LOCALISING THE SUPPLY CHAIN

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Abstract
The UK committed in 2008 to reduce its greenhouse gas emission by 80% by 2050. The construction industry is a key contributor to the greenhouse emissions and future legislative adjustments for the built environment are well underway. The industry will face many challenges and it is expected that its profile will be very different by 2050. The scenario that there will be pressure for the supply of labour, materials and components to be much more localised due to increased energy costs is very likely. In turn, supply chains, which currently are becoming increasingly long as the demands of projects become increasingly complex, will inevitably have to face the localisation challenge.
The long supply chains provide the increasingly high levels of technical input relating to design, manufacture, installation and servicing in the context of an industry anxious to maintain flexibility in the face of uncertain levels of workload and investment. These tall contractual hierarchies contain a massive amount of expertise but the contractual hierarchy constrains the effective management of knowledge and innovation through excessively long network paths, containing multiple, perversely incentivised, network bridges and gate keepers. Contractual relationships, knowledge management and information exchange networks define the localised supply chains and important work needs to be done to examine the potential for these networks to be established and be maintained. Social network analysis can be employed to map existing supply chains and to provide predictive models for local supply chains in 2050.
The paper discusses how to best examine what the capabilities of the local supply chains today are and what their capabilities would be if they were specifically enhanced to meet 2050 challenges. These capabilities inform supply chain management targets which mainly focus on continuous improvements of the supply chain increasing value and stimulating knowledge sharing and innovation. Sustainability targets are yet to be fully incorporated in the value equation, which is what the 2050 challenge requires; therefore particular attention is paid to it. It is suggested that exploring the location of intellectual capital in construction supply chains, demonstrating how the use of BIMs and vertical integration of the supply chain might be exploited to provide interfaces between local supply chain actors and end-users, examining the logistics and embedded energy, comparing the today's logistical demands with a 2050 localised supply chain scenario, is a starting point in developing the concept of the localised supply chain as a successful approach to the sustainability problem.

Keywords: Sustainability, Localisation, Supply Chain, Knowledge Management, Information Exchange Networks

INTRODUCTION

The UK's commitment to reduce greenhouse emissions by 80% from 1990 levels by 2050 has been the driving force for legislative changes; it has also raised issues associated with sustainable development and its meaning. Sustainable development has three dimensions; economic, environmental and social. Changes to accommodate the demanding environmental targets by 2050 have to deal with the forces opposed to the economic and social dimensions. It is generally perceived that the relationship between the economic and environmental dimensions require the negotiation of trade-offs, which is not always true because many of their objectives can be found to be perfectly aligned creating a win-win relationship (Quariguasi Frota Neto et al., 2010).

Increased public awareness and governmental regulations are imposed on various industries and as result many organisations and brand companies like Xerox, IBM, and Sony have initiated significant reforms in the entire supply chain systems (Lu et al., 2007). Supply chains not only get extended to include the end-of-life phase of products but also Supply Chain Management (SCM) principles are facilitated to improve the environmental performance of the manufacturing processes with suppliers and of products with customers (Lu et al., 2007). This is leading the most recent concept of Sustainable Supply Chain Management (SSCM), which advocates the integration of sustainability within SCM for successfully achieving the implementation of sustainability targets at business strategic level (Adetunji et al., 2008). The construction industry, which encompasses the design, construction and operation of the built environment, plays an important role on both the growth of the economy and the rate at which resources are being used. It is responsible for almost half the UK's carbon emissions (HM Government, 2008) and a similar proportion of its energy consumption (Miller, 2001). Legislative adjustments for the built environment are well underway and the industry is expected to face many challenges. Its profile will be very different by 2050. However, SCM's appropriateness, scope and ways of implementation in construction is still debated (Pryke , 2009) and only a few major clients and contractors have successfully implemented it in their business strategy for procuring projects (Adetunji et al., 2008; Pryke, 2009). The construction industry is lagging behind in its focus on SSCM because the debate is still on going on about sustainability and SCM as separate concepts and integrating them considerably increases the complexity of any discourse (Adetunji et al., 2008).

