SUPPLY CHAIN ANALYSIS AND THE SUSTAINABILITY OF POST DISASTER CONSTRUCTION

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Abstract

Producing buildings call on the expertise of a wide range of people, initially with the design of the building and finally with its construction. This process is becoming increasingly complex and the industry has developed, over time, methods of accommodating this complexity which it has embedded into the management of such projects. Relationships are set out in well-known contractual forms and the process of design deadlines, deliverables, sourcing, delivery, pre-assembly and final erection continue to be refined with new technologies and working methods. While the interaction between the design and construction aspects of such a process are fascinating, this paper looks at the supply chain management (SCM) associated with the sustainable construction side of this process and more specifically, at the situation of post disaster reconstruction of housing in Aceh following the tsunami of December 26, 2004. This paper examines the adoption of sustainable practices at all stages of the supply chain and as well as the implications of such practices in post disaster reconstruction. Lessons learnt are given so that a more sustainable response to post disaster reconstruction can evolve and be adopted.

Keywords: Supply Chain Management; Sustainability; Post Disaster Construction.

Introduction

SCM Literature Overview

In order to accommodate the growing complexity of construction process, various management systems and methods have been developed in academic researches and well applied in industry practices. Among those, supply chain management (SCM) becomes increasingly popular, especially within the context of broader cooperation, vertical disintegration and the viewpoint of a networked supply chain in the construction industry. Its popularity has been stimulated by a range of sources including the quality revolution (Dale et al. 1994), notions of materials management and integrated logistics (Carter and Price 1993), a growing interest in industrial markets and networks (Ford 1990, Jarillo 1993), and influential industry-specific

studies (Womack et al. 1991, Lamming 1993). ‘Supply chains’, ‘demand pipelines’, ‘value streams’, ‘support chains’ are some examples of the terms used to describe this process.

A predominant approach to SCM research is the so-called ‘supply management’, which emphasizes primarily the buyer-supplier relationship (Leenders et al. 2002) within the process. Since suppliers have a profound and direct impact on cost, quality, time and responsiveness of the buying firms, the management of relationships with other members of the supply chain (i.e. buyer–suppler relationship) is increasingly being referred to as SCM (Chen and Paulraj, 2004). The literature on SCM has constantly emphasized the importance of effective two-way communication to the above relationship. Carr and Pearson (1999) argue that in order to jointly find solutions to material problems and design issues, buyers and suppliers must commit a greater amount of information and be willing to share sensitive design information. However, this is often achieved through engineer-to-engineer communication on design issues keeping in mind improved process capability, manufacturability and performance without affecting profit margins (Bhote 1987, Dobler et al. 1990, Turnbull et al. 1992). Poor communication was often a fundamental weakness in the interface between a buying firm and its supplier, it undermined the buying firm’s efforts to achieve increased levels of supplier performance (Lascelles and Dale 1989). This is a major problem experienced by various agencies involved in the Aceh reconstruction and embodied in competition for resources and increased difficulty in materials procurement.

Traditional practices of supply chain management tend to contract with multiple suppliers even for the same material or component. This is partially due to the consideration of risk reduction with multiple options and avoidance of becoming source dependent. However, reduction of the supplier base is a unique characteristic of contemporary buyer–supplier relationships (Newman 1988, Helper 1991), because the administrative or transaction costs associated with managing a large number of vendors often outweigh the benefits (Dyer 2000). This is especially the case in the Aceh reconstruction given the limited availability of construction materials and often inadequate administrative ability of reconstruction agencies. Many firms are reducing the number of primary suppliers and allocating a majority of the purchased material requirements to a single source (Pilling and Zhang 1992, Kekre et al. 1995). The benefits attributed to this practice often exceed those achieved through traditional bidding from multiple sources, which often emphasizes low price at the expense of performance (Mohr and Spekman 1994). Moreover, supply base consolidation sets the stage for future development of the chosen suppliers (Handfield 1993).

