Project Risk Management for Sustainable Building Repair & Maintenance in Developing Countries

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Abstract

Building repair & maintenance (R&M) are inevitable: building components deteriorate with time due to aging, constant use – causing wear and tear, possible design and construction defects, and the consequences of environmental agents and vulnerabilities. The situation worsens in developing countries where large number of externalities dictates the R&M decisions: lack of budget, enforcing regulation and building standards to name a few. These and other inherent uncertainties grow to be considerable risks of peculiar nature, which demand an active and customized management. The need to manage risk of R&M projects is paramount: starting from affective identification to seamless analysis, and suitable response planning to meticulous monitoring and control, a custom-structured project risk management (PRM) framework – a combination of specialized tools and techniques – will greatly help by considering how risky these undertakings are, dealing with apparent threats and converting them into opportunities. To this end, this paper, after reviewing the R&M state of affairs in developing countries, proposes a functional PRM framework to manage R&M risk.

Keywords

Project management, Project risk management, Repair & maintenance, Sustainability.

1. Introduction and Motivation

Building components are prone to ageing due to contact with external operating environment and deterioration due to constant use, resulting in reduced service life. So, if left without any measure, these components will eventually become inefficient, unreliable and may even fall apart. To counter the serviceability challenge, building components are so maintained that they continue to perform their assigned purpose. According to British Standard 3811:1984, *'maintenance'* can be described as the combination of technical and associated managerial actions aimed at retaining a building component in (or restoring to) a state in which it can perform its required function (Seeley, 2003). The objectives of maintenance are (Chanter and Swallow, 2008; Wordsworth and Lee, 2001):

- To ascertain that buildings, their components and their associated services are in a safe condition.
- To ascertain that the buildings and their components are in usable condition.
- To ascertain that all the statutory requirements are satisfied.
- To execute work necessary to maintain the building quality.

The maintenance activities, regardless of ‘preventive’ or ‘corrective’ in nature, must be considered as a project. Hence, the actions mentioned before are those associated with conception, planning, execution and close out – a typical project lifecycle.

In contemporary times, the notion of *‘sustainability’* seems to dominate the debate; owing to quickly withering environmental conditions and ailments, the idea of *‘sustainable development’*, as an effective response, has emerged. Sustainability (commonly defined as a complex – and often contradicting – interplay between economy, society and environment), in the context of built environment, is vital since the building activities have always had significant and sometimes unaccounted for consequences; globally, over 35% of industrial waste is contributed by these activities (Construction Materials Recycling Association, 2005; Hendriks and Pietersen, 2000), (38% in Hong Kong alone (Hong Kong Government – Environmental Protection Department, 2006)). Furthermore, the maintenance actions, where huge piles of waste are generated, also pose great threat to sustainability. To curb this menace, a number of studies have taken place (Furcas and Balletto, 2012; Yuan, 2011; Solís-Guzmán et al., 2009; Kourmpanis et al., 2008; Chung and Lo, 2003; Fatta et al., 2003) and developed nations have come up with strong regulations (Nitivattananon and Borongan, 2007; Cheremisinoff, 2003; Kreith, 1995).

The *‘attention to detail’* tendency for sustainable development in the context of developing countries is really alarming: restricted by weak economies, vulnerable social conditions and insubstantial appeal to environment, developing countries risk bearing greater losses trying to avoid smaller ones (e.g. having to face larger costs ultimately trying to save smaller ones by not taking measures when required). Correspondingly, proper and timely maintenance helps achieving longer economic life, resulting in lower depreciation costs and thus higher profitability. Although international efforts of venturing into sustainable development in these developing countries seem promising, they are still far away from achieving sustainable results without streamlining practically every aspect of sustainability.

