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Building up Resilience of Construction Sector SMEs and Their Supply Chains to Extreme Weather Events

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Abstract

Wider scientific community now accept that the threat of climate change is real and thus acknowledge the importance of implementing adaptation measures in a global context. In the UK, the physical effects of climate change are likely to be directly felt in the form of extreme weather events, which are predicted to escalate in number and severity in future under the changing climatic conditions. Construction industry; which consists of supply chains running across various other industries, economies and regions, will also be affected due to these events. Thus, it is important that the construction organisations are well prepared to withstand the effects of extreme weather events not only directly affecting their organisations but also affecting their supply chains which in turn might affect the organisation in concern. Given the fact that more than 99% of construction sector businesses are SMEs, they have to be paid special attention especially due to their inherent characteristics such as resource constraints etc. This paper presents the initial stage of a PhD research study undertaken to address the issue of extreme weather resilience of construction sector SMEs and their supply chains. The paper aims to identify the importance of being resilient to the effects of extreme weather events in a wider supply chain context. It attempts to identify the likely effects of extreme weather events on construction industry supply chains, and their consequences by reviewing the current literature. The paper also briefly reviews the drivers/barriers for implementing resilience measures to these issues in construction supply chains, especially considering the dominance of SMEs within the industry sector. Future directions of the PhD study will also be presented. Paper concludes by highlighting the importance of improving the coping capacity of construction sector SMEs and their supply chains to the effects of extreme weather.

Keywords: business continuity, extreme weather events, SMEs, resilience, supply chains

1. Introduction

Various stakeholders of a community are affected at varying magnitudes by EWEs. Small and Medium-scale Enterprises (SMEs), which form a significant portion in many economies, are also affected by such events. The SMEs are often affected disproportionately by EWEs when compared with their larger counterparts (Tierney and Dahlhamer, 1996, Webb et al., 2000, Alesch et al., 2001). SMEs are, in fact, considered as the most vulnerable section of the UK economy to the impacts of extreme weather (Crichton, 2006). Their vulnerability arises virtually by definition because of the small scale of their human and financial resources (Bannock, 2005). SMEs, being highly vulnerable to the effects of EWEs, are required to be adequately prepared to face such events, in order to prevent, withstand and recover following such an event. Previous research reveals that small businesses are not adequately prepared to cope up with the risk of EWEs and other natural hazards and to recover following such an event (Tierney and Dahlhamer, 1996, Alesch et al., 2001, Yoshida and Deyle, 2005, Crichton, 2006, Dlugolecki, 2008).

SMEs may encounter unfavourable consequences, if they are affected by EWEs, due to their increased vulnerability and not being adequately prepared to deal with such an event. Moreover, SMEs suffer even without having been directly affected by an EWE, due to the vulnerability of the supply chain, utilities and transport infrastructure (Burnham, 2006). Indeed there is a view that the risks to the supply chain are some of the most important (Huddleston and Eggen, 2007). Improving the resilience of SMEs to the effects of EWEs has thus become an important issue, with the increasing threat of EWEs. Being resilient to EWEs is particularly important to businesses, due to the fact that they present businesses with positive consequences in addition to the negative consequences. Being resilient will allow businesses not only to minimize the threat of negative consequences, but also to capture the positive consequences presented by EWEs. As far as SMEs are concerned, being resilient might well decide the survival or the failure of an SME affected, creating economic and social consequences. While the loss of an individual SME may not cause a significant impact on the local economy in terms of the earnings it generates or the number of people it employs, the collective losses of a number of small businesses from a weather extreme may devastate a local economy (Yoshida and Deyle, 2005). Hence, improving the resilience of SMEs and their supply chains to EWEs has become an important issue given the ever increasing threat of such events.

This paper presents the initial stage of a PhD research study undertaken to address the issue of resilience of construction sector SMEs and their supply chains to EWEs. It first presents the background to the research and research problem to be investigated followed by the aim and objectives of the research. The paper then discusses the extant literature and concludes by stressing the need for further research in this area and setting out the way forward of the research.