Supply Chain Localisation (SCL) could be considered as a bottom-up approach as its starting point is the study of transportation concerns and logistical implications for the greening of supply chains with the ambition to move towards the issue of SCM and SSCM. In other words, starting at an operational level to inform strategy. For that reason, the focus of the research might appear to be limited to solely the environmental implications and some associated economic factors. Construction supply chains might however be regarded as social networks, which affect and are affected by their surrounding environment.

This paper aims to introduce an alternative approach to the problem of making construction supply chains sustainable by advocating the importance of localisation. Presenting the paper in MISBE is considered the first step into refining the research problem posed and the appropriateness of the proposed method for future empirical data collection and analysis. Therefore, no empirical data or results are currently available.

WHY LOCALISATION? BACKGROUND

The consumption of natural recourses is a problem of two dimensions. One is the cost of the resource and the other its efficiency and therefore the price is a primary determinant of behaviour (Barrett et al., 2008). As the price of energy is expected to rise in the future it is highly possible that the supply of labour, materials and components will be significantly affected by it. For construction materials and components, particular attention must be given to the notion of embodied energy - the energy impacts of material and component production. The energy embodied in a material due to its transportation in most cases is small when compared to its total embodied energy and its quantification is typically oversimplified (Miller, 2001). This point is returned to later. It is, however, the transportation of labour that causes greater concerns. Efforts to reduce passenger transport by road have been made through traffic management approaches or land use changes requiring planning policy support (Barrett et al., 2008). Raising urban densities, which would result in shorter journey length and possibly replacing the use of cars with the use of public transport or even the use of non-mechanised transport such as walking and cycling (Barrett et al., 2008), is considered to be a move towards localisation or enhancing the supply of labour at local level.

Interestingly although many efforts are made to enhance the energy performance of operations and products, the demand for energy continues to rise (Barrett et al., 2008) and with it energy emissions. Through SCL, there is a need to consider increasing energy use performance but more so minimising the supply chain's dependence on energy. This could be achieved by identifying energy consuming processes and activities that could be omitted or replaced with others that require less energy.

SUSTAINABLE SUPPLY CHAINS AND THEIR MANAGEMENT

Focusing on the supply chain as a vehicle for accumulating value and improving efficiency is becoming increasingly important. Equally, the challenge to incorporate sustainability into business strategy has led many organisations to look at the activities of all supply chain actors in increasing detail (Lu et al., 2007). Therefore, consideration is given to the integration of sustainability and supply chains (Linton et al., 2007; Adetunji et al., 2008) in order to create sustainable supply chains. Sustainable development requires the triple bottom line of economic, environmental and social dimension to be satisfied (Linton et al., 2007; Quariguasi Frota Neto et al., 2010; Adetunji et al., 2008) and when integrating sustainability in supply chains their complexity increases significantly (Adetunji et al., 2008; Quariguasi Frota Neto et al., 2010).

Sustainable supply chains are extended supply chains, which include and integrate issues beyond the ones traditionally considered. These are product design, manufacturing and during product use by-products, product life extension, remanufacturing, products end-of-life and recovery processes at end of life (Linton et al., 2007). Their management moves from being reactive in the sense of monitoring general environmental management programmes to a more proactive direction through the implementation of energy/resource efficiency or reduction, re-use, rework, refurbish, reclaim, recycle, remanufacture and reverse logistics (Quariguasi Frota Neto et al., 2010). The end-of-life phase of the product life cycle has attracted particular attention and interest because this approach not only minimises waste but also captures any remaining value (Linton et al., 2007). This indicates a trend for sustainable supply chains to be 'closing the loop' with the introduction of reverse logistics (Figure 1).