Building repair & maintenance (R&M) decisions are critical in their nature owing to above mentioned facts. Also, based on evident reasons (Myeda et al., 2011; Amusan, 2011; Ali, 2009), the humble track record of developing countries in achieving sustainability in R&M actions is further complicated due to project externalities: lack of budget and enforcing regulation for example. An important of them is the inconsistency of planning and development policies; mainly influenced by short-term political goals, rise in housing demand due to increasing urbanization and near-constant upheaval in economic conditions, developing countries witness speedy and hasty construction, which result in higher R&M operations later on. Inefficient use of construction material, at the beginning, later triggers wasteful R&M actions: environment and economy suffer from constant construction and reconstruction and the money overspent, which could otherwise be used for social causes, harms the sustainability. Therefore effort must be exerted to manage risks R&M operations pose. Starting from affective identification to seamless analysis, and suitable response planning to meticulous monitoring and control, attempts are made to consider how risky these undertakings are and how to deal with apparent threats to convert them in opportunities.

Since R&M projects are high impacting in the realm of sustainability, it is opportune to have a customized systematic and formal PRM framework to cater to their risks. However, the common practices do not necessarily promote and upgrade R&M activities as projects and enable their risk management using customized approach. Also the literature seems lacking of such a methodical attitude and the diffusion of risk management techniques and standardized practices compared to other fields and industries. Ideally, these projects are vital concern for undertaking organizations as, if not managed correctly, the risk faced by the projects may not only cause failures (Krane et al, 2010) but also harm the notion of sustainability. Taking on the motivation, it can be deduced that there is the need to disseminate the knowledge of project risk management (PRM) (and its affectivity) in R&M sector and learn the lessons from construction industry as both share huge number of common features.

2. PRM Process

The process of PRM is a systematic and well-structured way of managing and handling risky situations. PRM is defined by PMI as a subset of project management with four integral processes: risk identification, risk analysis, risk response development, and risk monitoring and control (PMI, 2009).

Risk identification is the process of spotting risks prior to managing them. Identification surfaces risks and threats before they become problems, and adversely affect a project (Carr et al, 1993). Apart from various other techniques, interviewing and brainstorming are some of the most used; later being a combinatorial technique for identifying and analyzing risks (del Caño and de la Cruz, 2002).

After identifying the risks, their analysis is performed. Since all the identified risks cannot be practically managed, it is important to prioritize them. Risk analysis is the process of prioritizing the identified risks based on qualitative and quantitative assessment by investigating their probability of occurrence and resulting impact. In order to simplify the task, qualitative and semi-quantitative techniques are widely used (PMI, 2008). Qualitative techniques do not operate on numerical data but present results in the form of descriptions. The risk is evaluated in more conceptual terms, such as high, medium or low, regarding collected opinion and risk tolerance boundaries in the organization. The purpose of qualitative risk assessment is to determine the qualitative scales for the probability and impact of risk. Examples of qualitative techniques are brainstorming, cause and effect diagram, checklists, Delphi, event tree analysis, etc. (Hubbard and Evans, 2010). Semi-quantitative techniques are basically a derivative group. Semi-quantitative analysis can be defined by associating a scale factor to nonnumeric ranking. For example, a score of 1 to 5 can be assigned for ranking risk factors affecting project performance. Examples are interviewing, probability and impact matrix, risk probability and impact assessment, etc. (Baccarini and Archer, 2001).

Using risk analysis as input, the risk response is developed, which is the process of exploiting options and decisions for increasing the positivity and decreasing the negativity. Finally, the lifecycle process of monitoring and control takes place, which supervises the implementation of risk responses, identifies any new risk and brings them in the risk management process, and evaluates the overall affectivity of the entire process (Chapman, 1991).

3. Proposal of PRM Framework for R&M Projects

3.1 Context of the framework

The proposed framework provides a practical and convenient methodology to implement the PRM in R&M projects. It mainly deals with the risk assessment (combination of identification and analysis of risk). Based on the work of De Marco et al. (De Marco et al, 2012), and found on the knowledge of maintenance project drivers and general industry context, the framework recommends convenient and easy-to-use techniques, such as qualitative and semi-quantitative, for risk analysis. The more sophisticated (and to a certain degree demanding in terms of their input parameters) techniques, such as quantitative or simulation-based, may later be proposed once the industry inculcates the PRM culture and equips itself for the complexity and requirements of higher expertise essential for such techniques.

