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A framework for managing post-disaster housing reconstruction

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Abstract

The built environment is becoming progressively more complex and dynamic. These changes impose growing challenges on construction professionals in terms of disaster risk reduction. Construction innovations also have the potential to positively contribute to promoting disaster resilience and mitigating climate change. This initial investigation of the case studies from the literature focuses on the development of a general framework for the effective organisation and management of post-disaster housing reconstruction. The framework developed enables data collection for further investigative studies in order to improve management practices in future housing reconstruction programmes.

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1. Introduction

A *disaster* is the occurrence of an extreme hazard event that impacts on vulnerable communities causing substantial damage, disruption and possible casualties, and leaving the affected communities unable to function normally without outside assistance (Benson & Twigg, 2007). Whereas the most devastating disasters in terms of human casualties tend to occur in the developing world, the highest disaster-related economic losses occur in the developed world. The built environment plays a central role in both casualties and economic losses - its failures are associated with loss of life and it makes up, in infrastructure and real estate, most of the assets which get destroyed. Urbanization concentrates both lives and assets in cities which are typically located on coasts and on the banks of large rivers. Climate change raises water levels and imposes 'new normal' levels of precipitation and temperature extremes while technological and economic developments lead to our reliance on more complex, integrated systems

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and extended supply chains. It is thus conceivable that vulnerabilities to disasters might increase. Yet, the built environment can also be a platform from which to improve societal disaster resilience. With a reference to the disaster management cycle of mitigation and preparation prior to a disaster event, then disaster response followed by recovery and reconstruction (which then becomes the basis for improved mitigation), numerous authors have drawn attention to the resilience improvements which can be achieved by the construction industry. Notably, Bosher (2013) outlined the possibilities of built-in resilience with a focus on design and construction interventions prior to a potential disaster event. The Engineering and Construction Resource Partnership of the World Economic Forum highlighted the role of construction professionals and organizations in disaster response and recovery (WEF, 2010). In this paper, we focus on an investigation into the next step, reconstruction and particularly how the organisation of housing reconstruction programmes might be improved. This initial investigation of the case studies from the literature is intended to derive a general framework to describe the organisation of post-disaster housing reconstruction initiatives.

2. Challenges of post-disaster housing reconstruction programmes

Considerable challenges arise in post-disaster reconstruction situations, particularly those following large scale disasters. The post-disaster context is characterized by a lack of access, logistical issues and inadequate human resources (Davidson et al., 2007; Ophiyandri et al., 2010). Reconstruction efforts may be additionally hampered through institutional bureaucracy, corruption, inadequate coordination, inexperience of construction management and pressures from government and humanitarian agencies for quick project completion (Barenstein, 2006; Ophiyandri et al., 2010).

In terms of the implementation of housing reconstruction programmes, issues of community participation, communication, resettlement and the cultural appropriateness of recovery measures have been a recurring challenge and continue to cause housing reconstruction projects to fail with the supposed beneficiaries modifying or outright rejecting the housing provided or, in some cases, dismantling the houses and selling their components. All of these challenges must be adequately managed in order to have a successful reconstruction programme (Delany & Shrader, 2000; Barakat, 2008).

3. Housing reconstruction programme experiences from the case study literature

Drawing on the literature relating to the housing reconstruction programmes in Japan following the 2011 Tōhoku earthquake and tsunami, in Aceh, Indonesia and Sri Lanka after the 2004 Indian Ocean tsunami, in Bam, Iran following the 2003 earthquake and in Gujarat, India after the 2001 earthquake, the examples of successes and failures can be identified.

3.1. Successes and good practice examples in post-disaster housing reconstruction

From the cases of Japan, Gujarat and Bam, the importance of a suitable institutional framework is evident. A dedicated agency at national level with representation and units at state and local government levels should be set up to ensure central co-ordination of and support to the recovery and reconstruction effort. In these case studies, the institutional structures as well as overall guidelines for the planning and implementation of the housing reconstruction programmes were put into effect by legislative acts. Previous disaster experiences were built upon to establish base strategies for the housing reconstruction programmes (Ranghieri & Ishiwatari, 2014; Barenstein, 2006; Gharaati & Davidson, 2008; Mahdi & Mahdi, 2011).