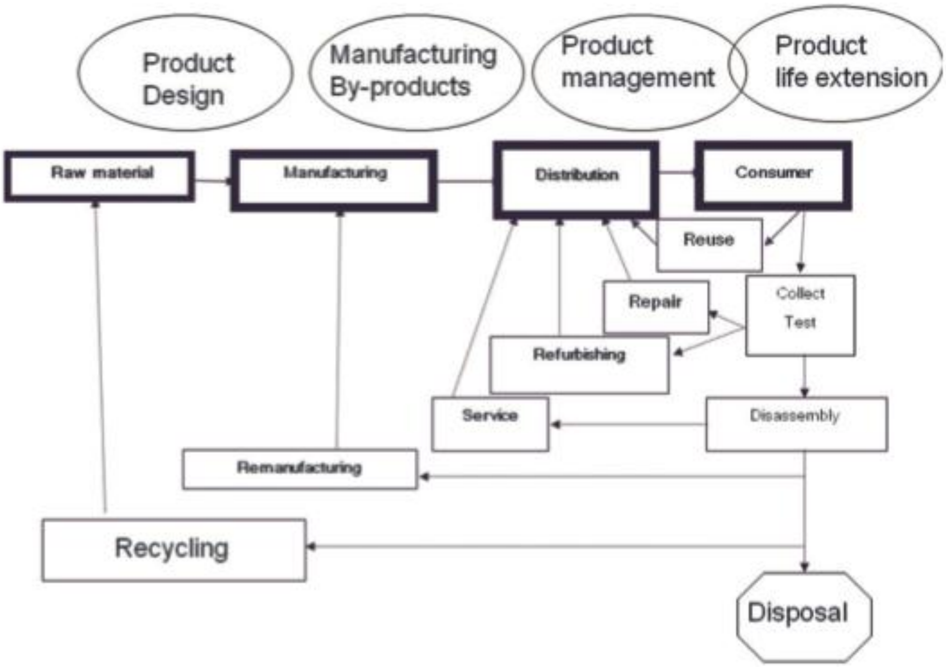

Figure 1: General framework of a closed-loop (sustainable) supply chain.
Source: Quariguasi Forta Neto et al., (2009), pg. 4465

Including the end-of-life phase, recycle and recover larger quantities of material are assumed to be proven measures to reduce the supply chain's environmental impact but this does not necessarily make it sustainable (Quariguasi Frota Neto et al., 2010). This is because energy consumption levels are not the same at the various phases of a product's life cycle and significant energy emissions do not always occur during the manufacturing process. Quariguasi Frota Neto et al. (2010) debated the sustainability aspect of closed-loop supply chains through the study of different electronic products' life cycles. Figure 2 illustrates how different the energy consumption profiles of products in an industry can be.