Long-term relationships between supplier and buyer have become a crucial characteristic of modern supply chain relationships (Shin et al. 2000). Through close relationships, supply chain partners are willing to share risks and reward and maintain the relationship over a longer period of time (Cooper and Ellram 1993, Stuart 1993). Hahn et al. (1983) compared the potential costs associated with different sourcing strategies and suggested that companies would gain benefits by placing a larger volume of order with fewer suppliers using long-term contracts. Moreover, through a long-term relationship, the supplier will become part of a well-managed chain and will have a lasting effect on the competitiveness of the entire supply chain (Choi and Hartley 1996, Kotabe et al. 2003). A well-coordinated joint order of similar construction materials by several NGOs would be a good example of sustainable management of such practice.

A recent trend of supplier certification provides a potential solution to the procurement problems relating to the selection of tenders. It involves the thorough examination of all aspects of a vendor’s performance and is expected to enhance buyer–supplier trust and communication; to improve supplier product quality, to reduce communication errors and to reduce inspection and inventory costs for the buyer (Schneider et al. 1995, Larson and Kulchitsky 1998, Ittner et al. 1999). Recently, supplier certification has been extended to include the logistics function. American Quality Foundation and Ernst and Young (1998), in their international quality study of

over 500 organizations, reported that formal programs for certifying suppliers showed an across-the-board beneficial impact on performance, especially in quality and productivity.

Sustainable Development in Construction Industry

As discussed above, SCM has long been considered an important strategy for public sector governance. It has, however, proven difficult for all governments, globally, to implement (Burnes and Coram 1999). Research shows that relationship management brings about more harmonious working relationships (Cheung et al. 2006). Relationship management is a sustainable approach to the industry in terms of social, environment and economics sustainability, as well as helping to satisfy client and stakeholder interests (Darwin et al. 2000; MacNeil 1978; Rousseau and Parks 1993). Clients and contractors can potentially make savings in their operations under a relationship management regime through sharing and exchanging technical and managerial knowledge of the project.

The quest for sustainability has put the construction industry under immense pressure from the Government and general public to improve its unsustainable pattern of project delivery. Sustainable development was popularised and defined by Brundtland (1987) as "development that meets the needs of the present without compromising the ability of the future generation to meet their own needs". Analysis of the construction industry's project delivery process substantiates the need for the industry to engage with sustainable development (BRE, 2000).

The implementation of sustainable development in the construction industry could be referred to as "sustainable construction". Sustainable construction comprises many processes through which a profitable and competitive industry delivers built assets to enhance quality of life and stakeholder satisfaction (DETR 2000). Embedded in this definition is the notion of economic growth with an emphasis on social and environmental integrity. The environmental, social and economic impacts of the construction industry are extensive, often irreversible, readily identifiable and sufficiently documented (Oforig 1992, Griffith 1994, Chen and Chambers 1999). Recent research has shown that it is becoming more apparent to the industry that the sustainability agenda falls beyond environmental protection but also includes social and economic objectives (CRISP 1999). Increasingly, sustainability is becoming a major part of project procurement criteria, which is a crucial factor to be considered, especially in post-disaster reconstructions.

Research methods

The methodology used in this research includes a comprehensive review through the modern literature of SCM, focusing on several aspects closely related to the post disaster procurement process in Banda Aceh, namely, communication needs, supplier base reduction, supplier and logistics integration, long-term relationship management and sustainable construction. These topics will later be addressed and referred to in case experiences discussions. Two authors of this paper spent a month fieldtrip in Banda Aceh, 2 years after the Tsunami, then followed up one year later with another 2-month fieldtrip working with the Indonesian branch of an international humanitarian aid organisation involved in the house reconstruction project for local refugees. During those trips, extensive interviews were carried out with construction managers, procurement managers from different NGO's and UN agencies, representatives from local authorities overseeing the reconstruction process in Aceh and local staff in those NGO's as well as members from the Village Development Committee and affected communities.

Major obstacles associated with construction materials procurement were identified during interviews. Two typical methods representing local and international supply chains for timber procurement were selected out for detailed analysis. Data collected and ideas generated from

this series of interviews and pilot case studies were incorporated and expressed in the discussions within the following sections. Several recommendations were made in the conclusions to tackle the problems encountered in post-disaster procurement to streamline the supply chain for reconstruction.

