Risk management for sustainable restoration of immovable cultural heritage, part 1: PRM framework

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Abstract

Purpose – The purpose of this paper is to introduce and develop a knowledge base for the restoration industry to understand and deal with risks arising in restoration projects in a sustainable way. Restoration projects face a number of risks and are viewed unfavorably. The research study, therefore, is expected to generate interest and debate among the professional and researcher community in the arena of restoration of built cultural heritage for formally applying Project Management (PM) and Project Risk management (PRM) theories and practices.

Design/methodology/approach – The research method consists of reviewing published literature and analyzing the dynamics of restoration industry (both from academic and practitioner point of view) in order to propose an application framework. Building upon and taking inspiration from the fundamentals of Construction Management, the proposed framework aims at methodically applying risk management within the proposed PM stages.

Findings – Research results confirm that the restoration industry has not yet exposed to formal PM and PRM theories and practices to a greater level. The restoration projects are not necessarily so sustainable in their approach. Thus, there is enormous impetus and ensuing incentive for incorporating the formal theories and customized tools.

Research limitations/implications – This research attempts to target the exceedingly important area of cultural heritage restoration and the missing aspect of PM and PRM. Further, the proposed framework is an attempt at bridging communication gaps between management and restoration experts. Thus, it highlights the importance of scientifically and effectively managing restoration projects. Nevertheless, this uniting attempt has its own risks in terms of terminologies, technical language, and the understanding of risk and its management which may be the effective limitations. Since in the field of engineering as well, the foundation of PM and PRM areas of knowledge finds its traces in Construction Management – which is further an application of management in construction engineering – therefore, it is rather challenging to reconcile knowledge from different areas.

Practical implications – The paper explores issues concerning sustainability of restoration projects based on their use of PM and PRM. Results are expected to help stakeholders of restoration projects understand and apply the proposed PRM framework. This study is also aimed to develop a foundation for dissemination of PM and PRM knowledge in the restoration industry, and provide an impetus for future studies to examine how restoration projects can deal with risky situations.

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Social implications – The paper explores the sustainable development aspects of restoration projects in order to help stakeholders of built cultural heritage make critical decisions because if not managed properly, risks in a restoration project may either cause project failure or damage the historical buildings. Therefore, from a sustainable perspective, it is imperative that stakeholders identify, analyze, control and manage risks before commencing the restoration activities.

Originality/value – The study is an original effort in examining the penetration of PM and PRM practices in restoration industry. Based on it, the study proposes an original framework for application of formal PRM for restoration projects. Results are of relevance in today's world where risks hinder and sustainability guides the decision making.

Keywords Project management, Sustainable development, Restoration, Cultural heritage buildings, Project risk management

Paper type Research paper

1. Introduction

Restoration of cultural heritage buildings, in the face of ever-uncertain and risky future, has become a worldwide trend due to the emphasis on its benefits concerning architectural, economic, social, political and spiritual values (Garrod *et al.*, 1996; Feilden, 1994). Its goal is to provide the correct maintenance of cultural heritage in order to enrich the future (Pinheiro and Macedo, 2009).

Disasters – of natural and artificial nature – are the core concerns for conservation experts. The literature is jam-packed with knowledge areas of "disaster risk management" (Kobe Report, 2005; Peek and Mileti, 2002) and "preservation risk management" (Waller and Michalski, 2004; Ashworth, 2001; Caple, 2000; Waller, 1994). These disasters pose ever-growing threat to the integrity and safety of heritage buildings. Though it is beyond the scope of this paper to argue over the need to restore such buildings, it will be sufficient to mention that these buildings represent history, community and national values and above all a sense of identity (Wangkeo, 2003). International giants, such as ICCROM and ICOMOS, have done a lot of work on the risk preparedness and prevention strategies to cope up with these disasters and as a result, international conventions have been formulated. Also recommendations have been published for analysis, conservation and structural restoration of cultural heritage. However, conclusive evidence suggests that sometimes these calamities get the better of human effort and end up with disastrous aftermath (Taboroff, 2000).

Restoration, preventive or corrective, is carried out in order to reinstate the historic building in as much its original shape as possible. Before moving any further and without taking sides of the argument that is built around the debate of "originality" in the realm of architectural heritage (Larkham, 1996), it is opportune to explicate that proposed definition of restoration mainly aims at reconditioning the artifact in its architectural originality. That is to say that a holistic approach is not only suggested and advocated here but measures are taken to ensure it is somehow realized.

