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Use of life cycle assessments in the construction sector: critical review

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Abstract

A life cycle assessment (LCA) is an internationally accepted and useful tool to assess the environmental impact of products. In this paper, the use of LCA in the construction sector has been critically analyzed. The analysis is based on specific literature cases and different standards and frameworks. As an example, a detailed comparison of four LCA studies for structural concrete is presented. LCA is one of the most promising techniques for an ecological design of products. However, in order to appeal to the benefits of LCA, it is important to know how to use LCA properly. From the review in this article it becomes clear that the LCA research is still in a fragmented state, due to the existence of various unspecific guidelines and different interpretations of those guidelines. Since for example the international standards on LCA, ISO 14040/44, only provide a global framework, and no exact technique to calculate environmental impacts, it is possible to create an LCA with different boundary conditions. Hence, a valuable comparison between distinct LCAs is difficult. Comparisons should thus thoughtfully be performed, taking into account all information about the LCAs under study. When this background information is communicated transparently, LCAs can be interpreted correctly.

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Keywords: Construction sector; life cycle assessment; ecology; sustainability; EPD; review.

1. Introduction

According to the United Nations Environment Programme (UNEP) three planets will be necessary by 2050 to bear the world consumption and our way of life. This will be the case if the current consumption and production is

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continued, taking into consideration the growing population [1]. Hence, in several fields, there is an increasing focus on sustainability in general and on the environmental impact of different processes in various sectors. In the European Union, approximately three billion tonnes of waste are generated each year. About one-third of this waste (i.e. one billion tonnes) has its origin in construction and demolition activities [2]. Moreover, the building industry is responsible for the consumption of more than 40 percent of the world energy and for approximately one-third of the emitted greenhouse gasses worldwide [3]. This "sector" consumes about 25 percent of the global wood harvest and approximately 40 percent of the materials entering the global economy. Every year, the construction sector uses three billion raw materials [4]. These facts reveal that the building industry has a large, negative impact on the environment. It is necessary to identify how this consumption, pollution and waste processing is caused, in order to address the causality of these issues.

To thoroughly analyze these causalities, a frequently used and generally accepted method is the life cycle assessment (LCA). This system is used to evaluate the possible environmental impacts and used resources throughout the whole life cycle of a product: starting from the extraction of resources, to the production and use phases up to the waste processing [5]. The introduction of LCAs in the construction industry is highly important since this system can systematically and objectively evaluate and quantify each ecological impact [6]. As such, LCA is one of the most promising techniques for an ecological design of a product.

Since the beginning of the 21st century, the interest in LCAs has increased strongly. This is reflected in the wider application of this methodology. Moreover, the use of LCA is further encouraged by incorporation in recommendations of authorities and the increased use of LCA on policy level [7,8]. For example, the Integrated Product Policy (IPP) has in this context been developed by the European Commission [9]. In 2002, the United Nations Environment Programme (UNEP) and the Society for Environmental Toxicology and Chemistry (SETAC) launched an International Life Cycle Partnership, known as the Life Cycle Initiative (LCI). This partnership enables users from all over the world to put life cycle thinking into effective practice [10].

Despite the different advantages of LCA causing this increased interest in the topic, various drawbacks still exist. To be able to clarify the use of LCA in the building industry, an extensive literature review has been carried out for this paper. Based on this review, a general background of LCA in the building industry is presented in this paper, together with a focus on advantages, recurrent drawbacks and possibilities to solve problems.

2. General regulatory context

The general standards in the context of LCA, ISO 14040:2006 and ISO 14044:2006, describe and specify respectively the principles and framework, and the requirements and guidelines for LCA [5,11]. These standards describe the four main phases (Fig. 1) of an LCA, of which the first is the definition of the goal and scope. In this first phase the purpose of the study, the system boundaries and the definition of the functional unit (FU) have to be determined. The FU should be defined very accurately, since all of the inputs and outputs are calculated per functional unit. To enable fair and equivalent comparison of two products, each system should thus be composed according to the exact same functional unit. In this context of comparability, attention should also be paid to other requirements, such as a closer look at the system boundaries and allocation principles. [12].

The second phase of an LCA is the life cycle inventory (LCI). This is the data collection process of all relevant inputs and outputs of a product life cycle. In this phase, it is important to work with very accurate data, since the accuracy of the final results of the life cycle assessment strongly depends on the life cycle inventory data [13].

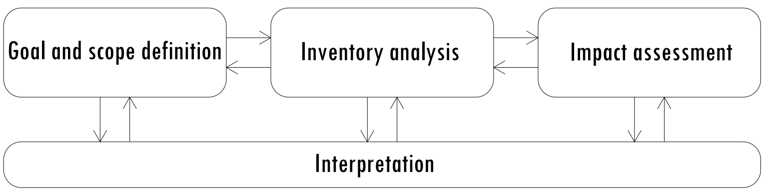

Fig. 1: Stages of an LCA according to NBN EN ISO 14040.[