Research results

During the 2004 Boxing Day Tsunami, some 130,000 people were killed in Aceh alone and 37,000 remain missing. 3 months later, another big earthquake on March 28 2005 added 1,300 to the death toll in Nias, Simeulue and the southern coastline of Aceh. These consequent tragedies caused immense economic, social and environmental devastation to Aceh and surrounding areas that were already under the poverty line. It is estimated in an official report (BRR April, 2006) that approximate 123,000 new houses are needed for re-establishment, relocation and resettlement of Acehese tsunami victims, let alone the accompanying tremendous reconstruction of infrastructure.

A major problem faced by almost every organization involved in the Aceh reconstruction is the supply and procurement of legal and sustainable construction materials, especially the massive need for timber. As mentioned in a NGO's report on supply chain management, "whilst timber has been previously procured, it has not been without delays and the quality in some cases has been questionable." A review and general introduction of timber supply problems inherited in the Indonesian context will first be made, followed with the analysis of the possibility and proposed procedure of procuring local and international timber.

Timber Supply Problems

Although costal areas were seriously damaged during the 2004 Tsunami, 70% of mainland Aceh is still covered by natural tropical forests: the best remaining tropical forests in Indonesia and rich in biodiversity. One can see the beautiful green land under the plane when flying over the Sumatra Island. It is the natural gift inherited by generations of Indonesian people but now forced "open for exploitation" (Indonesia-Relief News). In spite of a moratorium on logging in Aceh, implemented pre-Tsunami, extensive illegal logging is currently taking place in Aceh forests. This is usually referred in relation to a so-called "Timber Mafia" situation; a term used to describe a consortium of government officials, army, police, businessmen, etc who allegedly conspire together to gain large profits from the illegal logging of the forest estate. Problems in getting a legal and sustainable timber supply for reconstruction are a frustrating experience for almost every reconstruction agency and this situation could continue for longer.

The Government of Aceh (represented by BRR regarding reconstruction) is reviewing its timber policy in light of the Tsunami and the need for timber for recovery. The acting Governor is in favour of a "Green Aceh", with no logging and supports WWF and other conservation NGOs' programmes promoting the use of imported timber from sustainably managed forests for reconstruction. These are also supported by the Ministry of the Environment. On the other hand, the Government of Aceh realizes the tremendous need for legal timber supply within the area. At the end of 2005, Indonesian Ministry of Forestry decided to restore forest concession (HPH) to 11 companies in Aceh to enable them to supply timber needed for the Aceh reconstruction and agreed to increase timber quota for Aceh to 400,000 cubic meters for 2006. This decision had to be made since timber suppliers from other provinces, such as Riau and Kalimantan, are reluctant to cater for the needs in Aceh due to a high cost of transportation and the complicated process of applying for legal documents to facilitate transportation.

It is estimated in a survey conducted by BRR[1] and The World Bank (2006) that the bribes and illegal payments that truck drivers pay on the Banda Aceh - Medan road with corrupt police, military, state officials and preman (criminal) groups at various security posts and weigh stations are Rp. 340,000 on average (single trip in either direction).This not only constitutes a major cost for timber transportation but also has negative influences to potential timber dealers from outside provinces. However, the number of illegal payments experienced a significant decline with the pull-out of troops and police from the Aceh province mandated by the Helsinki peace agreement.

There are other specific problems in timber procurement in Aceh, such as the legitimacy of importing timber and associated timber treatment methods. It is partially due to confused and sometimes conflicting information from different government sources; which could only be explained as internal uncertainty and inconsistency with Indonesian timber policies or failure in execution of established standard regulations. A list of 25 local timber supplier companies approved by BRR was given to representatives from various NGO's during a BRR's timber policy meeting in July 2006, which, several days later was reduced to a list of 5 and handed out to local project managers during another local staff meeting. These were only recommended as reliable and not guaranteed as legal. The responsibility of ensuring the legality of procurement with those companies remains on NGOs' shoulders. It is almost impossible for any organisation to take on such a big risk (even one piece of illegal timber will result in the whole package being confiscated) and be able to continue operating.

