CONTRIBUTION TO THE IMPLEMENTATION OF RISK MANAGEMENT IN BUILDING REHABILITATION PROJECTS

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Extended Abstract

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Abstract

The building rehabilitation in Portugal is seen by many experts as a part of the solution to the crisis that the construction industry is currently undergoing. The housing stock is degraded and saturated and it is essential to encourage owners and researchers to rehabilitate. The project management and the risk management in particular, is necessary to achieve the objectives set by the Owner more effectively, on time and agreed budget.

This work aims to identify the main risk factors in rehabilitation work, which affect both the cost and the total time of the work, being given priority to the threats due to the characteristics of construction projects in general and building rehabilitation in particular. Based on bibliographic research on risk factors in construction projects, there were drawn up lists of risk factors in the perspective of the Project Owner, Designer and Contractor that were subjected to review by industry experts. It also proposes a methodology to convert the qualitative analysis of risk, that can be made based on lists of risk factors, in quantitative results using cost and schedule deviations records in building rehabilitation projects

Keywords: Rehabilitation, Risk, Risk Management, Time, Cost

1. Introduction

In Portugal, the urban development model has been based in new construction and expanding the urban centres. Until recently this was justifiable by the recorded deficit, mainly in terms of the infrastructure. However, it has been found that this model is no longer sustainable, in particular regarding the building stock. Therefore, nowadays, the conservation and rehabilitation of the built environment in general assumes a greater importance.

Risk management is another subject that is showing a great development in the construction sector in Portugal, especially since the publication of the international standard ISO 31000:2009. This is a management tool that aims to help the organizations to manage the uncertainty that emerges in every project. It also allows to make decisions with risk information and, in that way, contributes to achieve the project objectives and, consequently, meet the organization goals.

This research has one main objective which is to contribute for a sector of the construction industry that is inevitably growing and to promote the formal implementation of risk management, accordingly with ISO 310000:2009. Due to that, this research has a conceptual disclosure character of the risk management and the way it could be implemented in the construction industry, having as a complementary objective contributing to supress the existing information gaps and identify some aspects that can be improved to enhance the risk management implementation.

In this context, it is proposed a base methodology that constitutes the starting point to the identification of risks associated to building rehabilitation projects and assisting in the quantification of the negative impact in terms of cost and time deviation. The scope of the methodology is focused on the stage of proposal preparation, contributing to the definition of contingency margins and alerting to the need of implementing additional measures.

2. State of the Art

Building Rehabilitation

The Portuguese economy is facing major challenges, however the most important is the need to find a strategic solution that allows a sustainable growth, in the medium and long term. Part of this growth is inevitable linked to the construction industry, through the creation of a building stock and a set of infrastructure that exhibit and adequate performance in the several aspects of sustainability (economy, environment and social).

The conservation of the built environment is a great concern, being considered as part of government programs, at the regional and municipal level, as well as a priority in Portugal's sustainable economic development policies. Despite this, it has been verified that the conservation status of both private and public housing stock, as well the historical and cultural heritage is, in most cases, deficient. The cases of abandon, degradation and poor condition of use, salubrity, aesthetics and security are a reality too frequent (AECOPS 2009).

The Portuguese Legal Regime of Urban Rehabilitation defines the building rehabilitation as the "way of intervention destined to grant adequate performance and functional, structural and constructive safety to one or several buildings, or to give them new functional skills, in order to allow new uses or the same use with higher performance patterns".

The Decree-Law 53/2014 of Abril 8th changes the legal reality concerning urban rehabilitation since it privileges it, rather than investing in new construction. The operations of conservation, refurbishment, reconstruction and extension are nowadays seen as the most adequate solutions to the actual Portugal's financial situation. This is more obvious since this decree-law dismisses the compliances of some requirements which entail great costs and doesn't translate a true warranty of habitability of the refurbished building.

