OPTIMISATION OF PROJECT PERFORMANCE IN POST-DISASTER BUILDING RECONSTRUCTION PROJECTS IN SRI LANKA

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ABSTRACT

Natural catastrophes occur frequently around the world and cause severe undesirable impacts on human lives and properties of the communities. The restoration of a human life style after such massive event, consume some significant time and cost, comparatively to the conventional day-to-day constructions. Recovery and rehabilitation of the affected nature have to be completed at extreme cost and within strict time limitations, in order to achieve the project goals up to highest possible level of satisfaction. Whereas, numerous issues and challenges, affecting the reconstruction projects, leading to failures and inefficient outcomes at the project completion stage. Time, cost and quality parameters will always be the highlighted aspects in the process of determination of project performance level in reconstruction projects. Thus, the lack of strategies to enhance the degree of performance status, is addressed as the research gap of the study.

Case study was selected as the most appropriate approach for the study. Six interviews were conducted among Project Engineers and Managers and Client's Representatives. Further, document reviews also conducted in the case study. Consequently, code-based content analysis was used to capture the substantial factors as well as the probable elements that can be implemented to optimise project performance in post-disaster reconstruction projects in Sri Lanka. Thus, conclusions are drawn and recommendations are suggested.

The outcomes of the analysis were able to identify critical issues of post-disaster reconstruction projects in Sri Lanka, and probable attributes which can be implemented for a proper trade-off in time, cost and quality perspectives. The findings would be much effective for developing strategies to implement to achieve the best performance level in reconstruction projects.

Keywords: *Cost Performance; Post-disaster Reconstruction; Project Performance Optimisation; Quality Performance; Time Performance.*

1. INTRODUCTION

Catastrophes, both natural and human-caused, have been arising with aggregate frequency and influence in recent decades in many countries around the world (Schilderman, 2004). Societies are necessary to be equipped for natural and human-made disasters because they can strike anywhere, regardless of location, culture or history.

Moreover, Moe and Pathranarakul (2006) explained that, disasters cause a significant influence to the entire world. Further, authors have clearly highlighted that, the occurrences of natural disasters have increased sharply worldwide causing loss, disruption and damage to lives, built and social assets, and economy. Natural hazards endure to cause thousands of deaths and billions of dollars economic loses each year around the world.

According to Pathiraja and Tombesi (2009), disasters can affect the community through physical losses and economic losses and to overcome those losses post-disaster reconstructions are performed. Whereas,

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post-disaster reconstruction (PDR) and rehabilitation is a complex issue with several dimensions and those projects often deals with uncertainties. Meanwhile post-disaster reconstruction can be considered as a process with potential for creating a resilient built environment or for generating further vulnerabilities to the disaster affected communities and it is part of a sequence of three identifiable post disaster periods: emergency, restoration and reconstruction (Chang *et al.*, 2012). Therefore, the success of post-disaster reconstruction is a matter of delivering and constructing houses and towns, and how much it reaches the project goals.

However, the critical consideration in post-disaster reconstruction is that how a country's construction industry is able to engross and put to efficient rebuilding by using all the aids and resources available. Relief, recovery, rehabilitation and reconstruction are the main activities in rebuilding the affected nation where the government and non-government organizations are the major stakeholders (Freeman, 2007). Therefore, the challenge of recovering from natural disasters will create an unpredicted future with the burning necessity of effective post disaster responses strategies. Hence, post disaster reconstruction situation can be seen as one of new opportunities for reconciliation, investment and growth, sustainable resource utilization, human capital formation, employment generation and human development (Pathiraja and Tombesi, 2009).

Nowadays, it has been discovered that there are numerical challenges and barriers in post disaster reconstruction projects (Ahmed, 2011). There the time, cost and quality constraints have become major challenges that are difficult to overcome (Baroudi and Rapp, 2010). Hence, disaster reconstruction is all about certifying the properties are reassembled and it requires a substantial sum of funding for an adequate accomplishment. Another concern that can be identified is lack of time, since post disaster re-establishment work have to be done within a limited time period as the restorations are the "basics" of the affected communities. Furthermore, it is clear that inadequacy of qualified people may affect the reconstruction process duration and quality of the work done (Chang *et al.*, 2011).