Feasible Timber Procurement Procedures

In spite of these difficulties, timber for Aceh reconstruction is still procured legally and sustainably, or at least non-illegally and non-unsustainably, from some sources to some organisations. All of them can be categorized either as locally supplied or internationally imported/donated. The procedure followed in each will be introduced and generally reviewed:

International timber procurement

A sequential steps of international timber procurement procedure has been identified as below, based on an introductory paper of suggested purchase flow prepared by Ralph Douglass from British Red Cross (Douglass July, 2006).

[1] BRR: Aceh and Nias Rehabilitation and Reconstruction Agency (Badan Rehabilitasi dan Rekonstruksi), representative and coordinating body of Government of Indonesia in tsunami reconstruction process

Table 1. International timber procurement procedure for Aceh reconstruction

1. prepare house design and detailed Bill of Quantities	2. prepare purchase documents: a. Request for Quotation, b. Technical specification schedule, c. Proforma Invoice	3.send above documents to potential suppliers and invite to bid
		4. submission of bids and tenders evaluation
7. the Irrevocable Letter of Credit (ILC)[2] prepared by purchaser's bank accepted and confirmed by supplier's bank using the information in Proforma Invoice (2c)	6.successful tenderer accepts the offer and submits a Proforma Invoice (2c), thus a contract relationship is formed	5. notify successful tenderer and confirm intent by issuing a purchase order
8.production initiated		
9. shipping schedule organised and notified to the purchaser by the supplier	10. shipping documents[3] sent to the purchaser by the supplier on port of departure	11. purchaser applies to the BRR for tax free gift status on the basis of being a registered tsunami reconstruction programme in Aceh
		12. ILC payment and documents exchanges occur
	14.following logistics from ship at arrival port (Belawan, Medan) to final destination	13. purchaser or its shipping agent arranges customs pre-clearance, phytosanitary etc. using the shipping documents and support letter from BRR

Imported timber from New Zealand or Canada using the above procedures has usually been treated as a Hazard Class H3.1 standard for an above ground application. The specific treatment method is LOSP (Light Organic Solvent Preservative) rather than CCB and CCF used in Indonesia. The prices range from USD$420-590/m3 CIF (Cartage, Insurance and Freight) at Medan depending on required grade, treatment and processing options, while local timber prices are usually within USD$350 – 550/m3 from legal sources. Although the price of imported timber is understandably higher than the local supplies, there are several advantages of importing timber for the Aceh reconstruction.

The first advantage is the longer and guaranteed durability, protection from weather changes and protection from insects and fungi attack under Indonesian conditions. It has an internationally recognized guarantee of sustainable management and production of timber as well as with other internationally recognized 3rd party certification and audit of treatment standards, certificate of origin and chain of custody. Another advantage is the large amount available (30,000 – 40,000 m3/month if long term orders are placed) while uncommitted local supply is limited to approximate 1/10 of that from international sources. The supply chain is

[2] the basis and payment terms of international timber trade, almost no suppliers will start purchasing logs or initiating production without a satisfactory ILC confirmed by their bank first.

[3] including documents of clearance of goods through customs and quarantine requires: a. Invoice b. Packing list c. Phytosanitary certificate from port of loading d. Air Bill or Bill of Lading (B/L) as a substitute for other documents but only possible for a temporary period

simplified and bureaucratic process of applying SKSHH[4] and other legal documents from the Government of Aceh could be avoided. Most importantly, for every log sourced internationally for use in Aceh, one tree from local tropical forests could been saved.

However, some disadvantages are obvious and make this option less attractive when decisions are made at an individual organisational level. Besides the higher prices, the longer delivery schedules (at least 4-6 weeks, but generally believed as 10 weeks) often excludes it as an option. The required amount of timber is limited at each time of procurement, thus, the large availability of international sources is no longer an advantage. This is partially due to the lack of overall supply chain management and communications between procurement and project teams. A large order of timber could be streamlined and procured at a lower price, then subdivided into small packages with only several hundred cubic meters each and procured once in a while however this creates a longer and complicated timeline. Storage of a large amount of international timber is another problem because of the associated demurrage charges that are extremely expensive if the shipment has to be left at the port. Timber is a natural product that must be kept dry and out of direct sunshine if possible. Thus, warehousing facilities are essential in the logistics of transporting timber from port to construction site while, local timber could be delivered to the site at vendor's expenses as required each time. The uncertainty of legitimacies within the Indonesian context related to imported timber together with issues related to donation and standard treatments required, further contribute to the unpopularity of international timber procurement in Aceh.