According to a study conducted by INE and LNEC, between 2001 and 2011, it was verified a generalized improvement in the buildings conservation status, although there are still about one million buildings with great need of intervention. Furthermore, in that period of time, in comparison to the years between 1991 and 2001, was observed a gradual reduction of concluded buildings and a growth of rehabilitated ones. According to the Euroconstruct projections, from 2014 it is expected a productivity increase, although this increase is inferior to 3%.

In rehabilitation projects, the repair and substitution work is very frequent and resorts to techniques and materials used commonly in new construction projects. However, the execution conditions are significantly more difficult, which usually results in higher costs. Besides the execution conditions, the often lack of knowledge about the existing structure and the need of matching the new and old materials, are some of the examples of the differences between new construction or rehabilitation projects (AECOPS 2009).

Time and Cost

Another subject of this investigation is the project management, since its purpose is the execution of projects in the time and costs defined, assuring a determined quality level (Lester 2006). For that, and according to the ISO 21500:2012, it is determined the project deadline (through the definition of the projects activities, its sequence and duration and the schedule development), the cost variances, or delays, are characterized, and identified their causes. According to some authors, the main causes of delays are the lack of quality in the project's preparation and the owner's interference in the project.

Regarding the cost, the PMBOK guide, developed by the Project Management Institute states that the project's cost management includes the processes of cost estimate, determine budget and control costs, so that the project can be completed within the approved budget. On the other hand, it's necessary to correctly characterize the costs overruns and to determine the overrun's causes, that according to Akinci and Fischer (1998) are divided in two groups: factors that can be determined and factors associated to the project.

In the specific case of building rehabilitation, the fact of usually resorting to special resources generally results in increased costs, particularly in smaller projects, making it difficult to estimate with confidence the work's unit costs.

Risk Management

As the rehabilitation, the risk management is nowadays a very current and important subject in the construction industry. Through risk management it is possible to manage uncertainty that appears in every project, helping in the decision making process and having as main goal to achieve the projects set objectives (Sousa 2012).

The risk concept is inherent to any human activity since every action has some level of uncertainty associated to itself, which can result in opportunities or threats (Almeida 2014). According to the ISO 31000:2009 the risk management implementation, in an organization or project, allows to manage and treat those uncertainties effectively, providing an updated and comprehensive knowledge of the risk to make sure that the risk level is compatible with the defined risk criteria.

The risk management process focus on three major phases: context establishment, risk appreciation and risk treatment.

According to Baloi and Price (2003) there is a direct connection between an effective risk management and the construction projects success, when the risks are identified by their potential effect on the objectives. Usually the project's objectives are defined based on three pillars: time, cost and quality. Thus, the more important risks are the uncertainties associated with these three pillars. Note that these risks don't have need to be necessarily negative, they can consist in opportunities to some of the involved parts.

3. Risk management in building rehabilitation

This research proposes a methodology of risk analysis quantification with the ultimate objective of contribute in the risk management of building rehabilitation projects in Portugal.

To achieve this goal surveys were conducted to the three main actors of the construction projects: owner, designer and contractor. These surveys were meant to obtain information about the main risks in the several phases of a project from specialists in building rehabilitation. Each specialist classified the risks in a scale from 1 (not important) to 5 (extremely important).

The results of the interviews were statistically analysed to determine which were the most important and frequent risks in rehabilitation works. This analysis examined the consistency and the average of survey's responses. The consistency was obtained through the variation, or difference between the maximum and the minimum value of response of each risk. If the variation has a low value (0 or 1) it means that the specialists gave the risk a similar classification, therefore, there is consistency. On the other hand, the average of responses indicates the importance given to the risk. If the average is high (between 4 and 5), the risk is of high importance.

Based on this research, the most significant and usual risks that can appear in building rehabilitation projects were gathered in the list of **Most Important Risks**, presented below, based on the information gathered from *Observatório das Obras Públicas*, which only includes the Owner's perspective:

- failure to execute the maintenance plans;
- achieve profitability;
- insurance;
- building flexibility to ensure the diversification of investment risk;
- response to the expectations of the stakeholders;
- matching the size of the building relatively to population to be served;
- projects location;
- stipulation of adequate projects' deadline and costs;
- confidence in the contractor;
- legal management of the contract.

