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APPLICATION OF COST-BENEFIT ANALYSIS TO STRUCTURAL REINFORCEMENT OF ANCIENT BUILDINGS

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ABSTRACT

The present paper aims to propose an approach based on a Cost-Benefit Analysis (CBA) model in order to identify the phases of a methodology for socioeconomic assessment of structural rehabilitation projects. It provides a useful tool to support the main stakeholders in the decision process. The proposed model can be implemented by managers and by the designers of the different engineering projects in an intervention. For a practical application of the proposed CBA model a representative case study is selected. A multicriteria analysis is applied and the results are presented and discussed.

Keywords: cost-benefit analysis, structural reinforcement, ancient buildings.

INTRODUCTION

Currently in Portugal, the buildings rehabilitation and reinforcement are still relatively lower, compared to Europe where this activity represents about 35% of the Architecture, Engineering, Construction and Operation (AECO) sector. So, it is urgent to develop technical and scientific studies, based on the economic concept that allows the feasibility analysis of different strategies of intervention in the built park. It is also necessary to considering the different constructed typologies and the different risks associated for each alternative. CBA are methods for assessing the net economic impact of an investment project and can be used for several type of interventions, including their application to investment projects. Under these circumstances, the purpose of a CBA is to determine whether a project is feasible from the point of view of social welfare through the algebraic sum of its costs and benefits discounted over time (DFAA, 2006, EC, 2008; Mishan, 1998).

The present research study aims to present the basic concepts inherent to the CBA application, identifying the procedures and phases of the methodology to support the decision in interventions in structural reinforcement in the AECO sector. Two representative case studies are selected for the application of a CBA as an expedited form of decision support in the context of structural reinforcement. The results obtained are presented, analysed and framed within the scope of the CBA model presented.

RESULTS AND CONCLUSIONS

Building A (masonry walls in ordinary limestone masonry, brick partition walls and reinforced concrete slabs with flexible flooring in tiled plank) has 3 raised floors intended for housing, with 2 apartments per floor, with a covered area of 150m^2. For building A, intervention options (Lamego, 2014) are accepted: (i) application of reinforced plastering on both sides of the exterior walls (A1); ii) introduction of bracing wall (A2); iii) introduction of a reinforcing concrete lintel in the connection between exterior walls and roofing (A3).

Building B (reinforced concrete portico, floors made with lightweight slabs of precast beams and ceramic blocks, ladder and elevator boxes with reinforced concrete walls, and external and internal walls with clay-brick masonry) has 9 floors for housing, with 2 apartments per floor, with a covered area of 400m^2. For building B the following intervention options are considered (Falcão Silva et al., 2016): (i) metal bracing (B1); ii) addition of resistant walls in reinforced concrete (B2); (iii) Reinforced concrete pillars (B3).

The results from the application of CBA to the ancient building are shown in Table 1.

Table 1 - CBA ratio

	Strategy / Option					
	A1	**A2**	**A3**	**B1**	**B2**	**B3**
Cost (C)	33 200,00	3 300,00	3 900,00	37 200,00	25 800,00	40 400,00
Benefício (B)	89,38	30,28	22,56	81,25	72,62	41,23
Ratio C/B	371,45	108,98	172,87	457,85	355,27	979,87

The option corresponding to the lower value of the cost/benefit ratio (C/B) is the most favourable option because it represents a greater benefit for the same cost. For the building A rehabilitation technique, which seems to be more appealing, corresponds to the placement of a wall made of a vertically-perforated thermal clay-brick masonry with a thickness of 0,18m, towed and finished in a similar way to the other walls of the building with a C/B ratio equal to 108,98. For building B, the most cost-effective rehabilitation technique corresponds to the introduction of a reinforced concrete wall with a C/B of 355,27.

Further analysis to the studied buildings, as well as to other building types, should be performed in order to analyze different possibilities in structural reinforcement to support the decision process.

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