Methodology for estimating embodied carbon through a distributed ledger platform for construction supply chains

THE JOINING UP CONSTRUCTION CONVERSATION

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1.0 Background

Construction industry and its activities impose a significant impact on the environment (Ding & Langston 2004; RICS 2014; Sjostrom & Bakens 1999). The building sector contributes up to 30% of global annual greenhouse gas emissions (United Nations Environment Programme 2009) while Australia's construction industry contributes approximately 24% (Kember, Jackson & Chandra 2013). Thus, it signifies that carbon control in buildings has become essential (Committee on Climate Change 2013).

Life cycle carbon emissions in buildings can be classified into two main types as embodied carbon and operational carbon. Operational Carbon (OC) refers to the emissions, which occur during the operational phase of a building (RICS 2012). Embodied Carbon (EC) is the carbon emitted during the production process of a product/service within the system boundaries of raw material extraction (Cradle) to factory gate (Gate) or construction site (Site) or end of construction (Construction) or end of life (Grave) or reuse (Cradle) (Hammond & Jones 2011; Victoria, Perera & Davies 2016).

RICS (2014) have investigated on the overall carbon footprint during the operational stage of various buildings such as supermarkets, offices and others to discover the emission of OC comparatively quite higher than EC. On a similar note, Schinabeck, Wiedmann and Lundie (2016) disclosed that EC emissions in the construction industry accounts approximately 20% of all carbon emissions in Australia. However, the latest trend is to create zero carbon projects, which simply intends to reduce OC to zero making the remaining component, EC more significant (RICS 2014; Yokoo, Terashima & Oka 2013).

2.0 Research Problem

Globally, the construction industry is developing tools, databases and practices in order to measure the EC in building construction (De Wolf, Pomponi & Moncaster 2017). There are various EC estimating tools for early stage estimating and detailed stage estimating (Victoria, Perera & Davies 2016) whereas University of Bath's Inventory of Carbon and Energy (ICE), Waste Reduction Action Plan (WRAP) and UK Blackbook are quite popular among others. Haynes (2010) stated that the results of one EC calculation cannot be compared with another as the calculation boundaries of each calculation method may differ from each other. Therefore, the accuracy and reliability of these estimating methods is questionable, giving rise to the necessity of developing a methodology to calculate EC accurately. In order to develop an application that comprises of a methodology which calculates EC accurately, Blockchain, being one of the latest, innovative and modern technological approaches which stores financial transactions in a chain of blocks accurately, will be used.

Blockchain is a type of a distributed ledger, which enables the records to be stored in blocks (Chartered Accountants Australia-New Zealand 2017) and maintained on a network of servers called 'nodes' (Santori, DeRidder & Grosser 2016). At the outset, Blockchain Level 1 was initiated and used for cryptocurrencies (Dimitri 2017). Subsequently, Swan (2015) identified usage of Blockchain Level 2 for economic, market and financial applications such as stocks, bonds, smart property and smart contracts and Blockchain Level 3 for applications beyond currency, finance and markets, particularly related to government, health, science and others. Hence, the research focuses on using Blockchain Level 3 for estimating EC in construction supply chains.

3.0 Expected Outcomes

The research will be limited to activities and construction supply chain nodes related to land development. Limited number of activities and limited number of supply chain layers in land development projects makes it easier for testing and proof of concept. Ultimately, the study would produce an accurate methodology for estimating embodied carbon for construction supply chains and a Blockchain operated computer based prototype system that estimates embodied carbon.

This project enables carbon comparison of different projects, modelling of EC in land development projects thus leading to reduction of EC in future, carbon calculation and analysis of submitted bids when awarding contracts and many other benefits towards the industry as well as the environment while leading to improved sustainability.

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