3.2 Risk identification techniques

For identifying risks, the proposed framework suggests the use of interviewing, brainstorming and documentation review (PMI, 2009). The rationale behind interviewing is driven by affectivity offered in the form of personalized and focused data gathering. In a state where a sizeable amount of risk taxonomies and checklists are often not available, interviewing by human interaction can by helpful in gathering important risks.

Multidisciplinary interview sessions can be organized involving experts with prior background in R&M projects. The diverse team of participants may ascertain the identification of risk events pertaining to a broad spectrum. From semi-structured to non-structured interviews are suggested in order to ensure more in-depth and holistic risk identification.

Brainstorming is also proposed as a potential identification and ranking technique. It can be utilized for narrowing down the identified risks, thus refining the overall process.

Wherever possible, the risk identification phase may also benefit from reviewing previous documents. Documentation reviews involve reviewing as-built drawings, maintenance plans, detailed specifications, assumptions, historical information from a total project perspective as well as at the individual deliverable- or activity-level. This review may help the stakeholders identify risks associated with the objectives set out in the first place.

3.3 Risk analysis techniques

For analyzing risks, the proposed framework suggests to use qualitative and semi-quantitative techniques. The proposed qualitative technique is risk probability and impact assessment, which is a twofold analysis technique: risk probability assessment explores the probability of occurrence of risk and impact assessment examines the resulting effect on project objectives should the risk occur. This assessment can be performed by individual interviewing (high bias chances) or brainstorming (low bias chances). The participants pertaining to various expert areas of R&M and sustainable development nominate probability and impact of risks and later rank the risks in the order of their significance.

For semi-quantitative analysis, the framework proposes the use of probability and impact matrix. A likert scale, from 1 to 5, is advised for determining the subjective probabilities and resulting impacts for each identified risk from the experts. The suggested probability and impact scales are: 1 – Very Low, 2 – Low, 3 – Medium, 4 – High and 5 – Very High. The numerical parameters are then put into the matrix (Probability and Impact Matrix by PMI (PMI, 2009)) to find out the risk ranks in terms of their significance, such as High, Medium and Low.

3.4 Project Management process

R&M projects involve a multitude of competencies and need a team composed of, but not limited to, architects, engineers, technicians, managers, sustainability experts, environmentalists etc. Managing such diverse teams may prove to be extremely challenging. Therefore, it can be conclusively established that the management of R&M projects stipulates for specialized and customized PM process. Inspired from the work of Amusan (Amusan, 2011) and Croci (Croci, 2000), a detailed lifecycle of R&M projects is proposed, as shown in Figure 1.

3.4.1 Motivation/Need for R&M

The process starts with establishing the motivation and the need for repair and maintenance. It is probably the most important element of entire PM cycle. In the first phase, the physical analysis (synonymous to '*damage analysis*') is carried out. The material and structure are inspected for damages and decay, and the need to repair is realized as it is always significantly cheaper than replacement. It is important to comprehend the physical damage and its level before making any R&M decisions. Further a climatic analysis is carried out since it is very essential to consider the atmospheric conditions of the surroundings of the building because determining the kind of climate the building interacts with, it will be easier to take critical decisions regarding material selection. Afterwards, an analysis of variation is carried out where changes in geophysical and political/statutory conditions are examined. The upgraded hazard maps show increasing seismic risk in previously undocumented zones of the world which clearly indicates a variation in geophysical conditions resulting in seismic retrofitting as critical R&M action. Also the changing environmental and atmospheric conditions pose risks of their own kind, thus the maintenance is sometimes only motivated due to exogenous changes.

Corresponding to this phase of PM and with standard PRM process, risk identification is carried out, which is very important as it will unearth most of the threats and opportunities the project will be subjected to. Ranging from visual inspection to interviewing experts, reviewing old documents and as-built drawings to brainstorming amongst the experts, this initial stage demands rigorous usage of tools and techniques for affective risk identification. At the end of this phase, the project stakeholders may obtain a checklist of risks which may also be arranged into a taxonomy for future use.