2. Background

The world in recent years has witnessed increases in the intensity and frequency of Extreme Weather Events (EWEs) (Beniston and Stephenson, 2004, Thibault and Brown, 2008). These EWEs have created significant economic and social costs to the communities around the world. There is wider

speculation that this increased intensity and frequency of EWEs is primarily due to intensified climate change and that there is a strong link between the two (Stern, 2007). Increases in the number and severity of EWEs are expected in the future, due to the impacts of climate change (Environment Agency, 2005, Munich Re, 2007, Stern, 2007). Consequently, costs of EWEs are also expected to escalate in future and the Stern review (2007) reveals that the average annual costs of extreme weather could reach about 0.5 - 1% of world's GDP by the middle of the 21st century. Thus, threat of EWEs has, and will become a prime challenge to be dealt with by communities around the world. The significant scale of the risk of EWEs has made it important for the communities to be able to adapt to the risk created by them and prepare for the disruptions caused by them (Helmer and Hilhorst, 2006). Resilience to EWEs has thus become an issue of significant importance to the communities around the world, with the UK being no exception, as the risk of weather extremes are also expected to increase in future in the UK .

As discussed above, resilience to EWEs is specifically important for the SME sector due to many factors. This is of particular importance to the construction industry, given the fact that SMEs account for the bulk portion of employment (83.7%) and turnover generation (67.4%) in the industry (BERR, 2008a). Hence, it is clear that the successful operation of SMEs is of significant importance to the successful operation of the construction sector as a whole. Further, the need for more resilient structures and the need for reconstruction after the effects of a physically damaging weather event place a particular importance on the construction industry in terms of weather extremes. As construction activities are normally carried out in an open environment, their activities are largely dependent on weather unlike some other industry sectors. Thus, EWE resilience is a matter of significant interest to the construction industry. As the construction industry is overwhelmingly comprised of SMEs, SME resilience to EWEs has become an important aspect presenting many research opportunities.

3. Research problem

As discussed above, increased vulnerability to the effects of EWEs places SMEs at a higher risk when compared with their larger counterparts (Tierney and Dahlhamer, 1996, Webb et al., 2000, Alesch et al., 2001). As SME contribution is critical for the successful operation of local communities and economies, improving SME resilience against the effects of EWEs has become an issue which warrants considerable attention. Investigation of the business response to EWEs has long been neglected when compared with studies on the residential sector (Tierney and Dahlhamer, 1996, Tierney, 1997, Webb et al., 2002), and only a very few studies have looked at SME response to EWEs specifically. There seems to be an obvious gap between the increased need of improving SME resilience to EWEs and the current knowledge with regard to this issue.

As SMEs constitute more than 99% of businesses in the construction industry and as they generate more than half of the employment and turnover, SME participation is critical for the successful operation of the construction industry. Given that many large construction projects involve a large number of SME participants, delivery of a successful project is dependent upon the involvement of these SMEs. Government studies into the construction industry (Latham, 1994, Egan, 1998), have in fact, identified that the integration of the whole supply chain as a critical factor in improving

effectiveness in the construction industry. EWEs are capable of creating disruptions to the activities of construction sector, not only via their direct physical effects but also via disruptions to the supply chain of the industry. As the risk of EWEs is increasing, there is a growing need for preparing the construction sector SMEs and their supply chain partners to face the challenges created by EWEs. Further, EWEs also present businesses with positive consequences as well (Heliview Research, 2008, Norrington and Underwood, 2008, Metcalf et al., 2009). It is important that SMEs are prepared not only to minimise the negative consequences, but also, to exploit the positive consequences presented by EWEs. However, not many studies have been undertaken to study how the construction organisations have managed EWEs before. This research is developed to address this gap in the knowledge, identifying the growing need for improving the resilience of construction sector SMEs and their supply chain to the effects of EWEs.