Meanwhile optimisation is finding an alternative with the most cost effective or maximum feasible performance under given limitations, by making the best use of desired factors and minimizing undesired ones (Huimin and Peng, 2013). Furthermore, optimisation means trying to attain the highest or maximum result or outcome without regard to cost or expense (Alex, 1999). Therefore, optimizing project performance in post-disaster reconstructions is significant as those are facing many challenges as well as resources restrictions.

On the other hand, post-disaster reconstruction performance measurement is defined as the process of evaluating performance relative to a defined goal in post-disaster management and it provides a sense of where the reconstruction process lies and more importantly, where it happens (Khosrowshahi, 1997). Khosrowshahi (1997) further stated that, performance measurement can guide steady advancement towards established goals and identify shortfalls or stagnation and the significance of measuring performance.

Moreover, it is a widely accepted view that, performance measures of a project are based on time, cost and quality. Hence, Atkinson (1999) noted that these three components of project performance as the 'iron triangle'. As a result of frequent challenges faced in post-disaster reconstruction projects in Sri Lanka, the performance level of constructions is at a lower level (Pathiraja and Tombesi, 2009). The current situation in Sri Lankan post-disaster reconstruction projects is more severe due to numerous challenges faced by the industry. The construction industry in Sri Lanka is developing in order to manage post-disaster reconstruction work especially through the experiences of enormous destruction in Tsunami disaster in 2004. Although, government and non-government organisations contribute for post disaster due to the unavailability of standard performance measures, the direction of post disaster reconstruction projects, performance optimisation have been a significant challenge.

Further, lack of research has been conducted in order to address the gap of finding the way of optimising projects performance in post-disaster reconstruction projects in Sri Lanka. Therefore this research is focused to fill the research gap through developing a framework to optimize projects performance in post-disaster reconstructions. The scope of the research is limited to post-disaster building reconstruction projects and those projects were done due to natural disasters occurred such as landslides, tsunami etc.

Consequently, the research question is "how to optimize project performance in post-disaster reconstruction projects in Sri Lanka?"

2. LITERATURE REVIEW

2.1. DISASTER RECOVERY AND POST-DISASTER RECONSTRUCTION

Generally, disasters are known for its vast impacts on human lives, economy and environment (Moe and Pathranarakul, 2006). Disasters lead to terminate the developmental projects since the fund allocations should be transferred to the new outcomes for relief, reaction and rehabilitation work other than interrupting the usual life of affected groups. Post-disaster recovery and reconstruction is identified as developing a set of strategies to support a community in rebuilding after a disaster occurs (Newport and Jawahar, 2003). Recovery planning can also be thought of as building the outline for reconstruction of the community after a disaster. There are a number of activities that communities can engage in to address post-disaster recovery.

The most common goal in disaster recovery process is to restore buildings, infrastructure, business and activities of the government to the ordinary pattern that existed (Newport and Jawahar, 2003). Hence, post-disaster reconstruction can be indicated as a process of creating a resistant built environment for generating future vulnerabilities, to the disaster affected communities. It is a process of developing new buildings or refurbish the damaged constructions in order to replace the affected ones.

Major stages of post-disaster reconstruction projects can be identified as 'definition, design and implementation' (Attalla *et al.,* 2004). Yet, these projects always deal with uncertainties, complication and challenges as it has been done within the disaster-affected areas in most of the times. Therefore, PDR is a part of a long-period process including emergency, re-establishment, reconstruction and betterment construction.

2.2. TIME, COST AND QUALITY PERFORMANCE

Atkinson (1999) identified the three criteria of time, cost and quality as 'iron triangle'. The author further proposed that when other definitions of project management are developed, the 'iron triangle' is always used as time, cost and quality. The Iron Triangle was initially considered as a framework to empower project managers to assess and balance the challenging demands of time, cost and quality of the projects (Torbica and Stroh, 2001). According to Stojcetovic *et al.* (2014) this triangle was named as 'Iron triangle' because, the margins can reduce or extend, whereas the structure is unbreakable. Changes can be done in to one aspect; however other two also should be balanced and adjusted accordingly.

