

Quantity of Resources Required

The importance of this factor concurs with the assessment conducted by Hopkins (1995) who pointed out that the total resources needed for full reinstatement is a starting point for assessing the implications for reconstruction timing, resource availability and supply/demand. Reconstruction tasks were incommensurate in scale with the available resources in the wake of Wenchuan earthquake (2008) and caused a number of problems undermining the construction market such as disproportionate imbalance between construction material demand and supply, and precipitous wage increase of local labors.

As shown in Table 5, estimated supply breakdowns of main construction materials for the three-year reconstruction in Sichuan Province, China indicate the significance of resource availability in post-disaster rebuilding. The huge supply shortages were mostly induced by widespread and intensive rebuilding work which posed a significant challenge to the construction industry. However, the quantity of resources depends on a number of variables such as physical impacts of the disaster, construction type and method, and requirements of building owners, etc., all of which deserves proper consideration for both project procurement managers and reconstruction planners.

Table 5 Supply breakdowns of cement, brick and steel in earthquake -stricken areas in Sichuan Province, China

Building material	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: Adapted from http://www.sc.gov.cn

Resource Procurement Lead Time

Still one of the top ten factors, resource procurement lead time is concerned with the interval between the initiation of resource procurement and receipt of the resource into the project construction system. This result conforms with the findings of the study carried out by Singh (2007) who concluded that lead time associated with acquiring resources in post-disaster situations can be detrimental to the availability of these resources, especially in a construction industry which relies heavily on “just-in-time” delivery. Furthermore, the fact that most reconstruction projects are likely to be fast tracked means that lead time and delays will be even more critical. Some reconstruction failure examples (e.g. (Steinberg 2007; Zuo and Wilkinson 2008)) could be traced back to low resource coverage and long lead time in resource acquisition process leading to cost overrun and project delay.

Therefore, the inherent relationship between resource procurement lead time and other factors which affect it, especially those causes of prolonged lead time, should be understood by resourcing managers. Having a symptom-targeted procurement strategy prior would effectively reduce the risks of long lead time and at the same time, enhance procurement capability of resourcing professionals.

General Economic Environment

The overall economic environment, globally, nationally and locally, plays a prominent role in post-disaster reconstruction work which in turn provides a 'window of opportunity' to re-structure the economic layout. Jayasuriya and McCawley (2008) have exemplified the influence of this factor on resource availability in post-disaster reconstruction. They demonstrated that, unlike Indonesia, Thailand had not suffered from resourcing bottlenecks during reconstruction after Indian Ocean tsunami (2004) because of its particular economic circumstances. The higher demand in tsunami-impacted areas came in the context of a depressed construction sector which had not fully recovered from the 1997 economic crisis and so failed to cause price escalation post tsunami.

The general economic environment is, therefore, an influential factor impinging on resource availability after a disaster. Its facilitation function for post-disaster reconstruction resourcing efforts could only be realized through a prudent policy combination of robust and extensive program of global economic integration and domestic deregulation, as well as sound macro-economic management in disaster-prone countries.

Transportation Cost and Method

Transportation systems such as roads, airports, railways serve as lifeline access to available resources for a country's rapid and successful recovery. The mean responses of transportation cost and transportation method were 4.55 and 4.48 respectively. The significance of transportation has been confirmed in previous research. Some studies looking into post-disaster reconstruction logistics have manifested that high cost of resource transportation (Limoncu and Celebioglu 2006), and lack of delivery alternatives (Singh 2007) are a major concern for overall reconstruction. The unavoidable costs related to logistics, such as cost incurred by lack of consistency in delivery and by volatile price fluctuation of fuel and physical distribution, account for a large fraction of resource sourcing costs.

In a post-disaster situation, due to the disaster impacts on physical infrastructure and local geographic conditions, location of the construction site in association with distance, method and cost of resource delivery has an influence on resource availability. The questionnaire survey result shows that location of the construction site was deemed as an important factor ranked at 13^{th} with mean response at 4.38. Hanaoka and Qadir (2005) and Donnges (2005) advocated transport development programs to aid both immediate relief and long-term economic recovery after a disaster.

Given the salient importance of transportation in post-disaster resourcing process, the transport capacity extending strategies should be integrated into the pre-disaster mitigation program and be targeted at transport alternatives to enhance the resistance and resilience of the overall transportation system in disaster-prone areas. The strategic planning for infrastructure reconstruction of transport should also be in line with industrialization and urbanization in disaster-impacted areas taking account of natural environmental conditions and capacity.

Conclusions

Because of the complex, dynamic, and unpredictable environment in the aftermath of a disaster, the conventional procedures associated with project resource procurement are likely to be inapplicable to the disaster context. The ten most statistically significant factors affecting post-disaster project resource availability are useful for reconstruction planners and stakeholders to facilitate resource acquisition for rebuilding projects.

Continuous improvement to remove bottlenecks or constraints in the resourcing process and to tap resourcing paths and alternatives is a challenging job confronting post-disaster reconstruction practitioners. It is anticipated that the research constitutes an approach for understanding and adapting to these changes and uncertainties.

Each underlying relationship among factors identified is naturally intricate, causal and interrelated in post-disaster situations. Clearly, the nature of resourcing practice during post-disaster reconstruction requires a systematic thinking of how best to achieve resource availability for post-disaster reconstruction projects. The research in this paper provides a means in which to understand and enhance this practice.

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