3.4.2 Feasibility

The second phase of process deals with the feasibility study which aims at establishing the viability of maintenance viewed from different perspectives. The current level of structural integrity and its capacity to undergo a *'therapeutic'* procedure must be determined. Therefore, it is opportune to carry out the structural feasibility of building before making any restoration decisions. This may involve NDT investigation over various structural and nonstructural building components. Further, feasibility of maintenance in terms of repair/renovate/replace/refurbish is done with chief importance to the sustainability. In case of developed countries, where there are higher landfill taxes, there may be some incentive to repair and reuse but same can only be justified in developing countries based on replacement cost. Lastly, the financial feasibility, in terms of cost, revenues and taxes, must also be established and transformed into a Cost Management Plan (PMI, 2009). Since the serviceability of buildings is extended as a result of active R&M, the new depreciation must be taken into account. In case of public buildings, the serviceability is further affected by the use-value.

At the end of the feasibility phase, a conclusive decision may be made in favor of R&M project or vice versa. The PRM proposal for this phase stresses for further risk identification. Apart from interviewing, it is also advisable to perform brainstorming by bringing onboard experts from various disciplines, such as architecture, engineering, building, economics, environmental engineering, and project management. Also financial, structural and historic documents must be reviewed to countercheck, validate and strengthen risk identification. At the end of this phase, the project stakeholders may revise the taxonomy by updating newly identified risks.

3.4.3 Design Phase

Following the successful feasibility phase, a design of maintenance is planned in terms of materials and structure. The previously used materials may not be available in some cases due to a number of reasons. Therefore, it is important to first investigate for available ones which not only possess similar characteristics, but are also capable of facing modern challenges and are environmentally sustainable. Thus, a design phase is carried out where the suitable R&M materials are either selected from a range of available ones or designed on-demand, followed by structural design necessary for the intervention. It is important to design and guarantee the structural reliability of the building in the face of new material, possible additional fixtures and loads, and modern protecting techniques, such as retrofitting. Also, the standards and regulation pertaining to sustainable development must be considered on priority to ensure not only economic gains but also the environmental and social impacts.

During this phase, the PRM includes identification of risks introduced due to design, followed by their analysis. For qualitative analysis, risk probability and impact assessment must be performed and risks be ranked according to their importance. For semi-quantitative analysis, probability and impact assessment must be performed where, based on the expert judgment and physical data, risks must be allotted their relative probabilities and resulting impacts. Since all the identified risks can never be managed due to limited resources, therefore only the most significant and threatening risks are responded to. So, the analyzed and ranked risks are further filtered, based on a brainstorming, for selection of most significant ones for which the effective responses are developed.

3.4.4 Development

After the design, the R&M works are executed which involving onsite physical activities employing construction and restoration workers and engineers. The building is more susceptible and at risk during this phase than at any other time. Therefore, the project and site managers must be required to look for any new risks evolving due to the ongoing site work. Especially during the phases of deconstruction and dismantlement, it is important to hunt for the areas of concern; identify risky situations, analyze them and quickly come up with some practical response. Risk identification by visual analysis and interviewing the site staff is advisable. For risk analysis, semi-quantitative techniques are suggested, which will help in further proposing the corrective measures. Also, the notion of occupational health and safety must be deliberated and appropriate measures must be taken to ensure secure and protected site.

3.4.5 Closeout

After the successful development of the project, it is closed out. Starting with a detailed intervention report, the entire PRM process is suggested to be documented in this phase, mentioning the risks identified, threats faced and opportunities exploited along with their probability of occurrence and impact of consequence. Also, the corresponding preventive and mitigation measures must be documented. Together with that, other important project documents are suggested to be prepared. Moreover, the layout and as-restored drawings should be prepared to be made part of the record, which may be referred to and reviewed at a later stage or for the next maintenance.