In view of that, the restoration activity is a custom-built undertaking for every heritage artifact based on their variety and nature. Generic guidelines are available but fitting with specific conditions, tailor-made actions are inevitable, giving raise to adhocism. As a result, there is always a tremendous amount of uncertainty involved in these projects. Therefore, restoration projects are largely affected by risks. Moreover, these projects do not seem to take holistic view of the structure's lifecycle and therefore are subject to changing environmental conditions. This definitely has implications on the sustainable development aspect as well; in other sectors, the life-cycle thinking tools have been successfully utilized to ensure project sustainability (McConville and Mihelcic, 2007).

Historic buildings are more vulnerable during building works than at any other time in their lifecycle. Apart from the maintenance of originality, some other most important risks are the lack of availability and knowledge of historical material, uncertainty of construction techniques employed, and the availability and capacity of specialized workforce (Grama *et al.*, 2011; Wang *et al.*, 2008; Croci, 2000).

Therefore, the intricate nature of restoration projects and the involved risks demand for a systematic and formal Project Management (PM) and Project Risk Management (PRM) approaches, respectively. It also demands to clearly and distinctively address the assessments of risk and impact: the former involving exposure to danger (or well-being), whereas the later referring to occurrence of risk. In his influential work, Bellanca (2011) argues for and attempts to establish a methodical approach toward the restoration of historic architecture, yet the need and incentive for incorporating management approaches to restoration seem overlooked. The literature in general seems lacking of a methodical attitude, and the diffusion of risk management techniques and standardized practices compared to other fields and industries. Nevertheless, it is believed that there is enough rationale to advocate for this methodical attitude toward restoration by integrating the theories, practices, tools and techniques of PM and PRM. In addition, the gap does not appear to be limited to the literature only, but it seems deep rooted in the culture of restoration projects. Ideally, these processes must be vital and momentous concern as, if not managed, risk may cause project failures (Krane *et al.*, 2010). Taking on the motivation, it can be deduced that there is the need to disseminate the knowledge of PM and PRM (and their affectivity) in restoration sector, and learn the lessons from construction industry as both share some common features. However, the former still demonstrates different dynamics and challenges, and demands for corresponding responses.

The construction industry is characterized by carrying out green field building activities using the prevailing materials and techniques, whereas the restoration industry deals with the existing entities made up of ancient and oftentimes outdated materials posing risks of their own kind (Pinheiro and Macedo, 2009; Cultural Heritage Bureau, 2005). Also in the realm of construction industry, there is evidence of the Life Cycle Thinking approach (Olander, 2012; Kohler and Moffatt, 2003) which seems ignored for restoration projects. In the absence of this kind of approach, restoration projects may not successfully imbibe and respond to the uncertainties; precisely, they are not seen as futuristic in their approach. However, the lifecycle costing (LCC) approach is still not properly integrated into the construction projects, which is essential for environmental decision-making (Gluch and Baumann, 2004).

The ages-old construction techniques which were employed for them are also not necessarily well-documented and preserved. The as-built drawings and specifications are usually non-existent. In the midst of this uncertainty, the restoration projects are aimed at maintaining the originality and ensuring that the restoration "therapy" will respect the subject (building/monument/structure) and its fragility. If managed scientifically, these risks along with their affect can be minimized, potential opportunities can be exploited and project objectives, in terms of schedule, budget, quality, scope, originality, safety, sustainability, etc., can be affectively achieved.

Looking at the available literature, industry practices and the gravity posed by the reported risks, it is imperative to have a formal and specialized PRM process for restoration projects which possibly takes into account the entire lifecycle approach. However, it is still not practically introduced and employed due to apparent lack of motivation toward PM in the restoration industry. Of the few available material, ICOMOS (2003) has somehow pioneered the concept of risk in restoration and rehabilitation projects. Another notable "intergovernmental organization dedicated to the preservation of cultural heritage worldwide through training, information, research, cooperation and advocacy programs" (ICCROM, 2013) has also been striving to incorporate the risk management knowledge in cultural heritage (ICCROM, 2009). It is important to note here that general scope of projects is time bound; that is a project has a fixed beginning and end. On the other hand, the Life Cycle Thinking is a kind of approach which may be better integrated into operations management.