4. Aim and objectives

The aim of this research is to develop and validate a decision making framework for improving the resilience of construction sector SMEs and their supply chains against EWEs. In order to achieve this aim, the research sets the following objectives.

- To examine the existing coping mechanisms implemented by the SMEs in different industry sectors against EWEs.
- To assess the coping capacity of the construction sector SMEs against EWEs.
- To identify the key stakeholder organisations who interact with construction SMEs and to examine their interactions when faced with EWEs.
- To develop a construction sector specific decision making framework for SMEs to improve their resilience to EWEs.
- To validate this framework by adopting a focus group approach.

5. Literature review

5.1 SMEs in construction

The construction sector is a major component in any economy. In the UK, its output is worth over £100 billion a year, accounts for 8% of Gross Domestic Product (GDP) and provides employment for around 3 million workers (BERR, 2008b). The UK construction industry constitutes about 21% of the total enterprises in the UK (BERR, 2008a). Hence, the construction industry makes an important contribution to the competitiveness and prosperity of the economy (BERR, 2008b). The construction industry is not only a critical component of the nation's economy, it is also a fundamental factor in the quality of people's lives and the ability of the government to achieve many of its policy aims (Bosher

et al., 2007). Over 99% of private sector businesses operating in UK construction sector fall to the category of SMEs (BERR, 2007).

In the UK economy, 83.8% of employment in construction sector is provided by SMEs and 67.4% of turnover is generated by them (BERR, 2008a). These statistics depicts the significance of SMEs in the UK construction sector and their significant contribution to the national economy. A majority of these SMEs are sole proprietors or partnerships comprising only the self-employed owner-manager, or companies comprising only an employee director and hence fall to the category of micro businesses (BERR, 2008a). Whilst the bulk portion of the remaining is small businesses, only a smaller portion are medium-sized. Due to the presence of many SMEs and less large businesses, a supply chain consisting of hundreds of organisations tend to deliver major construction projects (Stewart et al., 2004). In the construction sector, the network of supply chain members can often be extremely complex, particularly on larger projects where the number of separate supplying organisations will run into hundreds, if not thousands (Briscoe et al., 2001). Citing a number of sources, Sexton and Barrett (2003) avow that the industry is generally driven by single and unique projects, each creating and disbanding project teams made up of varying combinations of large and small firms from across the supply chain spectrum. Thus, effective management and relationship of the entire supply chain is required to achieve best value in construction industry.

5.2 Supply chains involving SMEs in construction

5.2.1 Supply chains in construction

Love et al (2004) define supply chain as “the network of facilities and activities that provide customer and economic value to the functions of design development, contract management, service and material procurement, materials manufacture and delivery, and facilities management” from a construction project perspective. The Egan report (Egan, 1998) identified that the supply chain is critical to driving innovation and to sustaining incremental and sustained improvement in performance of the construction industry. According to O’Brien (1999), construction supply chain management offers new approaches to reduce the cost of and increase the reliability and speed of facility construction. It also offers a way to work that can fulfil the promise of a collaborative construction environment (O’Brien, 1999).

The Latham report (1994) has recommended that the separate parties in construction should work together in order to produce better work, higher productivity and a higher level of efficiency. The Egan report (1998) highlights the importance of organisation and management of the supply chain to maximise innovation, learning and efficiency in the construction industry. It places a strong emphasis on supply chain improvement measures in order to achieve best value in construction. Following the publication of these reports; which call for better integration throughout the construction supply chain, a marked shift of application of supply chain management practices in the UK construction industry has been observed (Akintoye et al., 2000). Yet, supply chains are still to reach their full potential in construction, due to the fragmented nature of its supply chain, which consists of a large number of small businesses and the adversarial nature of relationship amongst the supply chain members.

