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Selecting Criteria for Assessing "Environmentally-Friendly" Material Options in Construction: Part II

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1 Introduction

In the face of resource depletion and the likely suffocation with its own refuse within decades, humanity is dragged towards a sustainable economy and, in particular, sustainable construction (Goh, Chong, Jack and Mohd Faris, 2020). One of the aspects of construction sustainability is reducing the project's and the resulting built facility's impact on the environment. This impact is typically assessed in the course of a Life Cycle Analysis (LCA) (Ortiz, Castells and Sonnemann, 2009). The idea of LCA evolved into many methodologies that share the element of assessing the consequences of using particular construction materials in the building's fabric. However, even in this narrow aspect, the analyses' scope, criteria, and measures are not identical (Park, Yoon and Kim, 2017). The standards and methodologies evolve (Allacker, Mathieux, Pennington and Pant, 2017). Due to the proliferation of LCA methodologies, the comparability of information on products' environmental qualities becomes an issue (European Union, 2013).

This paper is a second part of the review of the most recent literature on selecting the "environmentally friendly" material and component options in construction. The authors discuss a sample of papers devoted to assessing the sustainability of alternative solutions (materials, material supply chains, component design) and optimizing construction components, focusing on the ways of defining criteria values, the criteria's relative importance, and selecting the methods of multicriteria assessment.

2 Materials and Methods

The sources' approach to the life cycle phases was juxtaposed to the life cycle phases used in LCA and adopted for Environmental Product Declarations (EPDs). The "environmentally friendly" aspects were considered only those covered by the scope of environmental impacts, aspects of resource use, and generation of waste as defined in EPDs prepared according to EN 15804:2012 (ITB, 2013). The query was limited to one database (Web of Science), publications from the years 2016-2020, and a particular structure of search terms, as presented in Part I. The selection was manually refined. The final sample comprised 43 publications. The sample was analyzed in terms of aspects of sustainability covered by the analysis, life cycle stages

considered, sources of input, and mathematical methods used for selecting the best option (if applicable).

3 Results and Conclusions

Values of the criteria related with environmental impact were either calculated or rated arbitrarily by experts. Among 35 papers that compared/ranked options or aimed at finding an optimal solution, a clear dependence was observed between the location of the object of analysis and the authors' method to define criteria measures. This is due to the geographical coverage of construction products' life cycle inventory databases. The laborious calculation of criteria values was not always exploited: frequently, the precision was lost if measures were subject to pairwise comparisons.

Defining criteria weights was most frequently done by collecting expert opinions: during panel meetings for direct consensus (10%) or in interviews or questionnaire surveys (40%). Thus, 50% of authors based on weights prompted by the literature or set arbitrarily. Multiple opinions were being aggregated in a number of ways: from mean scores to elaborate processes aggregating opinions of stakeholder groups. As for the multicriteria assessment methods in use, the most popular of the established ones were AHP, TOPSIS, and VIKOR. Some authors used hybrid methods or proposed their own to better reflect the character of the problem. Out of 27 papers that used one measure for ranking, 9 did not explicitly refer to checking sensitivity of the results to weights nor compared results with those obtained by means of other methods.

The sample of papers analyzed above is certainly not representative of the state-of-the-art research on the environmental impact of construction. However, it indicates that this field is still in the stage of development. There is no agreement on the type of criteria, on their importance, nor the methods of assessment in analyzing the sustainability of construction products and components.

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