In Japan, community involvement in the housing reconstruction planning was emphasized and a zone for reconstruction was established. Reconstruction plans included clear reconstruction schedules with public milestones and specific budgetary provisions for reconstruction were made in a supplementary national budget to secure finance for reconstruction and recovery. State and local governments prepared regional and local recovery plans within the framework of the national plan (Ranghieri & Ishiwatari, 2014).

In the case of Bam, a well-planned reconstruction programme enabled technical and financial monitoring and control. A range of preferred disaster resilient housing models were offered with allowance for design choice. The reconstructed housing conformed with national building codes and implementation took place under rigorous supervision from both agency representatives and the beneficiaries themselves. The locals attained technical knowledge from inspectors due to their close working relationship during the reconstruction and this led to reduced overall housing reconstruction times, higher productivity and better work quality (Gharaati, 2006; Gharaati & Davidson, 2008; Mahdi & Mahdi, 2011).

In Gujarat, five alternative reconstruction approaches were adopted: the owner-driven approach, subsidiary approach, participatory approach, contractor-driven in-situ and contractor-driven ex nihilo approaches. Area authorities for reconstruction and redevelopment were formed in four affected areas to facilitate and monitor reconstruction works. In this case, in light of the limited local capacity, local, international and private donor organisations as well as the beneficiaries themselves were all part of the reconstruction efforts. The private sector was engaged in damage assessment and engineering analysis (Barenstein, 2006).

A new building code was established to ensure the construction of safe buildings. Construction guidelines and procedures for building permissions were established and engineers working for government were appointed for site supervision to ensure for quality control and enforcement of safety standards. These engineers also performed post-construction validation and issued completion certificates. Particularly where the owner-driven approach was followed, beneficiaries were involved in the design, cost estimation and directly in the reconstruction works while material and financial support were provided to them. Their engagement was considered to create in them a sense of satisfaction and ownership in the process and in the product and this reportedly led to high levels of satisfaction and construction quality. Local capacities were strengthened through employment opportunities. Training programmes were provided to impart the skills needed for the reconstruction works and the vulnerable and poor were successfully included in the reconstruction initiative (Barenstein, 2006).

3.2. Failures and poor practice examples in post-disaster housing reconstruction

In Sri Lanka, there was no pre-existing policy or institutional framework that could be readily adapted to deal with the aftermath of the 2004 tsunami. Coordination and communication issues arose and the demarcation of responsibilities was unclear. A buffer zone along the coast was at first established but without sufficient community participation so that alternative livelihoods were insufficiently considered for communities resettled further inland. When exemptions to the buffer zone were subsequently granted to some commercial buildings, this raised suspicions of corruption, was widely criticized and eventually led to the reversal of the buffer zone policy. This U-turn resulted in the abandonment of some donor driven projects and underlined the insufficiency of skills for managing government-donor relations. Further obstacles included a scarcity of land for relocation, anomalies in the initial housing needs assessment with conflicting statistics from different government agencies, capacity constraints including a lack of expertise on the part of implementing agencies and pressure for quick results. The policy shifts and lack of reliable data affecting housing targets and reconstruction plans led to systemic confusion and, ultimately, reconstruction delays (Uyangoda, 2005; Grewal, 2006).

In Gujarat, a plan to relocate settlements to safer sites was proposed but people decided to go back to the disaster zone with a resolve for in-situ construction. The building permit acquisition process proved a barrier to local and self-build initiatives when some families who were eligible for housing compensation were denied building permission if they could not provide a legal document. In some areas, the reconstruction programme was not fully participatory in terms of consensus in relocation, house design or materials to be used in construction. In some cases, the materials and technology used for construction were not appropriate to people's cultural sensitivities or the local weather and this resulted in the rejection of provided housing. Comparatively little attention was turned to the repair and retrofitting of damaged buildings while emphasis was given to reconstruction of destroyed houses (Barenstein, 2006).

In comparison to the owner-driven approach, contractor-driven approaches resulted in large numbers of home owners being unsatisfied with the quality of the materials used and the quality of construction. This resulted in low

rates of resettlement as many people preferred to repair their old homes rather than live in new ones that would relatively isolate them from their communities (Barestein, 2006).