To this end, Part 1 of this paper introduces the concept of PRM in restoration projects, proposes a practical framework consisting of PM process and parallel PRM actions, and takes it one step ahead by motivating the industry to actually implement it. Although equally applicable to other cultural heritage artifacts, the framework has mainly been thought around the heritage buildings (including monuments, castles, churches/mosques/religious places, etc.). In Part 2 of this paper, the proposed framework is *ex post* applied on a restoration project and critical findings are gathered and discussed.

The paper is structured as follows: first, the literature is reviewed for establishing background and definitions; second, the PRM framework is proposed in conjunction with the PM phases; finally, conclusions are drawn with practical implications.

2. Literature review

2.1 Background

Cultural heritage is broadly defined as consisting of movable and immovable, tangible and intangible heritage with strong historic, artistic, scientific, social, economic and cultural values of identity (Kobe Report, 2005; UNESCO, 2005). Goods of cultural heritage include monuments, buildings, historic ensembles, works of art, crafts, documents, literary works, ethnological treasures, archeological remains and even the intangible attributes such as oral traditions, unwritten languages and folklore (Bedate *et al.*, 2004) which are of "exceptional universal value from the point of view of history, art or science" (Veco, 2010). Cultural heritage is important for the pride of host nation and community, and their internal cohesion (Bedate *et al.*, 2004). It has been gaining momentum at the global, national and local levels due to major significance toward sustainable development and its components of environmental protection, and socioeconomic development (Kobe Report, 2005). The increasing emphasis over sustainable development is more relevant in the context of cultural heritage as it is one of the few areas which have an effect upon all three pillars of sustainability: economy is associated with the commercial nature of these artifacts; society is at the core of cultural heritage as it represents historic and social affiliations; and environment (in terms of environmental changes and challenges) has a direct impact on these artifacts due to their old age and inherent fragility.

Although the value and authenticity of cultural heritage is hard to be assessed by fixed criteria (Bedate *et al.*, 2004; ICOMOS, 2003), attempts are still made to comprehend its cultural significance (Sanz *et al.*, 2003; Mason, 2002). The reason behind this laborious pursuit is the fact that cultural and historic values strongly shape the conservation (and restoration) decisions (ICOMOS, 2003) along with other economic, commercial, environmental and national/regional drivers.

Owing to their age, location and previous maintenance, cultural heritage buildings are vulnerable to a number of hazards, rare and catastrophic, and continual and slowly damaging, originating from diverse material composition and geographical spread of heritage structures (Brokerhof *et al.*, 2007). In order to respond to these threats, restoration is carried out which is the methodological moment when the building is appreciated in its original material/structural form, and in its historical, social and aesthetic triality with a goal to pass it on to the future generations (Brandi, 1977). It is opportune to realize and appreciate the exceeding complexity of restoration decisions: the effect of an erroneous choice may cost dearly to the building, society and economy, thus posing a threat to the sustainability. Hence, in retrospect, the resolve to restore is a tricky undertaking in itself which needs some serious "impact assessment" (IA). IA is the process of structuring and supporting restoration policies, which are then translated to individual projects. It defines and assesses the risks and hindrances at hand, and the projected goals. It classifies the major choices for achieving the goals and analyses their expected impacts in the economic, environmental, social, historical and structural/engineering fields. It sketches the costs and benefits, advantages and disadvantages, and cultural implications of each choice and investigates into the possible synergies and trade-offs (European Commission, 2013). Risk assessment, being a phase of risk management, forms part of IA as the risks are identified and measured (qualitatively or quantitatively) during this process. The risk assessment output acts as critical input to restoration decision making. Formalizing further, it is preferred that risk management is supported by heritage impact assessments (HIA) and environment impact assessment (EIA) (Roders and van Oers, 2012). Though restoration does not entail new development, it nevertheless involves site operations which might cause harm to heritage artifact under restoration or others nearby. Incorporating HIA and EIA as predecessor to PRM will greatly help in ensuring that the restoration works will be in harmony with the existing cultural ecosystem.

Restoration projects face a number of risks. "Risk" is defined in the context of PM as an uncertain event whose occurrence may have a negative or positive effect on the project objectives (Raftery, 1994; Chapman, 1991). For a restoration undertaking, the project objectives may be reinstatement of the originality of the historic building keeping in view the safety of structure, users of the place and sustainability concerns.