Local timber procurement

Similarly, in order to understand the local timber procurement procedure, a flowchart developed and handed out as a suggested guideline by BRR is attached below:

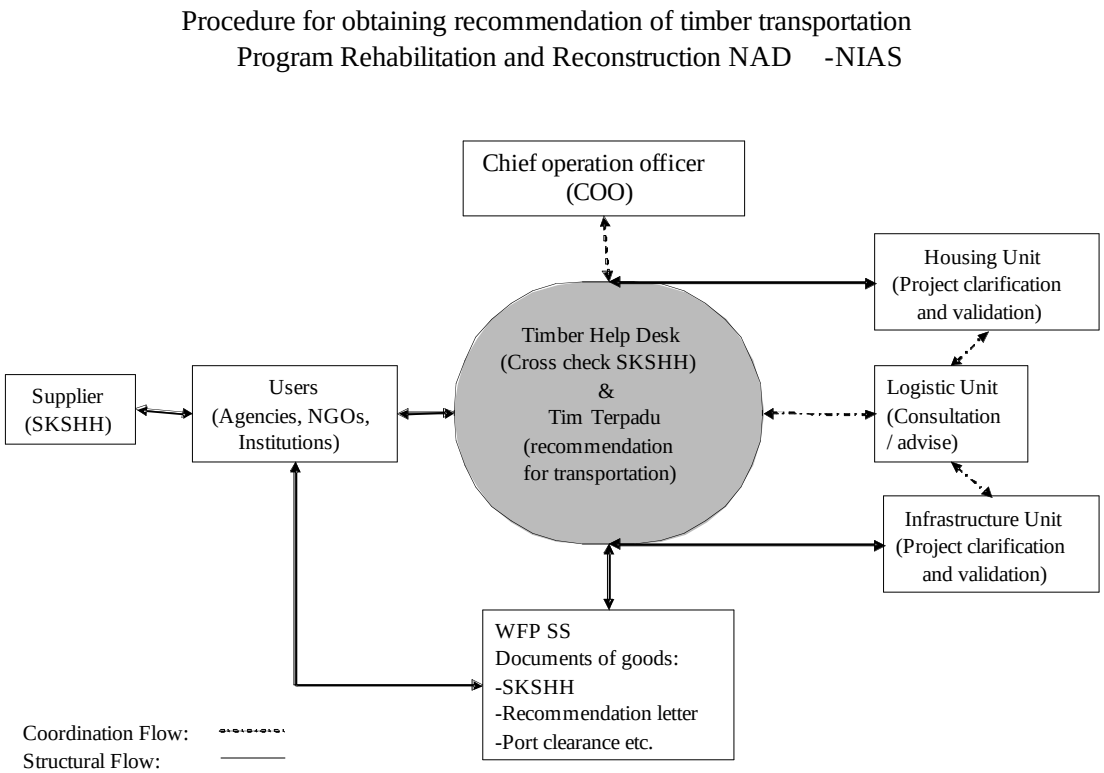

Fig. 1. Local Timber Procurement Suggested Procedure from BRR

[4] a legal document for cross-provinces timber transportation in Indonesia, only valid per truck per travel

Although aiming at providing recommendations for timber transportation, this flowchart could also be used as a guideline for local timber procurement and associated logistics. There are some terms used only in Indonesian timber industry that are worth explaining. The big circle in the flowchart represents Timber Helpdesk and Tim Terpadu at BRR headquarter; the most important interface to users, suppliers, shipping agencies and other departments in Government of Aceh. Timber Helpdesk was designed by BRR in order to address timber issues for reconstruction and rehabilitation in Aceh and Nias. It has a dual role; to facilitate the demand and supply of timber and to monitor the timber used for reconstruction within this region. SKSHH appears many times within the flowchart, as explained in footnotes before, it is a set of documents used to define the legality of timber and it is required when the log is transported from the concession companies to the industry or when semi-wood products are ready to be marketed and transported to their final destination. It is worth noting that SKSHH is not required for imported and donated timber.