In Bam, techniques acquired during the formal supervised reconstruction period were not thereafter transformed into operational knowledge and skills. Problems later developed in some buildings with regard to joints, in particular, bonding problems between traditional and new materials. While implementation was relatively good, skills to enable the community to maintain their buildings were not adequately transferred (Gharaati, 2006; Gharaati & Davidson, 2008)

Several factors led to the failure of the housing reconstruction programme in Aceh including: inadequate strategic and operational management planning, satellite office planning, insufficient time allowed for community mobilization and difficulties in the resolution of land issues. In addition, the unavailability of skilled manpower, poor coordination and problems with logistics, materials sourcing and supplies negatively affected housing reconstruction delivery and quality (ACARP, 2007; Kennedy et al., 2008; Ophiyandri et al., 2010)

4. Issues from post-disaster housing reconstruction implementation

4.1. Monitoring and control issues

In Aceh, the detailed planning was largely in place - work schedules with critical milestones and scope of work were established and production drawings, material specifications, workmanship and quality requirements were all available. However, failures occurred in terms of the monitoring and control of the housing reconstruction. These related to numerous challenges faced at implementation but particularly the very small number of technical officers per district with very large work-loads and limited technical knowledge. As getting approvals was slow, it is unsurprising that work progress was affected and led to time and cost overruns (Assaf & Al-hejji, 2006; Kennedy et al., 2008; Ophiyandri et al., 2010)

The situation was, however, different in the Bam reconstruction programme with its generally effective monitoring and control under experienced professionals in possession of the required technical expertise and backed-up by adequate resources. These reportedly contributed to higher production rates, an overall reduction in housing reconstruction time and better quality housing (Fallahi, 2007; Gharanti, 2006; Gharanti & Davidson, 2008; Mahdi & Mahdi, 2013).

4.2. Logistics and supply chain issues

Logistics and supply issues have always been a feature of humanitarian operations. Following large scale disasters, the loss of access, infrastructure and services typically renders local industries and supply systems useless so that the local construction market is in disarray (Long & Wood, 1995; Gustavsson, 2003; Kovács & Spens, 2007; Chang et al., 2011). Housing reconstruction programmes rely on the ability to procure, transport and receive supplies at the point of need and inadequate provision of resources for post-disaster housing reconstruction significantly limits the prospects for successful implementation of the reconstruction works (Thomas, 2003; Chang et al., 2010).

Material demand for housing reconstruction is unpredictable and a high level of logistics and supply chain expertise is called for to ensure adequate supplies of materials to site as and when they are needed (Kovács & Spens, 2007; Ophiyandri et al., 2010). The Aceh reconstruction programme provided examples of severe supply chain issues leading to time overruns. However, some agencies that applied the contractor-led approach to reconstruction in Aceh did succeed in establishing effective, local supply chains while others resorted to bulk material importation to overcome the problem (Ophiyandri et al., 2010).

4.3. Risk management issues

The disruption and destabilization of the environment following a disaster suggests the need to give special attention to potential hazards. While many risk management decisions must be made in the reconstruction planning phase to avoid the reconstructed housing contributing to communities' vulnerability in future disasters, risk management issues also arise in the reconstruction implementation stage (Wamsler, 2004).

In the case of Bam, the bonding issues between old and new materials (already mentioned above) provide a good example of the type of technological risks which must be dealt with (Gharaati & Davidson, 2008). Wamsler (2004) notes that the risk of beneficiary rejection of the housing units can increase when housing reconstruction or retrofitting does not adequately follow design and construction guidelines. The implication of this being that a proactive approach of risk identification, analysis, response and control should be adopted to ensure the successful delivery of the reconstruction works to time and cost.

4.4. Human resource issues

A national construction industry can adequately manage a small to medium scale disaster reconstruction exercise provided that the base work load remains at an average level. However, for large scale disaster reconstruction situations, additional construction industry workers will be needed (Le Masurier et al., 2006). The recruitment of construction experts and skilled labour is often a major challenge given the poor post-disaster working and living environment. There is often encouragement to engage the affected communities to drive their own recovery through their direct participation in reconstruction programmes implying the parallel organisation of training opportunities but these again require expertise (Kennedy et al., 2008).