Further, according to ISO 8402:1995/BS 4778, risk is a combination of likelihood (probability) for a certain problem to occur with the corresponding value (impact) of the damage caused. It is the occurrence of a negative event or the non-occurrence of a positive event. In the restoration literature, the risk taxonomies, which can normally be found in other engineering fields, are missing. Taxonomy is a breakdown of possible risk sources and is considered to be a prime tool for identification. In any case, some of the reported risks are the availability of knowledge of material, construction techniques and specialized workforce, the changing underground conditions and structural dynamics, changing national and international regulations, damage to structural integrity, availability of information on previous interventions, innovation in technology, concealed and hidden uncertainties, etc. (Grama *et al.*, 2011; Wang *et al.*, 2008; Croci, 2000). A formal PRM process, described in next section, is at the core of addressing risks in restoration projects.

2.2 PRM process

"Risk Management is the systematic process of identifying, analyzing and responding to project risk. It includes maximizing the probability and consequences of positive events and minimizing the probability and consequences of adverse events to project objectives" (PMI, 2009). The process of PRM is a systematic and well-structured way of managing and handling risky situations. PRM is defined by PMI (2009) as a subset of PM with four component processes: risk identification, risk analysis, risk response development and risk monitoring and control (Ward, 1999). Rigorous risk analysis – and thereafter the risk management – has the potential to minimize the impact of negative events in a restoration project while exploiting the impact of positive ones.

Risk identification is the process of spotting risks prior to managing them. Identification surfaces risks and potential 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, latter being a combinatorial technique for identifying and analyzing risks. Delphi technique may also be suggested which, though a little more laborious, has the advantage over brainstorming in a number of ways. The motivation comes from the fact that these techniques are highly effective in situations where established taxonomies are either scarce or does not exist, such as the restoration projects of cultural heritage buildings. Also, the tacit knowledge of risks can effectively be secured by human interaction and investigation.

Interviews of skilled personnel (ranging from project managers to subject matter experts), with prior knowledge of restoration projects, are carried out for identifying risks. Appropriate individuals are identified and briefed about the project. They then identify project risks based on their experience, project information and exogenous factors (del Caño and de la Cruz, 2002). However, it is opportune to remark that personal biases and perceptions may hinder and affect the objectivity of information gathering during personal interviews. Individuals, though experienced and skilled, may tend to respond by raising non-risks, concerns, issues, etc. which requires filtering either by expert judgment or by comparing with other individual responses (Tworek, 2010).

Brainstorming is used to identify and rank risks. This technique may involve a big variety of participants; ranging from project team members to multidisciplinary experts. Ideas are generated under the leadership of a facilitator. Risk sources are identified and ranked in broad scope (Turner, 1999). Also, in case of brainstorming, there are certain downsides which affect the neutrality and objectivity of results, such as individual or groups may gain the general attention of the group by expressing ideas faster and more effectively. Thus, it is prone to Groupthink and other group dynamics (Tworek, 2010). In such a case, Delphi technique can be suggested where consensus of group members is reached and bias is minimized along with the influence of any one person or part of the group on the outcome. The process involves a facilitator who uses a questionnaire to seek for ideas about the important project risks which are submitted and categorized into risk groups by the facilitator. The risks are then circulated to the group members for further comment. Finally, consensus on the main project risks may be reached after a few rounds of this process (PMI, 2009).

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 (PMI, 2008). In order to simplify the task, qualitative and semi-quantitative techniques are widely used. Although these categories of analysis techniques are limited by their sophistication of results, they provide the convenience of use. So, in short, some risk management is better than no risk management at all!

Furthermore, the usage of complex quantitative and simulation-based techniques requires a lot of past data. Restoration projects, where the utilization of PM and PRM tools is in its infancy, might not be well suited to such advanced techniques for a while.

But once the industry picks up with the PM and PRM culture, more sophisticated and demanding techniques may be suggested.

Qualitative techniques do not operate on numerical data but present results in the form of descriptions (Hubbard and Evans, 2010). 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.

Semi-quantitative techniques are basically a derivative group. Semi-quantitative analysis can be defined by associating a scale factor to non-numeric ranking. For example, a score of 1-5 can be assigned for ranking risk factors affecting project performance (Baccarini and Archer, 2001). Examples are interviewing, probability and impact matrix, risk probability and IA, etc.

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). The entire PRM process is depicted in Figure 1.