A typical procedure for local timber procurement could be categorized in 3 steps, with different relationships between timber user/ purchaser and other involved parties, demonstrated below:

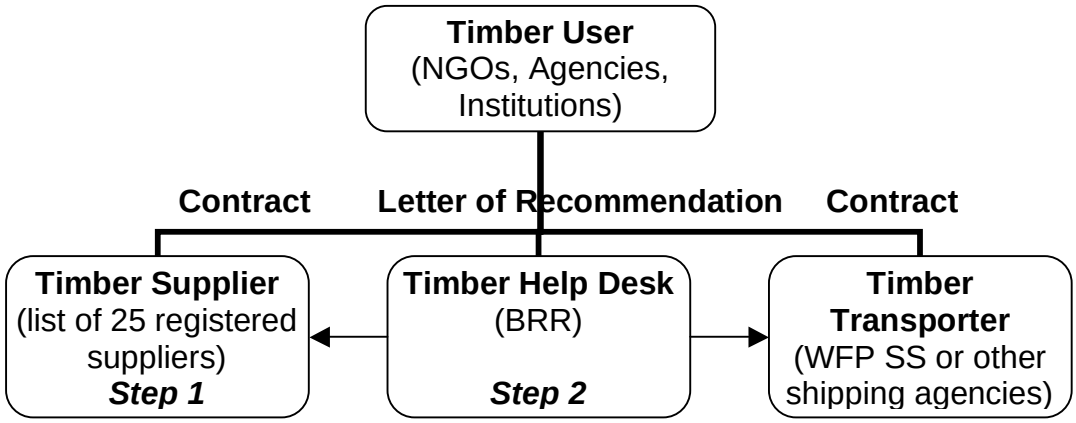

Fig. 2. Typical Procurement Procedure for local timber supply

As can be seen from above table, in order to procure local timber, the user has to contact a potential supplier based on the names registered with BRR in step 1. Then the classic tendering process needs to be completed within this step and an agreement or formal contract needs to be entered into with the preferred supplier. After this, the user moves to step 2 and submits a request to Timber Help Desk in BRR for a Letter of Recommendation to purchase timber. In order to process this request, BRR has to check with its Housing Unit and/ or Infrastructure Unit for the project clarification and validation to make sure that the user is permitted to order timber and that the amount and type of timber requested is in accordance with their needs (Fig. 2). Photocopies of the user's Project Concept Note[5] and the Contract in previous step are required in order to issue the recommendation letter. Then in step 3, the user has to provide photocopies of documents gained from step 1 and 2 (Contract and Letter of Recommendation) together with an order request to the timber transporter and enter into another contract for transportation. The transporter recommended by BRR to reconstruction agencies in Banda Aceh is the shipping services provided by WFP (World Food Programme).

Overall, it is important that timber users understand the definition of legal timber and the assurance measures in obtaining only legal timber. Legal timber as defined in a BRR guideline (BRR July, 2006), means that the timber is harvested from legal concessions in accordance with national regulations. Legal concession is a legal timber company that holds a permit for forest

[5] Project Concept Note should be approved beforehand by BAPEL BRR, the executing agency.

utilization from the Ministry of Forestry. The user can purchase timber or timber products directly from merchants, but the responsibility for obtaining legal timber remains that of the user. It is recommended that all the timber bidders for the Aceh reconstruction are required to provide valid forestry permits as well as SKSHH as a pre-qualification for tender.

Review of Other Options

Alternatives to limited timber supply and other options for sourcing materials for construction are explored and reviewed by organisations involved in the Aceh reconstruction. Those alternative methods and suggestions include using steel trusses (or steel high-pitch roofs) windows, doors and ventilation frames or coconut trees as structural component as replacements to timber products.

