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Environmental feasibility of heritage buildings rehabilitation

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ABSTRACT

Rehabilitating a building is a unique opportunity to reach higher levels of environmental performance and reduce energy consumption and CO_2 emissions required for its operation. In contrast to the activities of demolition and construction of new buildings, rehabilitation brings environmental and economic advantages. When applied to buildings with cultural significance, architectural rehabilitation also promotes an important social capital – the built heritage. However, rehabilitation activities have an environmental load in themselves. Even the interventions aiming to improve the performance of existing buildings can have a negative effect on the environment. The prospect of environmental indicators to evaluate the feasibility of architectural rehabilitation has been the focus of interest in this research. An extensive literature review on the subject addressed studies from the 1970s to the most recent works, finding that the concept of avoided environmental impact is a relevant approach. In this concept, the feasibility of rehabilitation can be determined from the comparison between the environmental impacts involved in the rehabilitation and use of an existing building and those arising from the demolition of a building followed by the construction and use of a new equivalent building. As for establishing indicators based on the concept of avoided impact, studies of excellence rely on life cycle assessments. The life cycle assessment is a unique method to assess the environmental performance of buildings and in decision-making in building projects. Rehabilitated buildings have their usage value restored and their obsolescence reversed. The use value of a building can be determined in terms of environmental, social and economic indicators. To be effective in restoring the use value, the building rehabilitation should be feasible in those three aspects. The ability to demonstrate the environmental benefits in conserving buildings of cultural value brings new alternatives to preserve that heritage.

Contents

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1. Introduction

The construction of buildings is an activity responsible for several environmental impacts. In Canada, for example, this activity accounts for 50% of natural resources use, 52% of drinking water consumption and also generates 11 million tons of waste per year [1]. In England, 24% of all waste is produced by construction and demolition activities [2]. This percentage is even greater in developing countries, due to economic conditions and poor quality constructions. In Brazil, it is estimated that the annual consumption of natural aggregates reaches 210 million tons [3], and this quantity only takes into account the production of concrete and mortar. In big cities, the waste resulting from the construction and demolition activities can reach 70% of the total mass of municipal solid waste. Half of it comes from site activities of new construction and the remaining from maintenance and demolition activities of existing buildings [4].

The environmental consequences of the building stock operation are also considerable, particularly regarding the energy consumption. In the European Union, residential, commercial and institutional buildings are responsible for 38.7% of final energy use [5]. In the United States of America, this percentage is 42% [6]. In Brazil, it corresponds to 44% of the total electricity used in the country [7]. A major part of the energy used in buildings comes from non-renewable and potentially pollutant sources. Around 26% of all greenhouse gases released in the atmosphere are due to the production and the use of energy resources. Approximately 8.6 Gt of CO_2 per year (the major cause of greenhouse effect) are released into the atmosphere as a result of the energy use in buildings – considering the direct emissions and those related to electricity consumption. It represents 33% of the total global emissions. Adding to it the emissions of other greenhouse gases, the emissions are close to 10.6 Gt of CO_2-eq per year [8].

Adopting measures to improve the built environment sustainability is essential and urgent. In this context, the building stock requalification through rehabilitation of existing buildings can be a realistic alternative to reduce the environmental impacts caused by the construction industry. Architectural rehabilitation involves the retrofitting of outdated buildings in order to meet current energy efficiency regulations, construction guidelines, and standards on comfort and usage. The rehabilitation of buildings presumes a new stage in existing buildings life cycle (Fig. 1), by largely reusing their already built components and structures, with minor addition of materials and energy disposal. Rehabilitating a building is also a unique opportunity to reach higher levels of environmental performance and especially to reduce the energy required for its operation.

In contrast to the activities of demolition and construction of new buildings, rehabilitation brings environmental, social and economic advantages [9–11]. When combined with preservation policies for buildings endowed with cultural or historical significance, architectural rehabilitation retains and promotes an important social capital: the built heritage [10,12,13]. However, the inclusion of the built heritage preservation among practices considered as sustainable, and the development of public policies for such, cannot ignore the definition of social, economic and environmental performance indicators [14–16]. The social performance indicator is difficult, if not impossible, to be measured. Studies about the economic value of cultural heritage are already common in the literature [17]. The environmental aspect, however, although increasingly studied, still is a theme to be explored.

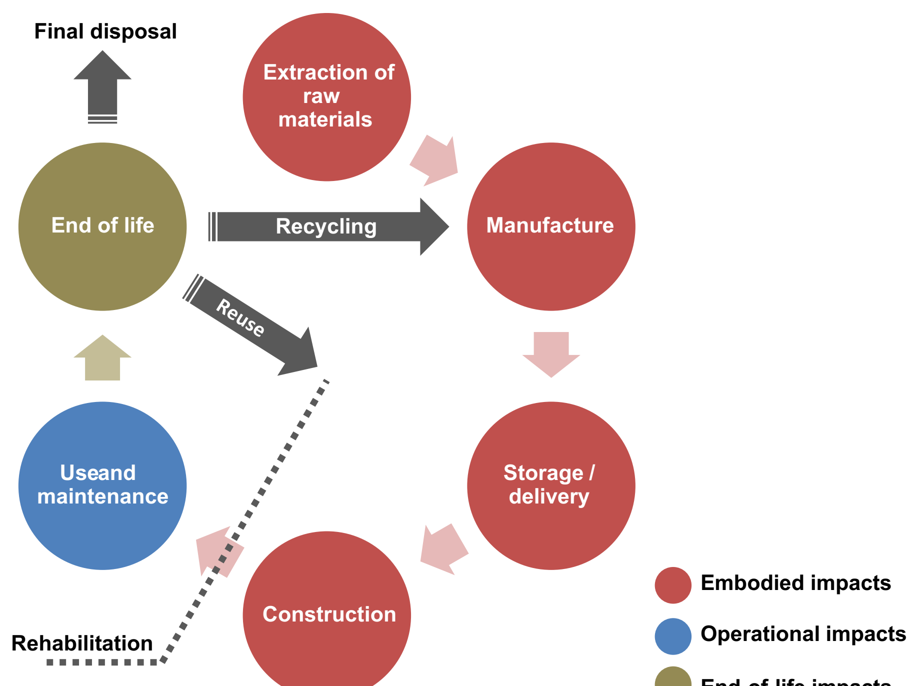

Fig. 1. Extended life cycle of a building when considered the possibility of its rehabilitation.