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A relational study of supply chain agility, competitiveness and business performance in the oil and gas industry

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ABSTRACT

This paper assesses the link between dimensions of agile supply chain, competitive objectives and business performance in the UK North Sea upstream oil and gas industry. A questionnaire was designed and administered covering important criteria of agility identified from the literature. The questionnaire was sent to a sample of 880 supply chain managers within the UK oil and gas industry and a net response rate of 17.8% was achieved. Statistical tests for validity and reliability were carried out. Also, the KS statistical test for normality was undertaken on the data. All the tests affirm that the data came from a normal distribution. Non-response bias analysis was conducted through wave analysis using one-way ANOVA and no statistically significant difference was revealed by the *t*-test result. By examining the whole supply chain associated with agile practices in an important sector, the paper identifies the most important dimensions and attributes of supply chain agility and provides a deeper insight into those characteristics of agility that are most relevant within the oil and gas industry.

1. Introduction

According to the Global Supply Chain Forum, supply chain management seeks to integrate the key business processes, from the original suppliers of raw materials to the end user of the manufactured product. The processes create products, services and information that add value to the stakeholders of the supply chain (Lambert and Cooper, 2000). In tracing the evolution of supply chain management (SCM), Lambert and Cooper (2000), Lamming (1996) and Lamming et al. (2000) observe that the term SCM was introduced by management consultants in the early 1980s and has since generated wide and keen interest across disciplines. Initially, supply chain management was perceived simply as the logistics of manufacturing and distribution, which extends from outside the firm to include customers and suppliers. However, SCM is now conceptualised and applied as the integration of all the business processes across the supply chain. Thus the new model of SCM encompasses all the other business functions, including extended, multi-tiered suppliers and end customers (Pihkala et al., 1999).

The continuously evolving and dynamic nature of the supply chain presents many interesting challenges for effective system coordination. Supply chain members cannot compete as independent members. The product used by the end customer passes through a number of entities that contribute in the value addition of the product before it is consumed. Furthermore, modern traits like globalization, outsourcing and reduction in supply base have exacerbated uncertainty within, and risk exposure of, supply chains. Supply chains have become more prone to sudden disruptions. Systems thinking, which considers both the whole and the constituent parts of ecosystems (Gharajedaghi, 2005; Skyttner, 2006), is providing a new perspective for examining and managing supply chains as both uncut and cut (partial) entities that continuously exchange energies and products.

Recently, Ngai et al. (2012) highlighted the importance of energy saving in production, particularly in textile processing using soft systems methodology. The reported empirical investigations and results in this paper contribute to effective management of oil and gas production and distribution, which in turn will support global energy needs and sustainable resource management.

In trying to understand the circumstances leading to the evolution of SCM, Hill (2000) asserts that companies rarely own the resources and activities to make a product or provide a service

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from the beginning to the end. Indeed, Ramdas and Spekman (2000) contend that, since purchased goods and services account for 50 to 70% of manufacturing company's potential value, a firm's competitive advantage depends largely on the links it forges with external organisations rather than its internal capabilities. Furthermore, Richardson (1972), and Grandori and Soda (1995) argue, from a transaction cost economics point of view, that the organisation of industry should take cognisance of similarities and complementarities of activities. In addition, Loasby (1998) points to the fact that "all firms depend on the capabilities of their suppliers, and every firm that is not a retailer depends on the capabilities of those who provide it links to the final consumer." In fact some of the activities in the value stream of the product or service delivery system are often not undertaken by the organisation itself, but rather sourced from external vendors. This underpins the need to manage effectively the internal and external phases of the supply chain as an integrated whole.

The oil and gas supply chain, especially the upstream segment, is inherently typified by the above characteristics, with large numbers of small and medium-sized enterprises (SMEs) that provide services and technology to support the operations of the major oil companies. How well these service providers are managed as part of the total supply chain of the major companies is of significant importance to the effectiveness and efficiency of the oil and gas supply chain. Further, the agility of these firms across the oil and gas supply chain and the impact of supply chain performance are of great importance in achieving related supply chain competitiveness.

The survey results reported in this study seek to establish, on the one hand, relationships between the dimensions of agility and related attributes, and, on the other hand, business performance and competitive bases. The paper is divided into four parts. The first part is the literature review that examines issues in supply chain management as well as, in particular, an overview of oil and gas supply chain. The second part discusses the methodology including research questions, sample profile and data collection. The third part presents the results and analysis in an attempt to answer the research questions. The fourth and final section is the conclusions and suggestions for further research.