From the data existent in *Observatório de Obras Públicas*, concerning rehabilitation projects conducted in Portugal, a sample of rehabilitation and refurbishment projects was selected containing information about cost and time of those projects. The information available included the projects main dates (submittal, delivery and others), contractual term and cost and total final cost. This information was used to determine time and cost deviations and initial and final updated costs.

This sample of projects has been refined, eliminating the outliers. For that it was determined the difference between the value (cost, term or cost and time variation) and the samples average. If this value exceeds a critical value, then that element of the sample is considered an outlier. There are several methods to obtain the critical value, but in this research context, it was used the Modified Thomson Tau. This way, several of projects were identified as outliers and therefore, removed of the sample.

It's interesting to analyse the outliers influence in the results. For that, two charts were drawn showing the relation between the updated initial cost (euros) and the final deadline (days), with and without outliers (Figure 1 and Figure 2). In these charts a logarithmic scale was used since it's better adjusted to visualize the results and translates the Bromilow time-cost relation (Love et al. 2005). This model, developed by Bromilow in 1969, is considered to be robust and reliable, allowing to estimate the project time based on the expected final cost.

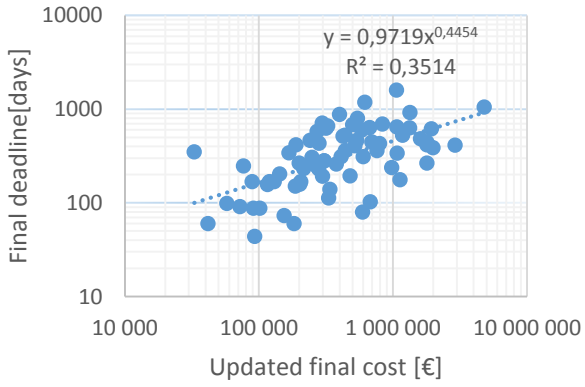

Figure 1 - Relation between the updated initial cost and the final deadline, with outliers

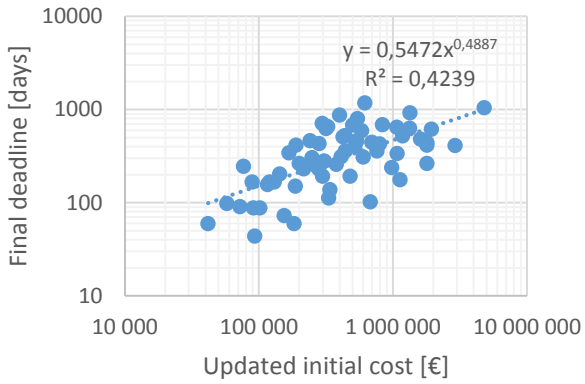

Figure 2 - Relation between the updated initial cost and the final deadline, without outliers

As can be seen by the equations (Figure 1 and Figure 2), the outliers have some influence since the slope varies significantly, from 0,9719 to 0,5472, despite the power value only varies from 0,4454 to 0,4887. One can then conclude that the values removed from the sample, for constituting an outlier, were sufficiently higher or lower than the critical value, to have a remarkable effect in the sample and hence the results.

After refining the project sample, the cost and time deviation distributions were adjusted (Figure 3). The cost deviation was best adjusted with a Slash distribution with location an shape parameters of -7,06267e-53 and 1,54627 . The time deviation was best adjusted with a Fatigue distribution with location an shape parameters of -63,77741, 119,934434 and 0,60935. The adjustment quality was evaluated using the AIC criteria. These distributions allow estimating the likelihood of a certain magnitude of time and deviation.

