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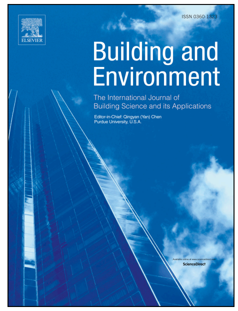

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LCA and BIM: Visualization of environmental potentials in building construction at early design stages

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Abstract

The vast majority of scientists and policy makers agree that environmental impacts of buildings need to be reduced significantly, and that Life Cycle Assessment (LCA) is a methodology well suited to support this. The importance of evaluating potential improvements to the environmental life cycle performance of buildings in early design stages is widely acknowledged; the wide application of LCA during design however, is restrained by the great uncertainty in design and material decisions at this stage. To support decision making in the early design stage, we propose an approach using Building Information Modeling (BIM) to assess a wide range of construction options and their embodied environmental impact. We use a conceptual BIM model to evaluate a variety of material compositions for different building elements and the potential contribution of elements to the total embodied impact of the building design. The BIM-integrated approach enables identification of design specific hotspots which can be visualized on the building model for communication of LCA results and visual design guidance.

Keywords: Life Cycle Assessment; Building Information Modeling; Embodied Environmental Impacts; Visualization; Design Guidance

1. Introduction

The built environment is commonly recognized as a major contributor to global environmental impacts [1]. In continental Europe, the energy used in buildings alone is responsible for up to 50% of carbon dioxide emissions and consumes up to 40% of all raw materials extracted from the lithosphere [2,3]. The international goals of mitigating the related problems of climate change, loss of biodiversity and other environmental impacts will thus require ambitious improvements in the environmental performance of the built environment [4,5].

Until recently the main focus was placed on improving the operational stage of the building life cycle as the main energy consumption in the Western building stock comes mainly from the heating of buildings. For new buildings, tremendous improvement has been achieved in reducing this operational energy to a minimum, shifting the focus toward energy and resources required to build and maintain the buildings [6–12]. The Life Cycle Assessment (LCA) method has been widely accepted as a means to evaluate the environmental impact associated with the construction, maintenance and demolition of buildings and is therefore increasingly applied to assess buildings over their life cycle [13–17].

LCA, being a data intensive methodology, requires a high level of information, especially for the assessment of embodied impacts of building materials. It is therefore mostly applied ex-post, i.e. once the building has been constructed and all information for applying the method is available. This means currently LCA is limited to being descriptive in hindsight, rather than providing feedback and guidance on how to effectively improve the building during design [18–23]. Furthermore, uncertainties regarding the effective service life of elements [24] and the difficulty of having a