THE DESIRE FOR THE CONSTRUCTION INDUSTRY TO MOVE TOWARDS LIFECYCLE CARBON EMISSIONS ANALYSIS

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A significant reduction in carbon emissions is a global mission and the construction industry has an indispensable role to play as it is a major carbon dioxide (CO_2) generator. Over the years, various building environmental assessment (BEA) models have been developed to promote environmentally responsible design and construction. However, limited attention has been placed on assessing and benchmarking the carbon emitted throughout the lifecycle of building facilities. In this paper, current BEA approaches adopted by the construction industry are first introduced. The focus of these models and concepts is then examined. Following a brief review of lifecycle analysis, the boundary in which a lifecycle carbon emission analysis should be set for a construction project is identified. The paper concludes by highlighting the potential barriers of applying lifecycle carbon emissions analysis in the construction industry. It is proposed that lifecycle carbon emission analysis can be integrated with existing BEA models to provide a more comprehensive and accurate evaluation on the cradle-to-grave environmental performance of a construction facility.

KEYWORDS: Carbon dioxide, emission, building environmental assessment, buildings lifecycle

INTRODUCTION

The increased atmospheric concentration of carbon dioxide (CO_2) has become a very critical and urgent problem, having been shown to exacerbate many environmental hazards. As a major industry in most countries, the construction sector emits significant amounts of carbon directly and indirectly from various activities.

To encourage the design and construction of more environmentally responsible buildings, various building environmental assessment (BEA) concepts have been developed. However, current BEA approaches evaluate general environmental performance of a building, rather than focusing on carbon emissions. There is a lack of systematic approaches to audit and benchmark the lifecycle CO_2 emissions generated by a construction facility.

This paper summarises the current development of BEA tools, followed by a discussion on the relation between the cradle-to-cradle concept and carbon auditing. The paper concludes by examining the challenges of analysing lifecycle carbon emissions in the construction industry.

DRAWBACKS OF BUILDING ENVIROMENTAL ASSESSMENT

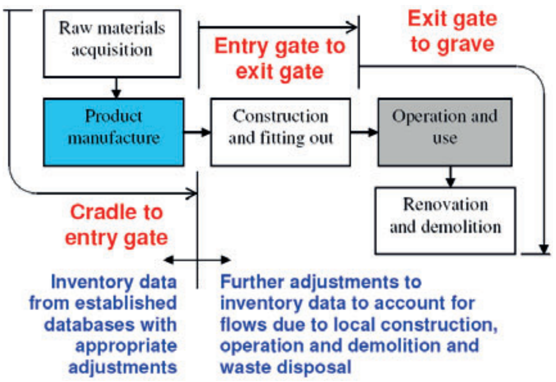
Despite the success of BEA tools to date, some weaknesses have been identified (Ding, 2008):

- The assessment process is usually carried out when the project design is almost finalised, limiting the use of BEA methods as design guidelines.
- Since BEA methods are used to evaluate building designs, they are less useful for selecting optimum projects where different options or locations of development are considered at the feasibility stage.
- Some assessment tools such as BREEAM, BEPAC, LEED and HK-BEAM has limited emphasis on the financial aspects in the evaluation framework. The project may be environmentally responsible but offer insufficient financial returns to the developers.
- Most BEA methods were developed for local use and do not allow for national or regional variations. While the BEA tool has been developed for regional use, there are still some limitations, namely: when evaluating buildings, the weights are scored subjectively; the complexity of the BEA framework makes it difficult to use; the BEA has led to a very large and complex system, causing difficulties and frustration for over-stretched assessors rather than producing a global assessment method as intended (Curwell et al., 1999).
- BEA methods have overly comprehensive criteria.
- Current BEA methods cannot measure and evaluate qualitative environmental issues.

APPLYING LIFECYCLE ANALYSIS IN CONSTRUCTION PROJECTS

In the construction industry, not much attention has been directed to evaluating the lifecycle CO_2 emission of a construction facility. Therefore, it is necessary to carefully consider and evaluate the lifecycle emission of construction facilities, viz. the extraction and processing of raw material, production processing, distribution, operation and waste management, etc. The carbon emissions for a construction facility should be presented as the tonne of carbon dioxide equivalent (tCO_2e) generated by each metre square of the floor space or per dollar spent on the construction at least from the cradle to grave perspective (Figure 1).

Figure 1: A cradle-to-grave concept for assessing the carbon emissions in the construction industry.



This can be realised by first delineating the emissions generated during the manufacturing and transportation processes up to the point of the entry gate of a construction site. While further processing would be necessary on site, the energy consumed during the construction process until the facility is built (i.e. to the exit gate) should be carefully accounted for. More importantly, one should not undermine the energy usage during the operational stage and that used for disposing the materials at the end of the facility's life.

In general, the implementation challenges of the lifecycle carbon emissions analysis comprise four groups (Proveniers et al., 2009):

- Conceptual challenges – including inexperience with the lifecycle carbon emissions analysis concept, lack of lifecycle carbon emissions reduction design and building materials, as well as associated risks.
- Economical challenges – due to the traditional way of thinking focusing only on initial investment, not being willing to pay more, and pre-judgement of the expense involved.
- Actor challenges – the many people involved in a lifecycle carbon emissions analysis process can cause internal and external conflicts of interest among parties. The complex relationships between industrial activities and different stakeholders make it difficult to implement lifecycle carbon emissions analysis strategies.
- Measurement challenges – recent material and energy accounting methods are not broad enough to provide sufficiently comprehensive data (Liu, 2009).

CONCLUSIONS

While many studies have confirmed that a construction facility produces a significant amount of CO_2 throughout its lifecycle, a radical rethink of how to improve the current building environmental assessment approaches to incorporate the lifecycle carbon emissions is imperative. Apart from the operational phase, with the highest contributor to CO_2 emissions, any emissions generated during the planning and design phase, material manufacturing phase, construction process phase, maintenance and renovation phase, as well as deconstruction and disposal of waste material phase should be taken into consideration. By adopting a lifecycle carbon emissions analysis concept, the potential for reducing the dependence on raw materials, recognising the negative impacts caused by producing new materials, and intensifying the recycle and reuse process should increase across the construction industry.

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