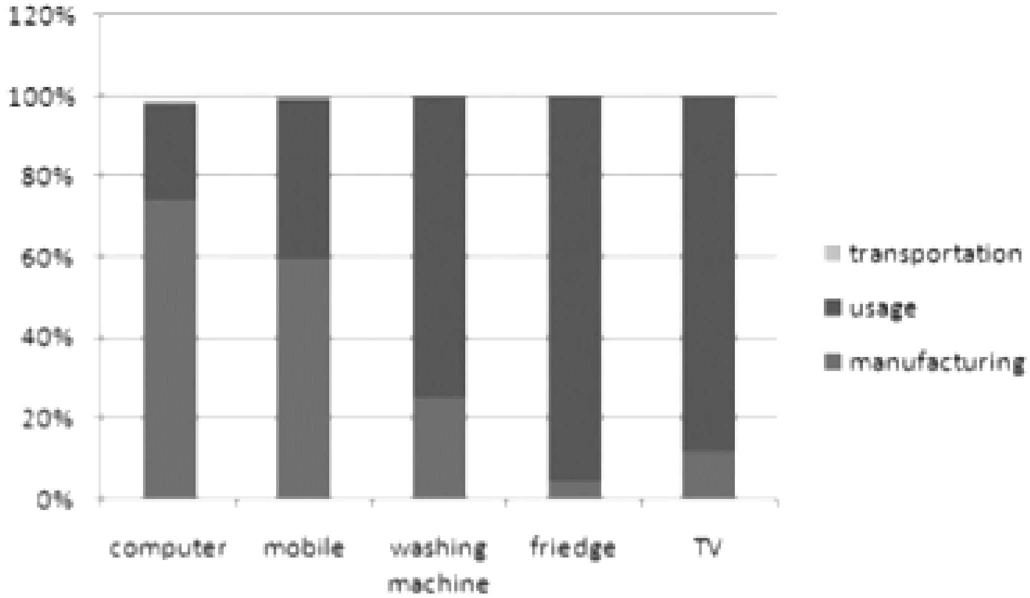

Figure 2: Energy consumption profile for PCs, mobiles, washing machines, fridges and TVs.
Source: Quariguasi Forta Neto et al., (2009), pg. 4470

The different consumption profiles prove that the scope of closing the loop of all supply chains might not be the most effective way of creating a sustainable supply chain. For the products that have high energy consumption levels during manufacture, the scope of closing the loop is very high. However, an alternative would be to extend the product's life cycle (Quariguasi Frota Neto et al., 2010), which is a product design consideration. For products with low manufacturing energy consumption, little improvement can be obtained via the adoption of end-of-life decisions (Quariguasi Frota Neto et al., 2010), and the maintenance service supply chains could be the focus for improvement to support the products efficient use of energy during its operation.

Energy consumption due to transportation is treated as negligible when compared to the total energy used for the production and operation of products and buildings. However, it is recognised that it is a significant source of cost in the supply chain and that, in extreme cases it can consume up to 8% of the energy needed over the entire life-cycle of a product (Quariguasi Frota Neto et al., 2010). Transportation is required for both the forward and reverse directions of the supply chain, and although it might be negligible in the forward direction, its energy consumption levels at the reverse direction become critical (Miller, 2001).

Buildings are responsible for almost half the country's emissions, about one third of landfill waste and use one quarter of all raw materials (HM Government, 2008). Efficiency in design, managing construction waste through increasing reuse, recycling or incineration, and reducing landfill waste are the main foci of the efforts aimed at making construction supply chains sustainable. The consideration of the energy consumption due to transport is almost non-existent as in common practice the energy embodied in the winning and manufacturing process is considered, which excludes the final delivery to the construction site (Miller, 2001). However, relative proportions of transport energy can vary greatly for different projects, which require different material and supply chains (Miller, 2001). The energy consumed in the delivery of materials can attribute 1.5% of the total embodied energy of materials for a new build project and up to 20% of the total embodied energy of recycled materials (Miller, 2001).

WHAT IS A LOCAL SUPPLY CHAIN?

Localisation in the context of this study is perceived in two dimensions, which should both be considered in the efforts of localising the supply chain. The first is the obvious dimension of geographical/ spatial location, which aims to shorten travel distances and stipulate local sustainable growth. However, this dimension is vulnerable to the energy efficiency of the transport modes available to the geographic area. Transport modes vary in their cost and impact with rail being 3.4 times more efficient than truck, barge 2.5 times more efficient than rail and 8.7 times more efficient than truck (Kendall et al., 2010). The second dimension is when supply chains are viewed as networks of production processes and localisation in this sense refers to the partial supply chains that are part or make-up the whole (global) supply chain (Albino et al, 2002). This dimension is highly relevant to construction because construction projects in addition to the construction (forward) and demolition (reverse) supply chains also require a Facilities Management (FM) supply chain. Also, construction supply chains require technical input of knowledge and expertise. Knowledge and information exchange networks can therefore be considered as partial supply chains. Localisation in that respect, therefore, allows for the efforts to minimise energy consumption at a local/ partial level of the supply chain. The importance lies into establishing localised boundaries, which would effectively be different for professional services, materials, plant and labour.