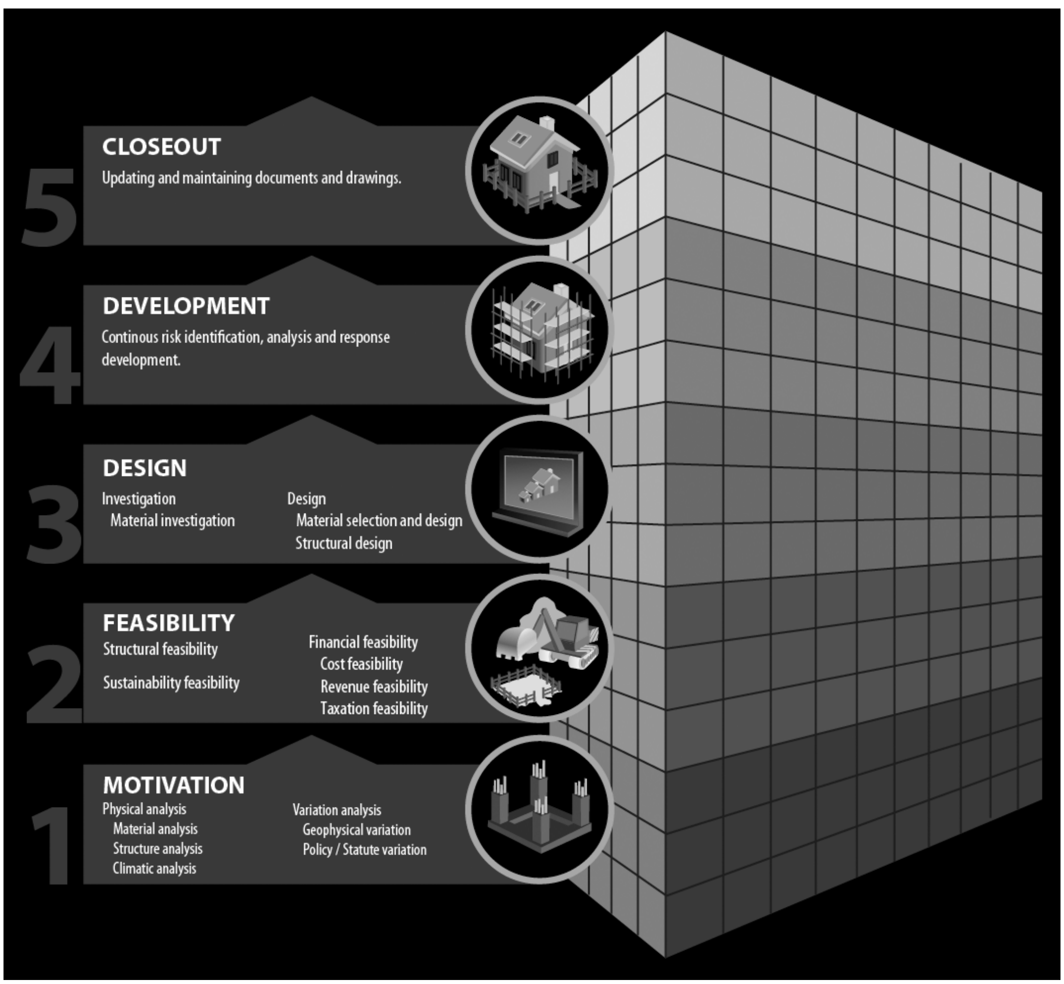

Figure 1: PM process for R&M projects

4. Conclusion

Repair and maintenance works are creating nuisance for sustainability and *'waste regulation'* is dictating R&M decisions, which are not aptly streamlined with PRM framework. The story is even more aggravated in case of developing countries where environmental concerns are further burdened by weak economies, and indifferent and dispassionate societies. This poses greater need to streamline sustainability anxiety into active project management and project risk management practices by offering customized frameworks and tools. This paper proposes a theoretical framework customized to manage the R&M projects and deal with their risks in a sustainable manner. The framework is further tweaked keeping in account the conditions and challenges of developing countries where priorities can be drastically diverse and focus can be shortsighted.

For improving the efficiency of R&M projects and ensuring the sustainable development, the framework may achieve the objectives in a systematic manner. Further, the proposed techniques will ensure required level of details for risk identification, analysis and response development.

Based on the novelty of PM and PRM areas of knowledge for the R&M context, the framework has been restricted to convenient tools and techniques due to inadequate maturity of the industry. In order to improve the efficiency of the current framework, more sophisticated tools and techniques might be included at later stages strongly based on industry acceptance and positive feedback.

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