3. Proposal of PRM framework for restoration projects

3.1 Context of the framework

The proposed framework provides a practical and convenient methodology to implement the PRM in restoration projects. It mainly deals with the risk assessment (combination of identification and analysis of risk). Based on the work of De Marco *et al.* (2012), which is further refined in De Marco and Thaheem (2014), and found on the knowledge of restoration project drivers and restoration industry, the framework recommends more convenient techniques, such as qualitative and semi-quantitative, to suffice for the purpose of risk analysis. The more sophisticated and demanding (in terms of their input parameters) techniques, such as quantitative or simulation-based, may later be proposed once the restoration industry inculcates the PM culture and equips

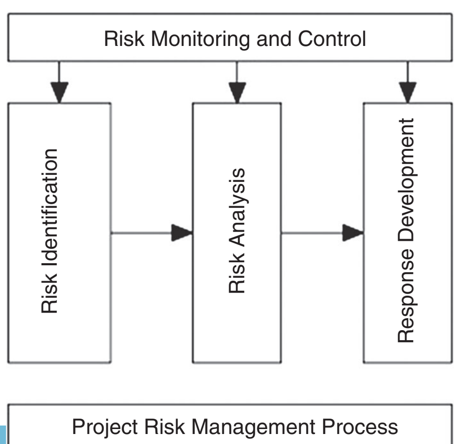

Figure 1. PRM process

itself for the complexity and requirements of higher expertise essential for sophisticated techniques. Nevertheless, these techniques may be applied for large and complex restoration works.

3.2 Proposal of risk identification techniques

For identifying risks, the proposed framework suggests the use of interviewing, brainstorming, Delphi technique, documentation review and SWOT analysis (PMI, 2009). Also, the proposal suggests use of visual and structural risk identification techniques. The motivation for interviewing is based upon the significant affectivity offered in the form of personalized and focussed data gathering. In a state where the restoration industry lacks a sizeable amount of risk taxonomies and checklists, interviewing, human interaction and investigation can efficiently help in gathering unstated and inferred knowledge on restoration risks.

Multidisciplinary interview sessions can be organized involving experts with prior background in restoration 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, and to avoid the selective information gathering based on selective exposure theory (Sears and Freedman, 1967).

Brainstorming is also proposed as a potential identification and ranking technique. In the phase of risk identification, brainstorming can be utilized for narrowing down the identified risks, thus refining the overall process. Though there may not be a fix number of participants for brainstorming sessions, it is adequate to state that fair amount of representation from all the possible stakeholders must be ensured; otherwise chances are the decisions may bend in some particular direction (conforming to powerful individuals/groups) which will impair the objectivity of the process. Further, in order to get rid of Groupthink and social conformity, Delphi technique is also proposed for the phase of risk identification.

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

Though not covered in the existing formal body of knowledge on PM and PRM, the proposal advises use of visual and structural risk identification techniques. Experts may be asked to perform the field work and visit the building and nearby areas to formulate a visual log of risks involved (The Project Management Monkey, 2009). The structural risk identification involves the use of non-invasive and non-destructive testing (NDT) techniques in which the unexposed structural and geotechnical features are uncovered and pertinent risks are logged for further analysis. The expertise required for this type of identification ranges from technical to mechanical and all the way to architectural.

Finally, the proposed framework advises to perform SWOT analysis based on the information collected from interviewing and brainstorming. This analysis helps broaden stakeholders' perspective of where to look for risks and how to manage them.

3.3 Proposal of risk analysis techniques

For analyzing risks, the proposed framework implies the use of qualitative and semi-quantitative techniques.

The proposed qualitative techniques are brainstorming and risk probability and IA. Brainstorming is a combinatorial technique for risk identification and analysis (in the form of risk ranking), and can be used to categorize risks based on their general characteristics of probability and impact. The participants, pertaining to various expert areas of restoration, rank the risks in the order of their significance under the leadership of a facilitator. The analysis can be further narrowed to investigating the corresponding probabilities and resulting impacts, as reported by the participants. Risk probability and IA is qualitative analysis tool where probability and impact of risk items are qualitatively measured (such as very high, high, moderate, low and very low) and further evaluated based on their resulting impact on project objectives (PMI, 2009).

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, 2009) to find out the risk ranks in terms of their significance, such as High, Medium and Low.