Cho *et al.* (2009) have defined that project performance management reviewing the efficiency of the project by analysing the practices and procedures. The duration, cost and the quality are the basic criteria of high project performance level, which is identified and discussed by each and every academic and experts. In addition to those basic criteria, Cooke-Davis (2002) has identified that project psychosocial consequences that refer to the fulfillment of interactions and relationships with project team is also a cause to project success.

"Time" denotes the duration of the project from the inception to completion of the project. It is programmed to facilitate the building to be occupied by a date specified by client in accordance with his future plans. Time management is very critical and the project cost is highly depended on the estimated time duration (Kim and Garza, 2005). When the duration of a project is compacted it is essential to increase labour and more productive tools which increase the cost.

"Cost" is another significant aspect that determines the project performance (Cooke-Davies, 2002). Cost can be defined as the expenses incurred for labour, material, plant, financing, services etc. including the overheads and profit. It is very difficult for an organization to keep increasing the quality of projects and seeking to reduce their costs as the cost and the quality are inter-related aspects.

"Quality" is another principle that is highlighted by academics and researchers. However, assessing quality is relatively subjective. Stojcetovic *et al*. (2014) have defined that quality as the degree to which a set of essential characteristics satisfy the requirements of client or stakeholders.

Trade-off is necessary among the three targets of cost, time and quality in a construction project. The requirement of a project is to complete it within the specified time period, adhering to the budget and reaching the quality standards which are identified in the specifications.

2.3. ISSUES AND CHALLENGES THAT AFFECT PROJECT PERFORMANCE IN PDR PROJECTS

Various experts and researchers have been involved in defining cross cutting challenges that are faced by different post-disaster reconstruction stakeholders. Ismail *et al*. (2014), have identified delay, resourcing etc. as the major challenges. Further Comerio (1997) and Shaw (2006) have identified that, reconstruction financing and environmental sustainability are some other issues in post-disaster reconstruction projects.

1. Delay
2. Resource Challenging
3. Financing Issues
4. Lack of Coordination
5. Unstable Policies
6. Quality of Work
7. Cost Overruns
8. Shortage of Technical Staff
9. Inflation of Prices
10. Weak Regulation and Control
11. Unpredictable Weather Conditions
12. Risk and Uncertainty
13. Lack of Proper Training
14. Lack of Project Management Experiences
15. Non-Performance of Subcontractors
16. Design Changes
17. Contract Interpretation Disagreements
18. Conflicts between Parties

2.4. PROJECT PERFORMANCE OPTIMISATION IN POST-DISASTER RECONSTRUCTION PROJECTS

'Optimisation' is defined by Khosrowshahi (1997) as finding a substitute which reaches the performance to the maximum level with most cost effective within the given limitations, by making the best use of preferred aspects and minimizing undesired aspects. Maximization means trying to achieve the utmost or highest consequence despite of concerning cost or expenses whereas optimisation is restricted by limitations of time and cost.

Due to various limitations, the level of project performance in PDR projects is at a very low level (Baroudi and Rapp, 2010). According to Yi and Yang (2014), the methods of financing the reconstruction projects is a critical factor as there will be a strong pressure due to limited funds. Barenstein and Pittet cited in Thanurjan and Seneviratne (2009) identified that post-disaster reconstruction projects are one of the least effective sectors in the implementation stage.

Optimising the project performance is a concept of not merely increasing the level of performance, but providing splendid standards in all aspects of project performance. In simple terms performance is reaching project goals successfully and keeps the client's satisfaction to the maximum level in time, cost and quality aspects (Nkado and Meyer, 2001). The level of performance is highly depended on the activities of each stakeholder, resource allocation, construction management etc.