2. Literature review

Supply chain agility has been explored in a number of studies. It has been defined with respect to the agile enterprise (Whitten et al., 2012; Gehani, 1995; Browne et al., 1995; Browne and Zhang, 1999; Jagdev and Browne, 1998; Goranson, 1999), products, workforce (Breu et al., 2002), capabilities (Yusuf et al., 2004), virtual teaming (Bal et al., 1999), and the environment (Robertson and Jones, 1999). The early proponents of agility defined it as a system with exceptional internal capabilities to meet the rapidly changing needs of the market place with speed and flexibility. The internal capacities of the firm include hard and soft technologies, human resources, educated and highly motivated management, and information and communication technologies. A system that shifts quickly (with speed and high responsiveness) among product models or between product lines is said to be flexible. Flexibility often implies responding to customer demand almost in real time (Youssef, 1994).

Goldman et al. (1995) defined agility as a dynamic, context specific, aggressive change that embraces and pursues growth, success, profits, market share and customers. Gehani (1995) and Gligor and Holcomb (2012) contend that an agile organisation can quickly satisfy customer orders, can introduce new products frequently in a timely manner, and can speedily get in and out of strategic alliances with its trading partners. In this case the nimbleness of alliance and partnership formation also constitutes agility, which underscores that the notion of agility is context specific (Goldman et al., 1995; Whitten et al., 2012).

Agility has also been defined in terms of specific activities and operational issues. Kidd (1994) proposed an operational definition of agility as a combination of a number of enterprises such that each has some core skills or competencies that they contribute to a joint business operation. This enables the cooperative enterprises to adapt and respond quickly to changing customer requirements (Kidd, 1994; Yusuf et al., 1999). Kumar and Motwani (1995) defined agility as a firm's ability to progress activities rapidly on the critical path, which is a direct indicator of the firm's capacity to compete on the basis of responsiveness. Thus, agile supply chains use total cycle time-compression as a parameter of competition (Mason-Jones and Towill, 1997, 1999; Mason-Jones et al., 2000). Similarly, agile supply chains may be defined as being about mastering market turbulence (van Hoek, 2000, 2001; van Hoek et al., 2001). This requires specific capabilities, in addition to those that can be achieved by means of lean thinking. A key consideration in this definition is the fact that agility is built on leanness. Thus an organisation needs to become lean by implementing practices that will reduce waste in its operations before it can achieve agility. Thus, leanness and agility are complementary rather than being mutually exclusive. Therefore, leanness and agility can be integrated in practice (Yusuf and Adeleye, 2002; Yusuf et al., 1999, 2003, 2004).

From a manufacturing perspective (Yusuf et al., 1999; Miles and Snow, 1987, 1992), agility can be defined as the successful adoption of competitive bases (speed, flexibility, innovation proactivity, quality and profitability) through the integration of reconfigurable resources and best practices in a knowledge rich environment to provide customer-driven product and services in an uncertain market setting.

The various definitions of agility from some of the key and highly cited works on the subject are summarised in Table 1. Although each of the definitions highlights distinct issues, there are themes that are common to all the definitions. The regular themes can be summarized as customer sensitivity, network integration, process integration, leveraging the impact of people and information. These four principal dimensions of agility will be tested for their impacts on business performance and competitive objectives in the oil and gas clusters.

In the oil and gas supply chain, as in other industries, minor suppliers tend to have limited influence on their supply chains. Wisner (2003) contends that, in most cases, SCM is not feasible in situations such as "when the focal organisation is not in a position of power or structural dominance". It is important therefore for the major operators in the industry to lead the development of SCM. This is increasingly being recognised, as major oil companies for example, believe that agile supply chain rather than internal operations will become the main source of performance improvement. In fact, SCM practices are now seen as offering opportunities to upscale performance when the latitude for cutting internal costs and re-engineering business processes has been exhausted or does not exist (Ernst and Steinhubl, 1997). This follows the trend already set in other sectors (Ramdas and Spekman 2000). In spite of the need for greater SCM practices in the oil and gas industry, evidence suggests that a significant number of oil companies have doubts about the effectiveness of their supply chains and less than half believe they have the requisite tools and skills to optimise their supply chains (Ernst and Steinhubl, 1997). As oil companies move from the practices of retaining all needed capacity in-house to a higher level of outsourcing, greater integration and SCM capability have become profoundly important (Zhou et al., 2010a,b). In our interviews, some industry executives have suggested that up to

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