5.2.2 Construction SMEs in supply chains

Sexton et al (2006) mention that small construction companies, along with all companies, do not operate in a vacuum. Accordingly, they are situated in a number of fluctuating inter-organizational networks of varying complexity (Sexton et al., 2006). As the majority of construction organisations in the UK construction industry are SMEs (BERR, 2008a), their involvement in various supply chains is inevitable. Dainty et al (2001) state that, despite the high level of fragmentation within the industry, the role and influence of SME subcontractors and suppliers within partnering and strategic alliances have largely been ignored. They declare that this is a serious omission, given the large number of smaller firms that form the supply chain of most construction projects, and that this could inhibit the achievement of better supplier integration, process conformity and alignment. Bourn (2001) identifies that the entire supply chain including clients, professional advisers, contractors, subcontractors and suppliers of materials must be integrated to attain best value in construction, thus again highlighting the importance of SME involvement.

Briscoe et al (2001) suggest that skill deficiencies and attitudes can pose barriers to the efficient operation of supply chains involving SMEs in the construction industry. Hence the study identifies the importance of dispensing with some major negative attitudes such as lack of trust of supply chain partners, apparent unwillingness to share information and knowledge etc., if a successful supply chain relationship is to be established. Dainty et al reveal that (2001) there is a general mistrust within the SME companies that make up the construction supply chain, and a general lack of belief that there are mutual benefits in supply chain integration practices. However, Davey et al (2001) have found that by interacting with other groups within a non-adversarial environment and benefiting from the process, partnering was seen as both desirable and possible by SMEs. They further reveal that the trust and confidence generated from working together successfully also led construction SMEs to share good practice with others from the industry, including local competitors. Thus it shows that it is possible to overcome the negative attitudinal barriers which prevent positive supply chain relationships.

Dainty et al (2001) declare that the UK construction sector is a long way from being able to derive benefits from true supply chain integration. They further highlight the importance of the active involvement of small businesses in supply chain practices, if the supply chain integration is to be achieved successfully. Thus, the importance of SME involvement in SCM practices becomes crucial if the UK construction industry is to achieve the objectives highlighted by the Latham (1994) and Egan (1998) reports.

5.3 Extreme weather events and supply chains

5.3.1 Vulnerability of supply chains

Supply chains face disruptions of various sorts (Snyder et al., 2006) and such disruptions are a common phenomenon (Svensson, 2000). Natural disasters, industrial disputes, terrorism (Christopher and Peck, 2004), dependence on a single supplier, supplier bankruptcy, war, and political instability (Wilson, 2007) have all resulted in serious disruptions to supply chain activities. Recent events such as the fuel protests in 2000, foot and mouth disease in 2001 (Peck, 2005) and the hot summer in the

UK in 2003, hurricanes Katrina and Rita (Snyder et al., 2006), September 11 terror attack (Sheffi and Rice, 2005) in the USA etc, have demonstrated that a disruption affecting an entity anywhere in the supply chain can have a direct effect on a businesses' ability to continue operations, get finished goods to market or provide critical services to customers (Jüttner et al., 2003). Snyder and Shen (2006) declare that supply chain disruptions can have significant costs (e.g. damage to facilities, inventory, electronic networks, and infrastructure) and subsequent losses due to downtime. Inventory costs due to obsolescence, markdowns and stock-outs can be significant (Christopher and Lee, 2004). Moreover, a company that experiences a supply chain disruption can expect to face significant declines in sales growth, stock returns, shareholder wealth, and customer goodwill (Snyder and Shen, 2006). Therefore, it is critical to account for disruptions during the design of supply chain networks so that they perform well even after a disruption (Snyder et al., 2006).

5.3.2 EWEs and supply chains

Extreme weather events such as floods, hurricanes, storms etc can have significant effects on supply chains (Christopher and Peck, 2004, Kleindorfer and Saad, 2005). As mentioned earlier, vulnerability of supply chain to EWEs is capable of creating significant business impacts, even without the business concerned being directly affected by the event. Indeed, there is a view that the risks to the supply chain are some of the most important (Huddleston and Eggen, 2007), especially due to the widespread nature of modern supply chains which run across different industries and economies. Table 1 shows the effects experienced by UK businesses which were affected by floods in year 2007. Many of the major effects experienced are related to supply chain of those businesses, and thus provides evidence for the argument that risk to the supply chain are significantly important.