The high prices associated with using steel trusses as replacements for timber are the main obstacle. Several factors may contribute to the problem. It is understandable that steel is more expensive than timber but this shortfall could be reduced if less steel is needed for a roof than the amount of timber needed for a timber truss. Actually, a steel high-pitch roof requires much less steel in volume than a traditional timber truss roof. The high price is partially because the mass produced steel roof systems commercially available mainly cater to the needs of factory storage and heavy industry buildings. The pricing of steel roofs for Tsunami relief houses could be significantly reduced if all the reconstruction agencies with the same intention in Aceh organize their individual requests into a bulk order and choose both local and international companies with reliable reputations for a competitive tender for mass production. This is more easily said than done. However, the current coordinating agency BRR has growing power and may be able to do this for its prefabricated houses in the future. Another concern about the use of steel trusses is their acceptance by the community. People are more conservative in remote areas and it is still unclear whether they are willing to move into a “light and shining” steel roof house. This will require a significant amount of on-site community participation and socialization beforehand.

Coconut trees in the form of “palmwood”, as another alternative to timber, is a relatively new process but has huge potential to ease the pressure on the world’s rainforests, especially in Banda Aceh coastal area, as an ecological substitute to endangered and limited hardwoods. They usually come from farmed plantations of old coconut trees and really are an enormous source of timber that until now have been a wasted by-product from the fruit and food industry. In recent years people have recognized and explored the potential use of this vast, alternative supply of timber and found that it performs as well as or even better than traditional hardwoods.

Usually, the outer, harder part of coconut trees is used in structural materials for building construction, flooring/decking and furniture design, while its relatively soft inner core is suitable for cladding, screening and homewares. These could be used as profitable by-products for the milling workshop owners if mass production of coconut timber for construction is feasible in Aceh in the near future. Another advantage is that the coconut palm is branchless; palmwood is free from knots, which makes it an ideal timber. The issues related to the level of acceptance by the affected community and forestry authority remain. The mass production of coconut timber in Aceh remains a good theory. As more and more research results and real life experiences in favour of this option become available internationally, it is a good opportunity to explore this idea further in Aceh using a government or community-based initiatives to cater the massive needs for timber.

Discussion and conclusions

The incorporation of sustainable considerations into the design of procurement routes for post disaster construction is well recognised. This starts with the need for more effective and efficient communications along the stream of the overall supply chain and within each and every individual organisation forming this chain. As mentioned earlier in the SCM literature review, buyers and suppliers must commit a greater amount of information and be willing to share sensitive information to achieve increased levels of supplier performance. Good communication is the basis for building a long-term relationship with reliable suppliers. This should be encouraged in order to reduce the supplier base and minimise the administrative or transaction costs associated with managing a large number of vendors. Certain certificates or well-designed criteria for pre-qualification will contribute to the supplier selection process and supplier base consolidation (e.g. require timber bidders for Aceh reconstruction to provide valid forestry permits as well as SKSHH before further consideration of their tenders). Integration, another key principle in contemporary SCM, is suggested in the Aceh reconstruction practices at both supplier and logistic levels.

As relating to the timber procurement process, the procedures of international and local timber supply for reconstruction in Aceh are reviewed in this paper followed by discussions on alternative ways of using steel trusses or coconut timber as solutions to the current problem. It is suggested that reconstruction agencies should seek every possible way of using local timber sources with policy clarifications and transportation suggestions from local reconstruction authority BRR, while exploring the legal, economic and logistic feasibility of imported timber. In order to facilitate the process, it would be better to have an overall procurement plan for the whole project rather than a range of small ones, before starting any negotiation with potential vendors. This should streamline the supply in later stages and result in a better supply arrangement. More studies are required as to the use of coconut timber. It remains an attractive potential for rural areas and isolated islands when policy barriers have been removed. The possibility of milling and use of seized timber or timber from other sources should also be investigated.