Once the risks have been ranked, the managerial decision can be taken as to which category(s) of risks will be actively responded to. The purpose of responding and treating risks is to minimize or eliminate the potential impact they may pose to the achievement of set objectives. Usually this kind of decision is driven by multiple criteria ranging from cultural, historic and national values of the heritage artifact to the availability of monetary resources. Also, the national/regional conservation and restoration policies (if any) play an important role here as they benchmark the identified risks against the established national/regional tolerance levels.

3.4 Proposal of PM process

Restoration projects involve a multitude of competencies and need a team composed of, but not limited to, historians, architects, engineers, social scientists and managers (Croci, 2000). Managing such diverse teams may prove to be extremely challenging. Therefore, it can be conclusively established that the management of restoration projects stipulates for specialized and customized PM process. Inspired from the work of Croci (2000), a detailed lifecycle of restoration projects, as shown in Figure 2, is proposed.

3.4.1 Motivation/need for restoration. The process starts with establishing the motivation and the need for restoration. It is probably the most important element of entire PM cycle. It is important to have a holistic and lifecycle view of the reasons which motivate the restoration; keeping in view the environmental, social and economic condition, a thorough study is warranted at this stage. Adding into it, the environmental IA is also proposed in order to gain useful insight into the kind of future uncertainties the building may be exposed to. Thus, in the first phase, the physical analysis (synonymous to "damage analysis") is carried out from multiple points of interest. The material and structure are inspected and investigated for damages and decay, and the need to restore is realized. It is important to comprehend the physical damage and its degree before making any restoration decisions. Not only the structure itself, but nearby and tributary areas are also checked for structural and material analysis. Afterwards, a study of variation is carried out where changes in geophysical

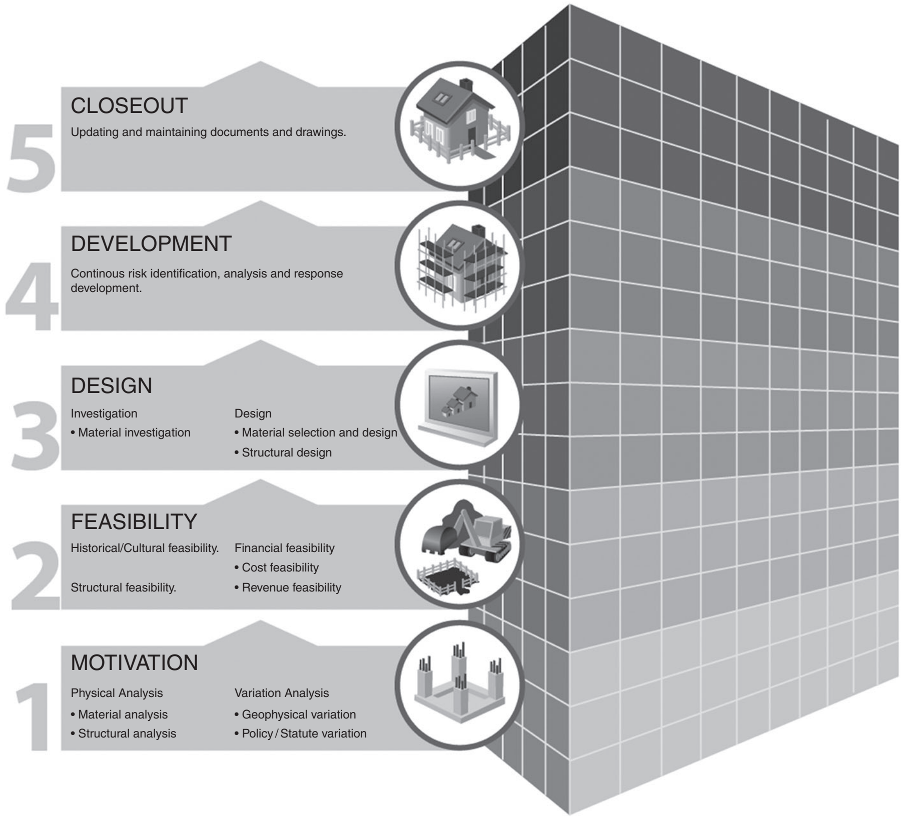

Figure 2.
Restoration project management process

and political/statutory conditions are examined. The improved seismic zoning has put a number of ancient architecture in earthquake-prone zones which were considered free of this natural force of disastrous nature before. Also, the changes in political and statutory realities may demand for some additional preparation. Often times, the restoration is only motivated due to exogenous changes, as was the case of infamous Pisa Tower in Italy, where the restoration was obligated due to deteriorating ground conditions (Croci, 2000).