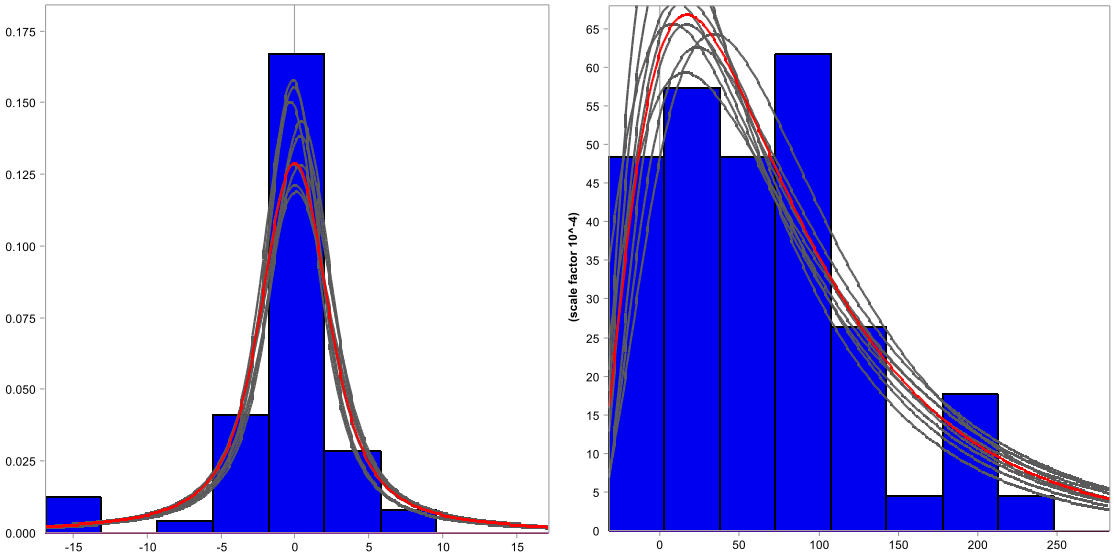

Figure 3 - Cost and time deviation curve, respectively

The results translate the deviations of the owner's time and cost, since the baseline information are from the owner's perspective. It is important to note that an owner's cost deviation may not

represent an additional cost to the contractor, it may even constitute a profit and a different MIRL was developed from a contractor's perspective.

In order to relate the risks and the cost and time deviation, a scale of Project's Level of Risk was created that, according to the number of risks existing in the project, allows to estimate the likelihood of a certain deviation. This scale means that if, in a rehabilitation project, there is between 0% and 10% of important risks present in the MIRL, the project is a Risk Level 1, if there is between 10% and 35%, it is a Risk Level 2 and so on, as shown in Figure 4.

Figure 4 - Risk Level scale

It is possible that a risk may have different importance in different projects. In the context of the research presented, it's proposed that if one or more risks, present in the MIRL, exist and are important, then, these are the ones that affect the overall risk level of the project.

It is also possible for some risks of low importance that are present in the MIRL to exist. This way, it's proposed that if these risks make up to 50% of the lists total number (5 risks), the Risk Level is increased in 1 level. If the project only has low importance risks, it's considered that the project's Risk Level is 1.

Having the project's Risk Level defined, it's proposed a correlation between this and the time and cost deviation, since each level corresponds to a probability, assuming the values in Table 1.

Table 1 - Correlation between Risk Level and Probability

Risk Level	1	2	3	4	5
Probability	0,1	0,3	0,5	0,7	0,85

The charts that relate the Risk Level scale with the cost and time deviation curves are presented in Figure 5 and Figure 6, respectively. The horizontal axis represents the cost or time deviation, in percentage, as calculated for the rehabilitation project data. The vertical axis represents the cumulative probability, in other words, the probability of a certain deviation has a certain value, in units (from 0 to 1).