The use of familiar and locally available materials for reconstruction should be encouraged. The sustainability dilemma with regards to the use of timber is the balance between the preservation of the environment and the provision of housing. The supply of offshore timber might provide great relief at initial response but in long term effects, it means that the important economical "kick start" provided by aid in country (and specifically in Aceh) is lost. The aftermath are people housed in a context of greater poverty. This leads to the need for alternatives such as the use of coconut timber and other possible substitutions for the major uses of timber in house reconstruction.

Recycling certain construction materials from damaged houses remains another possibility. Most steel doors and window frames post-disaster were not seriously damaged and are in large demand. Substitutions could be the use of light gauge steel sections, roofing that can span without the need for timber trusses and different door and window frames. Furthermore, there is also the option to use shorter life span materials for doors and windows with the idea that they would need to be replaced earlier than usual (lowering quality). Although more expensive than timber, steel trusses could be a back up option given the short time and high demand. With a more integrated and sustainable supply chain, prices could be lowered with mass production. This could be made possible through the joint efforts of other reconstruction agencies.

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Author's Biography

Kelvin Zuo is a lecturer in the Civil and Environmental Engineering Department, University of Auckland. He received his Bachelor Degree (Hons) in Civil Engineering (2003) with a management focus from Sichuan University and a Master (Hons) of Engineering Studies (2005) from University of Auckland. Since then, he has engaged in research for his PhD under the FRST funded project – "Resilient Organisations". He is particularly interested in the contractual aspect of civil engineering management, especially the procurement systems used in different construction projects. It first stemed from his fieldwork (2002) in Three Gorge Dam in China and further developed in his master thesis, a tendering systems comparison between Chinese and New Zealand models. His current PhD topic concerns the procurement and contractual systems for disaster reconstruction.

Suzanne Wilkinson graduated with her BEng (Hons) and PhD from the Oxford Brookes University. Her PhD was in the area of construction management. She then moved to New Zealand and worked at Unitec before joining The University of Auckland in 1996. She is now an Associate Professor in the Civil and Environmental Engineering Department, University of Auckland. Her research interests are in project management, construction management and construction law. She is currently involved in two large Government funded research projects (over $5 million). The first project is Resilient Organizations, where she is leading the contract management component of the project (see www.resorgs.org.nz for all research publications and project details). This project examines the management problems associated with post-disaster reconstruction. The second project is "Retrofit Solutions" where she is also leading the financial analysis section of the project which is examining retrofitting New Zealand buildings to protect them against seismic damage (see www.retrofitsolutions.org.nz for all research publications and project details).

Regan Potangaroa is an Associate Professor at the School of Architecture, Unitec, Auckland. However, during the semester breaks he is on standby as a RedR Engineer (refer to www.redr.org), often being assigned to the United Nations in various disaster situations throughout the world. In the last 7 years has worked in Aceh (following the 2004 tsunami disaster), Pakistan (following the Afghanistan conflict and again follwing the 2005 earthquake), Syria (at the time of the Iraq conflict), West Timor (at the establishment of a separate Timor), West Darfur (during the initial onset of internal conflict) and Geneva (with UNHCR). In all, 16 such overseas assignments. Regan has Bachelor and a Masters degrees in civil engineering from Canterbury University, a Master in Architecture from Victoria University, and a Master in Business Administration and a PhD in Architectural Engineering from James Cook University in Townsville, Australia. Despite this academic background, his professional experience has been as a consulting structural engineer with 25+ years experience gained in 13 different countries. His research interests deal with both the qualitative and quantitative aspects of disasters under the general headings of: Management ~ Mitigation ~ Indicators.

James Olabode Rotimi is a Doctoral research student in the Department of Civil and Natural Resources Engineering, University of Canterbury. His background is in Construction Management and he has had various construction related experiences including an associate role in a quantity-surveying consultancy practice in Nigeria. James is a professional member of the Nigerian Institute of Building and the Institute of Management Consultants, Nigeria. His research is within the ambit of Objective 3 – Resilient Organisations research programme. He is evaluating the provisions of the Building, Resource Management and the Civil Defence and Emergency Management Acts to determine if they are in tandem with the likely demands for reconstructing physical facilities in the event of a major natural disaster in New Zealand. His evaluative study should proffer suggestions towards a policy framework for post-disaster reconstruction in New Zealand.