Table 1 - Effects of flooding on businesses (Source: Woodman, 2008)

<i>Effect</i>	<i>% of Businesses Affected</i>
<i>Staff unavailable for work</i>	<i>53%</i>
<i>Premises flooded (offices, shops, etc)</i>	<i>38%</i>
<i>Suppliers disrupted</i>	<i>27%</i>
<i>Increase in trade/demand for services</i>	<i>24%</i>
<i>Loss of power</i>	<i>18%</i>
<i>Loss of water supplies</i>	<i>11%</i>

Businesses may suffer without being directly affect by an EWE, due to the vulnerability of supply chain, utilities and transport infrastructure (Burnham, 2006). If the supply chain of a particular business is affected by an EWE which occurred elsewhere, it may affect the performance of the business, even without the particular business being directly affected by the actual physical EWE. It is

therefore necessary for business organizations to consider the wider impacts of EWEs that can affect their businesses and their supply chains, not only the direct physical impacts.

Summarising its experience of working with SMEs with regard to climate change and EWEs, the UKCIP identify that “key risks often related to markets and supply chains” for SMEs (UKCIP, 2009). This issue is one of the six key issues identified by the UKCIP with regard to climate change adaptation of SMEs. The importance of supply chain effects of EWEs were also highlighted in a workshop (organised by the London Climate Change Partnership) session facilitated by “Community Resilience to Extreme Weather – CREW” research team; of which this PhD research forms a part, for representatives of SMEs and support organisations for SMEs. Furthermore, the need to have coping mechanisms to deal with the supply chain disruptions was also highlighted by the SME representatives as it is often difficult for SMEs to control its supply chain due to their limited scale of operations. The other key issues raised were the need for specific and simple business advice, continuous help in implementation, enhanced awareness and a medium to discuss the supply chain related issues.

6. The way forward

The background to this research and the research problem to be investigated identifies the importance of further study on the issue at hand and sets the scene for this research. The aim and objectives were then derived in order to identify the direction and outcome of the research. It then has to be clearly identified the research methodology to be adapted in the process of searching for the answers to the problems set out in the research. According to Remenyi et al (2003), methodology is the “overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data”. Summarising the above definition, Collis and Hussey (2009) identify methodology as the “overall approach to the entire process of the research study”. Research methodology, as per the above definitions, is focused around the problems to be investigated in a research study and hence is varied according to the problems to be investigated. Thus, much attention has to be paid towards identifying the research methodology that best suits a research in hand. The next stages of this research will involve the design of appropriate research methodology and further review of related literature.

7. Conclusion

SMEs are increasingly affected by EWEs leading to significantly negative as well as positive organisational consequences. This has necessitated the improvement of their resilience to such events, not only to minimise the negative consequences, but also to effectively utilise the positive consequences. Improving the resilience of SMEs to EWEs requires a much broader view than the particular SME in concern alone, to include the supply chains in which a particular SME is a part of. This is of specific importance to a sector like construction, in which the SMEs play a major role of, highly vulnerable to EWEs, and comprise of complex supply chains. Although these issues presents many research opportunities, scant literature available addressing these issues portrays the lack of academic attention and the need for more focused studies in this respect. There is thus an obvious

incentive to focus on research related to resilience of construction SMEs and their supply chains to EWEs. Improving the resilience of SMEs is not only about implementing various coping mechanisms but also includes improving their capacity to cope with EWEs as well as ways and means of reducing the vulnerability to such events.

Despite the significant threat of EWEs and the possibility of further increases in the future, even the recent studies suggest that SMEs are less proactive in being prepared to face the threat of EWEs and other natural hazards. This raises the important issue and challenge of integrating the best practices into the mainstream of SME activities in verge of ever increasing extreme weather conditions. This research will provide valuable insights to such issues. The research also has broader relevance for policy and practice. The next stages of this research will involve the design of the research methodology, which is an important element if not the most in a research.

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