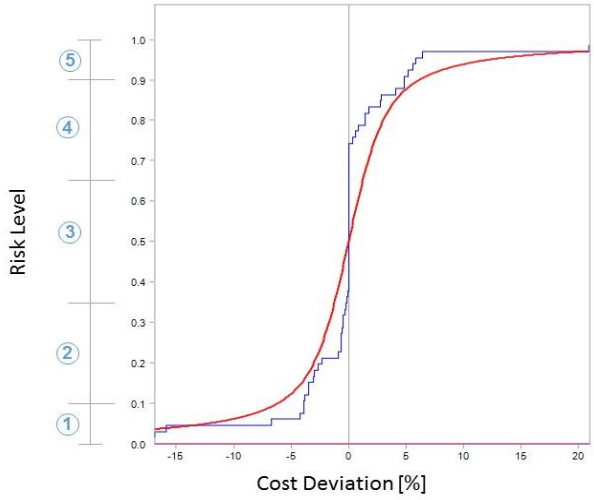

Figure 5 - Cost deviation curve

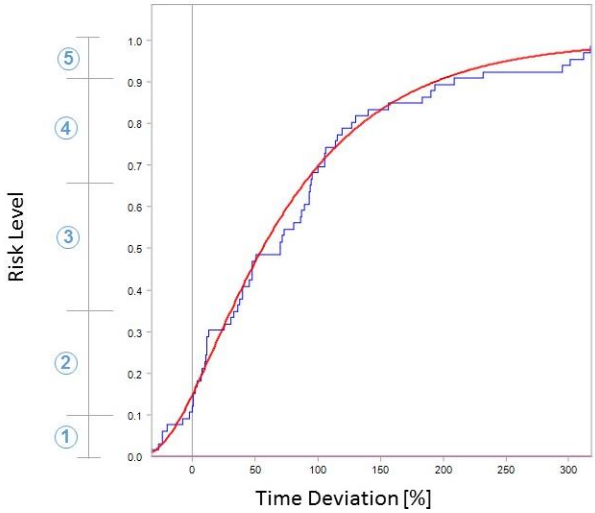

Figure 6 - Time deviation curve

4. Conclusions and future developments

This research intended to contribute in the building rehabilitation problematic but mainly in the risk management, which is still in an early stage, in the national context.

The model based in new construction and expanding urban centres is, actually, not a sustainable model, as proved by several studies. Because of this, rehabilitation and conservation of built heritage has been having a greater importance. Besides this, the estate presents substantial need of intervention, not only on an aesthetical matter but also safety and health.

This way, it is considered that all the objectives were achieved and it has been proposed a methodology that may be the starting point to statistically quantify the risk's impact in rehabilitation works, in terms of cost and time deviation.

Given the time available, this research imposed a limitation regarding the number of inquiries made. This is one of the most significant constraints, because with more interviews with rehabilitation Professionals would allow a more detailed and broader study, with a Most Important Risks List that translates accurately the reality of each intervening perspective (Owner, Designer and Contractor), therefore with more reliable results.

Regarding data obtained from *Observatório das Obras Públicas*, which were the basis of this study, one restriction identified was the fact that the causes of deviations of both time and cost were unknown. On the other hand, the information about costs is representing only the Owner perspective not translating Contractor's costs. Thereby a direct comparison with the identified risks by the Project Owner's perspective, contractor and designer constitute an inconsistency.

Another limitation identified in this study is the reduced number and nature of rehabilitation projects available. The sample was composed of 73 projects carried out between 2009 and 2014 and included a wide range of building rehabilitation projects (schools, military buildings, libraries, churches and habitational buildings).

Finally, obtaining information regarding rehabilitation Projects, especially in the private sector, could lead to more realistic distribution of deviations and allow to evaluate the differences between the public and private sectors.

The presented research constitutes a proposal for a link between the identified risks for a Project and time and cost expected deviations for that exact project. Having a base of work with more detailed rehabilitation work data from all perspectives (Owner, Contractor and Designer) will be possible to improve the final result, obtaining a statistical estimation of time and cost deviation more accurate.

With a more detailed study about this subject, it will be possible to create a Good Practices Manual, available to all stakeholders of the building rehabilitation Projects, in order to, in a practical and expedited way, relate the identified risks in the Project with the time and cost expected deviations. Therefore, will be possible to assist efficiently and effectively in the elaboration of Proposals, with more exact contingency margins.

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