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. With reference to Life Cycle Thinking, the risk identification must be aimed at not only the project concerns but beyond. Ranging from visual inspection to interviewing archeological and historical experts, reviewing historical documents to brainstorming and conducting Delphi sessions among the experts, this initial stage demands rigorous usage of tools and techniques for affective risk identification. Special attention must be paid on the fieldwork which will promisingly uncover a number of serious issues and risks. Site surveys using modern techniques as well as visual inspection must be carried out in order to familiarize and acclimatize with the structure and nearby area. 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 restoration viewed from different perspectives. Once again here, the investigation has to encompass the entire lifecycle of heritage artifact and the attention needs to be all-inclusive in nature. Historical/cultural feasibility tries to ensure that, despite being recognized as cultural heritage, the building being considered for restoration is historically and culturally important or not. Though arguable, the changes in demographics, sociopolitical conditions and behavioral interpretations may render some cultural heritage as "less valuable" than other, which paves the way for a study in this area. Also, the present level of structural integrity and its capacity to undergo a "therapeutic" procedure must be determined (ICOMOS, 2003; Croci, 2000). For this reason, it is important to carry out the structural feasibility of building before making any restoration decisions. This may involve NDT investigation over various structural and non-structural building components. Lastly, the financial feasibility, in terms of cost and revenues, must also be established; from project point of view, a Cost Management Plan (PMI, 2009) must be established and from a lifecycle point of view, a detailed LCC plan must be established. It is proposed to mimic The Stanford LCCA Procedure (2005) which, although with a focus on the context of greenfield construction, may prove beneficial in terms of organizing and analyzing the various cost and revenue centers.

Although there is a detailed debate around this argument (Greffe, 2004), some authors (Bandarin *et al.*, 2011; Throsby, 2003) consider all cultural heritage buildings as capable of raising revenues and promising economic benefit (Tuan and Navrud, 2008). Further, cultural heritage is also attributed to be of interest in terms of economics: it provides certain benefits and externalities to the areas where it is located. It is further credited to creating significant economic flows, along with being a means of transforming certain geographic areas, and thus providing stimulus to many local and regional economic development strategies and policies (Bedate *et al.*, 2004). Nevertheless, Navrud and Ready (2002) in their seminal work on cultural heritage valuation have analyzed in-depth the economic policy matters that come into play while taking restoration decisions. They raise important questions such as "should the restoration efforts be supported by tax revenues, or should cultural heritage goods be self-supporting, either through user fees or donations and subscriptions?" Therefore, it is important to perform cost-benefit analysis along with other financial and economic investigations before making any restoration decisions as the amount of stake involved and the kind of stakeholders who might be interested in such projects are of varied nature and their interests may not always be in the same direction.

At the end of the feasibility phase, a conclusive decision may be made in favor of restoration activity or vice versa. The PRM proposal for this phase stresses for further risk identification. Apart from interviewing, it is also advisable to perform brainstorming and Delphi sessions by bringing onboard experts from various disciplines, such as architecture, engineering, building, archeology, economics, sociology and PM. Also, financial, structural and historic documents must be reviewed to countercheck, validate and strengthen risk identification. In addition, further fieldwork is suggested in the form of visual logging and site surveys in order to custom-prepare the restoration activities. At the end of this phase, the project stakeholders may revise the taxonomy by updating newly identified risks. Afterward, the PRM proposal suggests performing risk analysis using qualitative approach of brainstorming. The identified risks are further evaluated using their probability of occurrence and resulting impact. Using this as input, the analyzed risks are categorized for further action.

3.4.3 Design phase. Following the successful precursor feasibility, a design of restoration is planned in terms of materials, structure and restoration technique. The historical materials in most of the cases may not be made available due to a number of reasons. In such a situation, it is important to first investigate for available materials which not only possess characteristics similar to those of historical materials, but are also capable of facing modern challenges and are environmentally sustainable. Consequently, a design phase is carried out where the suitable restoration materials are either selected from a range of available ones or designed on-demand, followed by structural design necessary for the intervention. Later, the restoration techniques are also designed using which the intervention will be carried out. Keeping in mind the fragility of structure, the technique may involve upfront shoring to avoid any collapse which may pose great threat to safety of workers and structure itself. 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 norms and standards of sustainable development must be considered on priority to ensure not only economic and social gains but also the environmental impacts.