2.5. CURRENT STATUS OF PROJECT PERFORMANCE OF PDR PROJECTS IN SRI LANKA

Empirical evidence revealed that the Sri Lankan cities face number of challenges in achieving a disaster resilient built environment. Some of the challenges identified are, lack of regulatory frameworks to regulate disaster resilient development, such as resilient building codes, planning regulations and risk maps; unplanned cities and urbanisation; old building stocks and at risk infrastructure; unauthorised structures; institutional arrangements; inadequate capacities of municipal councils; lack of funding; inadequacy of qualified human resources; and corruption and unlawful activities. Sri Lanka encountered a big challenge in reconstruction, as it had not earlier faced a disaster of the level of tsunami (Karunasena and Rameezdeen, 2010).

Post-disaster housing reconstruction is considered by many experts as one of the least successful sectors in terms of implementation (Barenstein and Pittet, 2007). Further, lack of effective information and knowledge dissemination can be identified as one of the major reasons behind the unsatisfactory performance levels of current disaster management practices (Haigh and Sutton, 2012). According to Banerjee cited in Haigh and Sutton (2012), lack of prior knowledge and proper point of reference have made most of the recovery plans guessing games, eventually failing without adding appropriate values to the recovery attempts.

3. RESEARCH METHODOLOGY

A research design is the logical sequence that connects the empirical data to a study, initial research questions and, ultimately to its conclusions (Yin, 2013). A research design is not just the work plan where a thing more than that with the purpose is to avoid the situation in which the evidence does not address the initial research questions.

Case study approach included two phases design called exploratory design where by collecting and analysing qualitative data at first and based on that collection and analysis of quantitative data is done to test or generalize the initial qualitative findings. Since this study was aimed to investigate the strategies used to optimise the projects performance in post-disaster reconstruction projects, multiple case study design was selected to obtain the realistic data and final conclusions.

Since this research depends on experts' knowledge and numerical data so as to carry out an effective data collection within the available time, and budget several limitations were undergone. Number of post-disaster reconstruction projects is limited and finding stakeholders who involved in them were hard to discover. In qualitative approach, interviews are most commonly used data collection technique. To collect the data on overall project performance, the critical factors identified were used in interviews. In order to cater for emerging questions in the interview, semi structured interviews were selected. Yin (2013) explained that, in-depth interviews were conducted to gather essential details from the experts while clarifying the doubts, asking further questions. Interviews were carried out with qualified and experienced representative such as Project Engineers, Project Manager and client's representatives.

Content analysis involved codifying qualitative information in to pre-defined categories while gathering data, to obtain patterns in the presentation and reporting of information. Yet, it is an analytic approach which undertakes similar cognitions in a same concept in a systematic and replicable manner. Therefore, as the qualitative data analysis software available, NVIVO (version 10) was used, manufactured by Qualitative Solutions and Research (QSR) International (Pvt) Ltd. for content analysis which enclosed graphical presentation of interpreting relationships.

4. RESEARCH FINDINGS AND DISCUSSION

As the initial step, in finding the strategies to optimise project performance in PDR projects, the interviewees were asked about the critical factors that affect the cost performance of post-disaster reconstruction projects. After that probable ways to optimise the performance level were identified through the semi-structured interviews. Figure 1 shows the critical factors affecting cost performance.

Nodes

Name	Sources	References
Critical factors affecting Cost performance	6	39
Changes in the scope of the project	2	5
Design Changes occured in construction stage	3	6
Inadequate experiences of the contractor	1	1
Incorrect planning and scheduling by contractors	3	5
Issues in material procurement	1	1
Poor site management	2	2
Price escalation	4	8
Shortage of workers	1	1
Underestimation	2	4
Unforeseen Ground conditions	2	6

Figure 1: Critical Factors Affecting Cost Performance in PDR Projects in Sri Lanka

As the next step in finding the methods to optimise project performance level, the respondents were questioned about the critical factors that affect the time performance of post-disaster reconstruction projects, with their involvement in these projects. Thus, it was identified that what kind of components have an influence on time performance.