THE SCOPE OF LOCALISING CONSTRUCTION SUPPLY CHAINS

As in the case of electrical products (Figure 2), different building types have different emissions profiles during their life cycle. Figure 3 present the percentages of embodied carbon and operational carbon for offices, warehouses, supermarkets and houses.

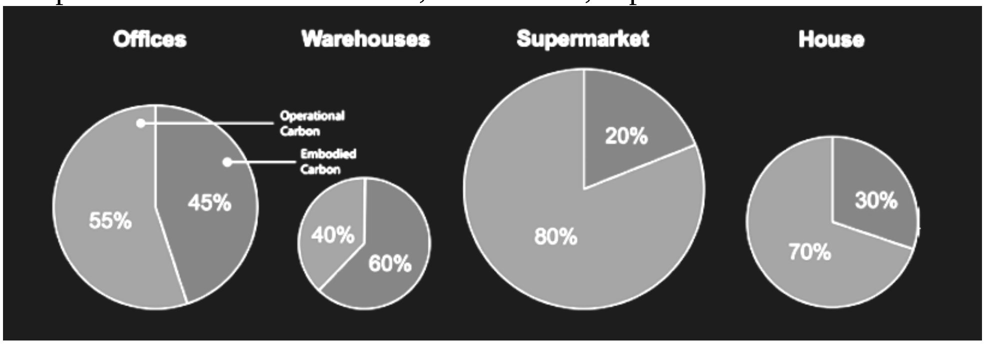

Figure 3: Typical different whole life Carbon splits for different types of buildings
Source: Sturgis & Roberts, (2010), pg 12

This can be treated as a guide on the construction phase's impact in comparison to the overall life cycle. It appears that SCL, in both geographical and at the construction/demolition partial supply chain dimensions, has a great scope for industrial buildings, where the embodied carbon percentage is much higher than the other building types. Having material production or recycling units in an industrial area does not raise particular planning implications, which could massively benefit the energy performance of the construction of new warehouses.
There is also scope for FM supply chains to become localised in areas where the demand for their services is high. FM is essential in maintaining the designed levels of energy efficiency of buildings. Therefore, for the building types where energy efficiency during operation is critical and more challenging to be achieved (e.g. offices), FM services, which in turn should minimise energy consumption, are expected to be in demand.

Key Themes	**Principal issues**
Economic sustainability 1.1 Improved project delivery	– Improved productivity
Environmental sustainability 2.3 Transport planning 3.1 Improved energy efficiency 3.2 Efficient use of resources	– Green transport plan of sites and business activities – Use of local suppliers and materials with low embodied energy – Use of recycled/ sustainability sources products
Social sustainability 4.2 Working with local communities & road users	– Contributing to local economy through local employment and procurement – Delivering services that encourage local environment – Building long-term relationships with local suppliers

Table 1: Key sustainability construction themes
Source: Adetunji et al., (2008), pg 166

However, the scope of localising the construction supply chain extends when considering the key sustainable construction themes. Table 1 lists the themes and the principal issues that relate directly to the issues discussed in this paper.

PROPOSED METHOD

Exploring the potential of SCL is extremely challenging due to its scope vagueness and as well as its interdisciplinary nature. This interdisciplinary nature is not only evident at the policy and industry level but also at a theoretical/academic level. The policy level initially requires for the issue to be considered as a critical adjustment in order to minimise energy demand but still maintain growth. However, an adjustment that requires moving away form the principals of globalisation to localisation raises implications of economic nature in addition to planning policy and social implications. The industry level requires cooperation and co-ordinated action by committed clients, design professionals and construction experts within a supporting policy framework. The industry and policy levels paint the picture for the vast number of theoretical/ academic disciplines, which are required to develop in an environment of cooperation. For the construction industry field of research some of those disciplines are planning, design (per design discipline), construction management and supply chain management including waste management, project management, economics of construction, facilities management etc.