During this phase, the PRM includes identification of those risks which are introduced due to design and then analysis of identified risks. Documentation reviews are suggested in order to identify new risks emerging from new materials and design. Material engineers must be equipped with the relevant literature provided by material suppliers in order to point out any possible risk. If the same material is used on some previous restoration, the report may be called from manager and material engineer of the project in order to look for possible problem areas. For qualitative analysis, risk probability and IA must be performed to rank risks based on their qualitative probability and impact, which must later be managed. For semi-quantitative analysis, probability and IA 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 rigorous Delphi session, for selection of most significant ones for which the effective responses are developed.

3.4.4 Development. After the design, the plan is executed which involves physical activities on the historic building. Development is the regular site work, involving construction and restoration workers and engineers, but the building is more susceptible and at risk during this phase than at any other time. Therefore, the project manager and the risk manager are duty-bound to look for any new risks surfacing due to the ongoing site work. Especially during the phases of deconstruction and dismantlement, it is important to look for any areas of concern, identify risky situations, analyze them and quickly come up with some practical responsive measures. Occupational health and safety concerns must be carefully responded to and the site workers must be fully equipped with necessary personal protective equipment. If the site remains open during the development phase (due to unavoidable circumstances), safe perimeter must be set in order not to let passersby and spectators get any closer to the restoration activities; this will ensure the safety of human subjects as well the structure. Risk identification by visual analysis, site surveys, non-invasive investigation and interviewing the site staff is advisable. For risk analysis, quick brainstorming along with semi-quantitative techniques are suggested, which will help in further proposing the corrective measures.

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 proposed 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 mitigating 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 intervention.

Though not falling in the realm of project, a monitoring phase may also be introduced after the project is closed out. The purpose of introducing this phase is to revisit the risk taxonomy (specially the part identified during design and development) and update the pertinent details. The possible advantage behind this cyclic activity may be exploited by the level of preparedness of taxonomy (along with relevant details) in the face of similar projects.

4. Conclusion

Though with growing threats to cultural heritage buildings and reciprocating restoration projects, practitioners and experts of the restoration industry still find themselves with negligible utilization of formal PM and PRM processes. Moreover, researchers often overlook the penetration of formal methodologies into the literature. Without incorporating the PM and PRM theories – with a successful track record – vulnerability of the restoration projects for not achieving their objectives rises exponentially. Not only the public/private money invested is jeopardized but the integrity and safety of heritage artifact may be compromised harming not only the notions of sustainable development but also the cultural-historic factors.

For improving the efficiency of restoration projects, safeguarding the historical icons and ensuring the sustainable development, a framework consisting of formal PM and PRM processes is proposed in this paper. The framework, though less sophisticated (because of convenience), is rigorous and involves using tools and techniques with proven affectivity in order to identify, measure and respond to the risk items involved in restoration undertakings. By carefully following the framework, restoration projects of cultural heritage buildings may achieve the objectives in a systematic manner. These objectives may range from integrity of the building, reinstatement of the originality, maintenance of historic and cultural importance, safety of workers, visitors, curators and other human subjects. In short, the application of this framework will help in achieving sustainability not only for the structure itself but also in correspondence with the pillars of sustainable development. 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 restoration professionals, the framework has been constricted to rather easy and convenient tools and techniques. It is due to the slightly inadequate maturity of the restoration industry in terms of awareness of PM and PRM. 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. It is, however, important to mention that the case study of the proposed framework, as detailed in Part 2 of this paper, which is a concrete application of the method to a real-life project, appears to sufficiently cover enough ground from the point of view of professionals involved in the project. It is a reasonable situation which not only warrants applicability but also provides necessary incentive to continue research in this area.

Thus, this paper is not only an important step toward generating a healthy debate among the restoration experts over the usage of formal PM and PRM practices but goes one step ahead by proposing an application framework which may not be a life-saver in the true sense of the term but provides practical tools and techniques to carry out risk management on a real life project. The possible value addition of this work may be realized in the initial phases of a restoration project where, based on the preparedness offered by applying the proposed framework, the project team and the restoration workers may gain important insights into the kind of scenarios they may be exposed to. The affectivity of application can seriously be augmented if the framework is aided by heritage and environmental IA as these processes can check and help ascertain that the dangerous and negative implications are minimized. The IA and risk assessment, in a way, may be intertwined to help decision makers and stakeholder for making informed decisions.

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