In Aceh, the beneficiary labour approach was widely applied and hands-on training was provided to allow affected communities to participate in the reconstruction works. At the same time, this provided them with housing and a means to a livelihood after the reconstruction period. To encourage community participation, house committees were formed and the communities were allowed to select the skilled laborer they preferred to work with them, while they managed the construction of their houses (Petal et al., 2008; Kennedy et al., 2008).

4.5. Health and safety management issues

Under normal circumstances, the construction industry tends to be unacceptably dangerous. According to Sawacha et al. (1999), fatalities associated with construction activities are five time more likely than in other production based industries. It is no surprise then that workers involved in post-disaster reconstruction operations are exposed to health and safety hazards and that this exposure may result in illness, injuries or death (Kennedy et al., 2008). However, in addition to the base level of hazards in construction, the considerable amounts of hazardous debris and contaminated water which are typical of post-disaster environments, greatly increase the exposure of reconstruction workers. According to Grosskopf (2010), the disaster reconstruction in the United States accounted for about 10% workers' exposure to the post-disaster reconstruction hazards. This implies that reconstruction workers require additional training and organisational support.

4.6. Workmanship and quality issues

Instances of poor workmanship and quality have been a feature of numerous housing reconstruction programmes including those of Aceh, Sri Lanka and Bam. In the case of Aceh, quality issues were reported to have led in some cases to rework, demolition and rejection by beneficiaries (Gharaati, 2006; Gharaati & Davidson, 2008; Kennedy et al., 2008).

Some of the causative factors for poor quality of work identified in the post-disaster context include: the lack of skilled labour and technical experts, poor quality materials, site conditions, lack or inadequate monitoring and

supervision, poor communication; inadequate information or failure to check information and inadequate feedback leading to recurring errors (Ophiyandri et al., 2010; Falahi, 2007; Gharaati, 2006).

4.7. Coordination

Post-disaster housing reconstruction projects typically involve the collaboration of numerous entities at different levels with differing perspectives and backgrounds and with possibly overlapping responsibilities for different but interconnected tasks. This makes it challenging for coordinating agencies to cope. Organisations managing reconstruction programmes must therefore have an efficient communication plan with appropriate feedback mechanisms and established communication channels for efficient information sharing and coordination (Le Masurier et al., 2006; Shaw & Ahmed, 2010; Patel & Hastak, 2013).

4.8. Financial management issues

Reconstruction programmes are often financed from a wide array of both domestic and external sources. For example, domestic resources might be provided through budgetary allocations, contributions from civil society and philanthropy and from insurance while external sources might include funds from multi- and bi-lateral donors as well as international NGOs (Ophiyandri et al., 2010; Patel & Hastak, 2013; Ranghieri & Ishiwatari, 2014). This may create a highly complex financial management environment where both competing accounting requirements and allocation time-frames can come into play. In Aceh, for instance, donor funds were often accessed in the 2nd and 3rd quarters of the donor's financial year and a spending deadline stipulated for housing reconstruction managers. Organisations managing the reconstruction were placed under stringent timelines for spending allocated funds and therefore had to rush the housing reconstruction and potentially compromise on efficiency, quality and safety issues (Steinberg, 2007; Kennedy et al., 2008).

5. General framework for the management of post-disaster housing reconstruction programmes

The nature of these successes and failures as identified, suggests that the housing reconstruction process may be usefully considered as comprising three general phases:

1. an enabling, strategic phase during which an institutional and budgetary framework for reconstruction is established following the disaster (on the basis of new legislation, if necessary)
2. a reconstruction planning phase where detailed plans and provisions are arranged and specific decisions are made
3. a reconstruction implementation phase where the actual reconstruction works are undertaken.

The authors' contention is that, whereas the first and second of these phases are characterized by the extraordinary nature of the post-disaster context – requiring special legislative acts and necessarily led from outside the affected communities – the third of these phases, concerned with reconstruction implementation, shares many features with 'ordinary' construction. It can be considered to be an extreme example of construction and may thus benefit from drawing on the existing knowledge of the organisation and management of construction. Conversely, the fact that post-disaster reconstruction implementation examples and case studies deal with extreme situations may potentially provide new and interesting insights and perspectives for our understanding of 'ordinary' construction.