Social Network Analysis (SNA) is proposed as a method to investigate the problem of localising the supply chain. Construction projects/ programmes/ enterprises can be seen as Social Networks (SNs). A particular characteristic of SNs is that they not only encompass information exchange networks but also value and resource flow networks. This allows non-social aspect of construction activity (Pryke, 2008) and organisations to be explored in conjunction with social aspects. Although, the use of SNA in the study of construction supply chains is not unknown, its application in the sense of concurrently investigating social and non-social aspects, which is proposed as bridging the economic, environmental and social dimensions of sustainable developments, is innovative.

Resource/value flows and logistics, knowledge management, contractual relationships, performance incentives and information exchange networks define the supply chains that are required to deliver construction services. These networks have a geographical dimension, which is considered in addition to the relationships between the supply chain actors listed above The existing energy demand profile of sustainable developments can be investigated by mapping current supply chains through SNA, starting at project level and expanding at programme or portfolio levels. The size and capacity, technical expertise, the geographical location of the supply chain as well as the location of the intellectual capital in it should be investigated in order to make a viable proposal about SCL. This would involve proposals on which local supply chains need to be enhanced, how best to enhance them and how the use of BIMs and vertical integration of the supply chain might be exploited to provide interfaces between local supply actors and end-users.

In summary, investigating the issue of localising the supply chain involves:

- Defining SCL.
- Investigating SCL’s input in dropping energy demand (define the scope for its adoption as a model).
- Investigating how to implement SCL through the industry’s cooperation and supporting policy.
- Investigating the viability of existing local supply chain infrastructure and its relevance and evolution over the coming decades.

PLANNING POLICY AND TECHNOLOGY DEVELOPMENT

Although SCL due to its strong dependence on the study of logistics and transport, appears to be an operational issue for the management of sustainable supply chains, instead of a strategic one (Srivastava, 2007), it actually finds its place in the heart of "the problematic bifurcation of sustainable construction into two exclusive agendas: the construction technology agenda and the urban sustainability agenda" (Moore & Rydin, 2008, pg 233). Moore's & Rydin's (2008) paper raises the issue of lack of integration between the two agendas, how it leads one agenda to be odds with the other and the detrimental effects on delivering mechanisms for sustainable construction that satisfy the technological imperative as well as the goal of sustainable urban development. Rydin (2010) raises the issue that 'the planning system is facing new challenges in which the nature of its engagement with technology is a driving force" (Rydin, 2010, pg 256). This is based on the observation that the sustainability agenda has created a shift in the society that puts technology at the centre and planning debates are evolving around the need to focus on technological issues.

SCL has undoubtedly planning implications and requires supporting policy for its implementation. Its scope, however, appears to depend on the technological advancements available. Investigating any potential benefit that SCL might bring is expected to also inform the problem between the technology and urban development agendas.

CONCLUSION

The main objective of this paper is to highlight that the issue of localisation appears to have been neglected in the discussion of sustainable supply chains. Starting from questioning the impact of transport in the total energy consumption of supply chains, and by attempting to impose those concerns on the management of sustainable supply chains the notion of localisation presents two dimensions; geographical and procedural. It is advocated here that both dimensions should be considered for successfully SCL and its scope in construction is briefly presented.

Localising the supply chain is being introduced as potentially an effective approach to achieving a sustainable reduction to the energy demand levels required by construction projects. Emissions from transporting construction materials and labour appear to be overlooked in the study of sustainable construction despite the fact that they are arguably more important than many of the factors currently regarded as central. They could be a reflection of the construction sector's reliance on energy, which in turn leads to increasing costs and contributes to greenhouse emissions. Questions centred on transport and logistics management, which are considered as processes that are heavily energy demanding, provide a starting point for a discussion on the definition of SCL and its scope for development and implementation.

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