Chapter 11
Optimization of Construction Supply Chains for Greenhouse Gas Reduction

Niall P. Dunphy
University College Cork, Ireland

John E. Morrissey
Liverpool John Moores University, UK

ABSTRACT

There is an increasing number of regulatory and public policy initiatives aimed at improving building energy efficiency, recognizing the importance of the built environment to achieve lower energy-related emissions. However, these efforts have generally focused on the building scale. A comprehensive reduction of carbon emissions from construction requires a wider focus, considering the building as well as the lifecycle of materials and their supply chains. There is a need for robust analysis of the Greenhouse Gas (GHG) implications of construction supply chains and to optimize supply chains configurations so as to minimize GHG emissions across multiple organizations. This chapter provides a rigorous means of assessing the dynamic and complex supply chains of construction to obtain optimal and sustainable levels of GHG reductions in a whole-of-chain approach. Outcomes represent critical new knowledge, enabling deeper understanding as well as enhanced capacity to maximize energy savings from the built environment.

INTRODUCTION

There are regulatory, environmental, social and increasingly financial reasons for businesses to reduce the greenhouse gas (GHG) emissions associated with their operations (Blengini & Garbarino, 2010). This focus is of particular interest for the construction industry, as the built environment is seen as the domain with the largest potential for reducing GHG emissions (European Commission, 2011), because its energy consumption and the associated GHG emissions are so significant, accounting for *ca.* 40% of EU energy demand (Cheng, Pouffary, Svenningsen, & Callaway, 2008).

The built environment is therefore seen as a critical arena to achieve lower energy related

DOI: 10.4018/978-1-4666-8228-3.ch011

emissions, through the construction of energy efficient new buildings and the energy retrofit of existing building. As a consequence, there are a large number of regulatory and public policy initiatives internationally, aimed at increasing building energy efficiency and reducing associated emissions, for example the Energy Performance of Buildings (Directive 2010/31/EU); increasingly more stringent national building codes; moves to implement green public procurement in respect of buildings (European Commission, 2014); innovative financial products such as: preferential green loans (Geller, Harrington, Rosenfeld, Tanishima, & Unander, 2006; Sweatman & Managan, 2010), the UK Green Deal (DECC, 2010), and the Property Assessed Clean Energy (PACE) initiatives in the USA (Ya He, 2012).

While these measures represent important innovations of policy, they are generally focused at the immediate building scale, and on the use of energy during the operational phase – the so-called operational energy. However, buildings are responsible for GHG emissions not just during their operation but throughout their lifecycle, arising from energy consumption and process emissions, during the extraction of raw materials; processing and manufacture; transportation; construction; renovation; and end-of-life activities in additional to the operational phase (Ayaz & Yang, 2009).

Historically, reducing GHG emissions in the built environment has been focused on minimizing operational energy, which typically accounted for 80% of life cycle energy of a building (Wallhagen, Glaumann, & Malmqvist, 2011) and the vast majority of a building's life cycle GHG emissions. However the historic relationship between operational and non-operational GHG emissions and their relative significance is changing. As the building stock becomes less energy intensive in the operational stage, through more efficient designs of new builds and upgrading of existing buildings, the relative importance of GHG emissions associated with non-operational phases of a building's lifecycle is increasing (Ayaz & Yang, 2009; Sturgis & Roberts, 2010). Additionally, the envisaged so-called 'decarbonization' of centralized energy grids (European Commission, 2011) will mean that energy used will be less 'carbon intensive', with less GHG emissions per kilowatt-hour (Jones, 2011), further increasing the relative significance of non-operational GHG emissions. A comprehensive reduction of GHG emissions in the construction sector needs to focus not only on the building itself and its operating energy performance, but also on the lifecycle of constituent materials and on the supply chains providing these materials. In this context, there is a pressing need to provide robust analysis of the GHG implications of construction supply chain configurations and to optimize supply chains in such a manner so as to minimize GHG emissions across the entirety of the supply chain.

To date, there has been a dearth of research in this area. Construction supply chains are transitionary and dynamic in nature centered on specific projects, in what might be termed temporary multi-firm configurations (TMFCs). Such configurations provide a level of complexity, which is not found in readily analyzed linear organizational structures such as those of traditional manufacturing processes. To adequately capture the dynamism and complexity of construction supply chains, new analytical approaches are required. This chapter builds on the value approach for modeling supply chains developed by Dunphy *et al.* (2013b).

While concerned with the construction sector, this paper is not focused on the impacts at a building scale. The supply chain focus implies a wider scope of analysis, which to date has been neglected in the literature. This paper provides a valuable contribution to initiating debate focused on this wider scale, enabling a better elaboration of strategic and long-term views on project business needs, and a means of better accounting for the specific challenges of project-based businesses by application of strategic and comparative approaches.

Related Content

Cooperative Pricing Under Forecasting Sharing in the Manufacturer-E-Retailer Supply Chain
Ruiliang Yanand Sanjoy Ghose (2008). *International Journal of Information Systems and Supply Chain Management (pp. 1-18).*
www.irma-international.org/article/cooperative-pricing-under-forecasting-sharing/2500

Design for a Closed-Loop Supply Chain System With Sensor-Embedded Refrigerators
Mehmet Talha Dulmanand Surendra M. Gupta (2019). *The Circular Economy and Its Implications on Sustainability and the Green Supply Chain (pp. 1-24).*
www.irma-international.org/chapter/design-for-a-closed-loop-supply-chain-system-with-sensor-embedded-refrigerators/220283

Disruption in Supply Chain
Mohammad Bakhshayeshi Baygi, Seyyed Mostafa Mousaviand Onur Kuzgunkaya (2012). *Supply Chain Sustainability and Raw Material Management: Concepts and Processes (pp. 205-214).*
www.irma-international.org/chapter/disruption-supply-chain/61739

Analyzing Requirements and Approaches for Sourcing Software Based Services
G.R. Gangadharanand Erwin Fielt (2010). *International Journal of Applied Logistics (pp. 53-63).*
www.irma-international.org/article/analyzing-requirements-approaches-sourcing-software/43590

Developing and Maintaining Trust in Hastily Formed Relief Networks
Peter Tathamand Gyöngyi Kovács (2012). *Relief Supply Chain Management for Disasters: Humanitarian, Aid and Emergency Logistics (pp. 173-195).*
www.irma-international.org/chapter/developing-maintaining-trust-hastily-formed/55199