To further investigate this, issues affecting reconstruction implementation have been identified from the literature. These have been tentatively categorized into eight areas (monitoring and control issues; logistics and supply chain issues; risk management issues; human resource issues; health and safety management issues; workmanship and quality issues; coordination issues and financial management issues) as shown in the previous sections. However, it is apparent that this classification is not yet optimal as there is a degree of overlap between the categories and it may also prove to be incomplete as further categories could yet emerge.

Fig. 1 illustrates an overall conception of the post-disaster housing reconstruction programme management problem. This framework is proposed on the basis of the three apparently differentiable phases of the housing reconstruction process (enabling, reconstruction planning and reconstruction implementation) and the insights into these phases which arise from a review of the case study literature.

6. Conclusion

This review of the case study literature underlines the considerable complexity of post-disaster contexts, the importance of establishing suitable institutional structures and engaging the affected communities to actively participate in the planning and implementation of reconstruction. The challenges are considerable but, unlike the provision of an enabling environment and the reconstruction planning which are largely defined by the specific details of the particular post-disaster context, the implementation of reconstruction faces the same management issues as normal construction does.

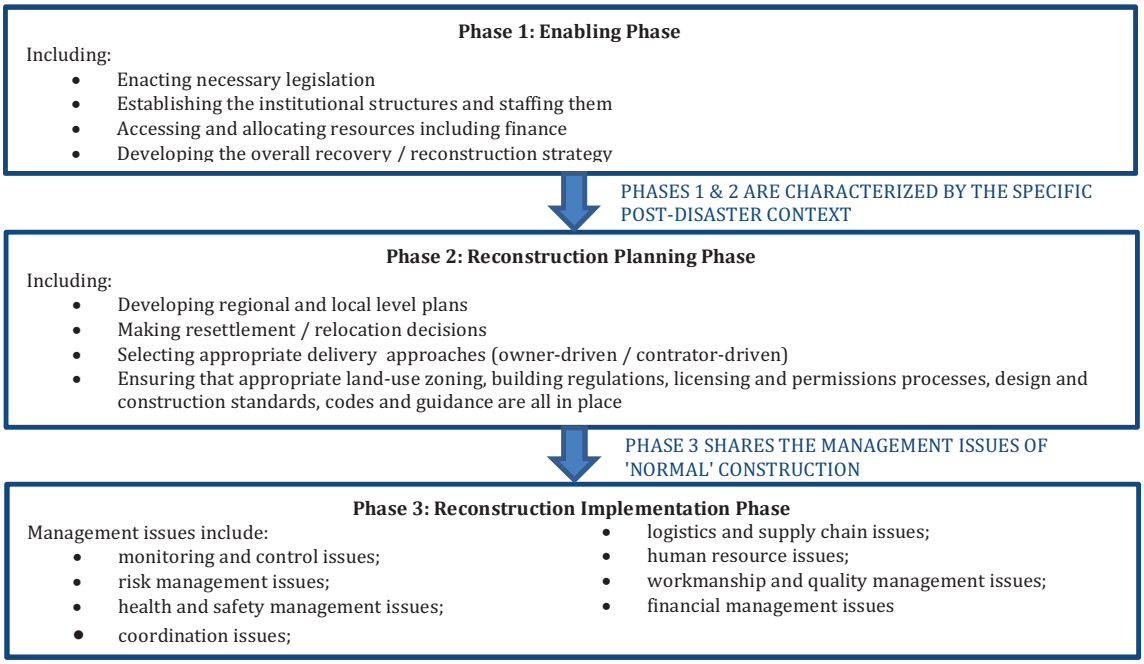

Fig. 1. Overall framework for the management of housing reconstruction programmes.

The post-disaster context may be considered an extreme situation but one which potentially allows for knowledge and insights to be drawn from existing 'normal' construction management best practices to improve reconstruction implementation processes. It is thus conceivable that improvements could be made to reconstruction efforts by applying existing knowledge relating to issues such as construction monitoring and control. On the other hand, some post-disaster challenges, such as health and safety management, require the further development of existing construction knowledge. Finally, there are other issues such as workforce training and community engagement where lessons might be drawn from established post-disaster reconstruction practices to improve current 'normal' construction practice.

The framework developed enables data collection for the further investigation of housing reconstruction.

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