Nodes

Name	Sources	References
Critical factors affecting Time performance	6	29
Average delay in regular payments	2	4
Delays due to no chain of command	1	1
Delays occured due to site preparation	1	1
Delays occured in fund allocation	2	2
Delays occured in site selection	2	2
Faults in the design	1	2
Insufficient site supervision	1	1
Insufficient skilled labour force	1	1
Low speed in decision making	1	1
Material Shortage	2	2
Unavailability of resources	3	4
Unforeseeable weather conditions	2	3
Variations occured during the construction period	3	5

Figure 2: Critical Factors Affecting Time Performance in PDR Projects

The interviewees were asked about the critical factors, which affect quality performance of the post-disaster reconstruction projects in Sri Lanka in accordance with experiences gained in the industry. Thus, some aspects were identified through the data collection as factors which are having a negative impact on the quality performance.

Nodes

Name	Sources	References
Critical factors affecting Quality performance	6	76
Changes in specification during the construction	4	8
Lack of quality assurance systems	5	12
Limited fund allocation	4	13
Design changes	3	11
Using low quality materials	1	3
Design errors	3	6
Less coordination of the construction team	2	7
Searching for ideal solutions instead of practical solutions	2	5
Insufficient experiences of the contractor	2	5
Insufficient qualified work force	2	6

Figure 3: Critical Factors Affecting Quality Performance in PDR Projects

All the respondents highlighted the issues that affect the project performance in PDR projects as critical factors that highly affecting time, cost and quality factors. As the next step, the interviewees were asked to expose the suggestions and probable attributes in order to optimise the project performance level.

- A broadly defined project team organisation structure (hierarchy) with a clear outline of duties, responsibilities, authority, and communication channels etc. For each and every individual of the project team.
- Preparation of comprehensive financial management plan and strict implementation ensure the availability of funds, before commencing the project or sections of the project.
- Preparation of comprehensive site organisation plan, optimizing the efficient usage of site space.
- Recruitment and appointment of competent professionals for the project team by analysing their level of knowledge, experience, skills and attitudes.
- Proper consultation on project definitions and requirements in order to minimize design errors and variation.
- Sequential development of the design with relevant professionals, in order to minimize design errors
- Strict evaluation on the capacity, performance and qualifications of the Contractor before awarding the Contract
- Establishment of firm site security and supervision structure.
- Comprehensive project time line or plan development with identification of resource requirements in each stage, in order to minimize lack of resources on time.
- Consideration of weather patterns as much as possible in planning stage and allow sufficient buffer time period for such unforeseen conditions
- Liaison between the parties regarding the project requirements in the designing stage in order to minimize design changes and emphasize on the importance of not changing the design thereafter and consequences, if it had to be changed.
- Incorporation of quality control procedure within Contractor and client as well.
- Introduction of severe penalties and damages for deliberate poor quality work.
- Increased defect liability period and high quality supervision procedure.
- Introduction of strict specification and standards for the construction materials and construction methods, in order to eliminate poor quality materials and workmanship
- Development of comprehensive cost plan for the work items and establishment of cost control procedure and cost analysis methods to avoid unnecessary cost overruns and wastage.

- Reduce time incurred to follow up office procedures and enhance the performance of government organisations

This research attends to determine probable attributes and suggestions that can be integrated into project performance optimisation of post-disaster reconstruction projects. Accordingly, there were several attributes highlighted in the interviews which would be better to suggest for time, cost and quality improvements.

5. CONCLUSIONS

Undertaking reconstruction projects after a major disaster can be identified as challenging task in Sri Lankan context. Furthermore, the importance of managing all stakeholders involved in the project for effective and efficient recovery of an affected community. It is emphasized and highlighted the significance of reconstruction planning as well as the accurate ways of executing the activities in the construction project. The research indicates the importance of reconstruction process referring to high-cost and long-term commitments required. The complexity of post disaster reconstruction, in related to various dimensions as risks and uncertainty lead the whole project in to unsuccessful.

The numerous critical factors affecting the time, cost and quality performance levels were identified in the research through expert interviews. Those aspects are within six main subsections such as, issues occurred in the planning stage, issues in related authorities and professional bodies, unforeseeable conditions, issues in the site, issues due to economic instability and issues of the contractor and suppliers. Ultimately, the probable project ways of enhancing and optimising the degree of time, cost and quality perspectives in post-disaster reconstruction projects in Sri Lanka were identified through the research.

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