Cluster supply chain management: A study of the UK upstream oil and gas industry.
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Abstract
In a bid to cope with market instability, companies now look beyond cost and quality advantage. The emphasis is on speed and flexibility, as means of responding to the unique needs of customers and markets. However, the core resource competencies required to achieve the extended range of objectives are often difficult to mobilise and retain by individual companies. As a result, a number of companies co-operate and leverage core resource competencies amongst themselves whilst competing. Recent work shows that the internal resource competencies of process automation and employee empowerment are characterised by negative interaction effects in their relationship with competitive and business objectives, implying that those internal resource competencies are inadequate for enhanced operational performance. Therefore, external competence building through supply chain integration as seamless flows of resource coalitions is essential for enhanced competitive performance. Unfortunately, the existing supply chain management tools did not take into account the existence of clusters. As a result, we are currently studying the diffusion of established enterprise agility attributes in the supply chain in the context of clusters. This paper is a review of the existing literature on supply chain management, examining currently established agility attributes; also reviews current supply chain practices in the oil and gas sub sector, and then explores aspects of the cluster concept that can enhance supply chain agility.

1 Introduction

Among the features of globalisation is the redefinition of the nature of competition between firms. The period preceeding the 1970s was distinct with firms competing between themselves. The dominant characteristic of firms then is they are vertically integrated and tend to make and assemble their products all alone (Carrie, 1999). Then outsourcing strategy was pursued vigorously by companies. Outsourcing is based on the premise that firms in the value stream have developed “distinctive competencies such as knowledge, experience and skills to perform particular activities in an industry (Richardson, 1972; Davies, 2004). However, with outsourcing companies became extended enterprises and competition largely became between supply chains. It is contended that with globalisation competition is now between clusters of companies located in a region instead of supply chains competing between themselves (Carrie, 1999; Carrie, 2000). Put differently where an organisation is geographically located is critical to its long time competitiveness. Furthermore the agility of an organisation depends on the strength of the regional infrastructures it is located.

This paper is a review of the existing literature on supply chain management, examining currently established agility attributes; also reviews current supply chain practices in the oil and gas sub sector, and then explores aspects of the cluster concept that can enhance supply chain agility.

After this introductory part the remaining parts of the paper is organised as follows. Section 2 provides some of the oil and gas process characteristics. Section 3 is a general account of developments in the field of supply chain management with clarification between supply chains and supply network. Section 4 looks at oil and gas
supply chains. Section 5 discusses the concept of clusters and industrial districts and how they create competitive advantage. Finally some concluding remarks are made.
2. Oil and gas process characteristics

In a business environment characterised by market instability and complex product, dynamic response by organisations is a necessary condition for survival. However, the effectiveness of an organisation’s response to the rapidly changing market conditions will depend, to a great extent, on the capabilities of the whole members of the supply chain. Thus an effective agile supply chain is necessary for the long term competitiveness of an organisation. It is therefore imperative for companies to cooperate and leverage complementary competencies. Agility concept is holistic in outlook rather than functional or single company focussed, and is of strategic rather than tactical importance (Power et al., 2001; Christopher and Lee, 2004). The compelling drivers of agility are market instability as a result of globalisation, dynamic customer tastes, product complexity and decreasing product life cycles.

The agility of a supply chain is a measure of how well the relationships both upstream and downstream involved in the value creating processes enhance four pivotal objectives of agile manufacturing. These objectives are customer enrichment ahead of competitors, achieving mass customisation at the price of mass production, mastering change and uncertainty and leveraging the impact of people across enterprises through technology (van Hoek et al., 2001; Yusuf et al., 2004). Figure 1 shows conceptual model of the four dimensions of agility according to Rigby et al (2000). Similarly Booth and Hammer identified five parameters of agility. These are change competency; customer focus; cooperation among members of the value creation; harnessing the capabilities of people and information and accounting for social values in decision - making (Adeleye, 2002).

![Figure 1: The four dimensions of agile supply chain (source: Rigby et al. 2000; 179).](image)

Yusuf et al.(1999) provided the attributes of an agile organisation. The suggested agility attributes are summarised in table 1. The table presents 32 attributes in 10 decision domains of an agile enterprise.
Attempts have been made to study the low volume high value capital goods supply chain. Though there is limited research account of the industry, nevertheless the few available have studied and characterised it from varying perspectives. For example, Tu (1997) studied the industry from the perspective of the uniqueness of the product, in which it was referred to as One-of-a-kind product (OKP). Looking at the properties of the product Hobday, (1998) characterised it as complex products and systems (CoPS). Equally, others (Caron and Fiore, 1995; Hicks et al., 2000) have used the relationship between the manufacturing system and the market to distinguish both the product and process typologies as being Engineer to order (ETO); Make to order; and Make to stock.

Table 1: The attributes of an agile organisation (Source: Yusuf et al 1999; 41)

<table>
<thead>
<tr>
<th>Decision domain</th>
<th>Related attributes</th>
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<td>Integration</td>
<td>Concurrent execution of activities</td>
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<td>Enterprise integration</td>
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<td>Information accessible to employees</td>
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<td>Competence</td>
<td>Multi-venturing capabilities</td>
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<td>Developed business practice difficult to copy</td>
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<td>Team building</td>
<td>Empowered individuals working in teams</td>
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<td>Cross functional teams</td>
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<td>Teams across company borders</td>
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<td>Decentralised decision making</td>
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<td>Technology</td>
<td>Technology awareness</td>
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<td>Leadership in the use of current technology</td>
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<td>Skill and knowledge enhancing technologies</td>
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<td>Flexible production technology</td>
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<td>Quality</td>
<td>Quality over product life</td>
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<td>Products with substantial value-addition</td>
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<td>First-time right design</td>
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<td>Short development cycle times</td>
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<td>Change</td>
<td>Continuous improvement</td>
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<td></td>
<td>Culture of change</td>
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<td>Partnership</td>
<td>Rapid partnership formation</td>
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<td></td>
<td>Strategic relationship with customers</td>
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<td>Close relationship with suppliers</td>
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<td>Trust-based relationship with customers/suppliers</td>
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<tr>
<td>Market</td>
<td>New product introduction</td>
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<td>Customer-driven innovations</td>
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<td>Customer satisfaction</td>
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<td>Response to changing market requirements</td>
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<td>Education</td>
<td>Learning organisation</td>
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<td>Multi-skilled and flexible people</td>
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<td></td>
<td>Workforce skill upgrade</td>
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<td></td>
<td>Continuous training and development</td>
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<td>Welfare</td>
<td>Employee satisfaction</td>
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In make to stock the company produce and keep inventory of the finished product. Make to order company produce after getting the order, while the engineer to order (ETO) company knows very little about what to order and manufacture until after receiving a customer order and development of engineering specifications. Thus the
ETO Company undertakes the design, manufacture, installation and commissioning of a complex system according to highly specialised customer requirements. The offshore engineering construction projects such as the oil and gas production platform is an example (Hobday, 1998; Hicks et al. 2000). Therefore there is distinction between the supply chains of the low volume capital goods sector and high volume products. Hicks et al. (2000) recognises that there is limited research in the low-volume capital goods sector with majority of the research in supply chain management focusing on particular industrial sector. Specifically, most research on supply chain management focussed on the automotive, consumer electronics and related fast moving consumer goods (FMCG) industry. Thus a study of supply chain management in other industries to relate their account in is relevant. Moreover, the prevailing business environment in which organisations operates is underpinned by dynamic customer requirements. Accordingly the need for organisations to become more responsive to changing customer and market requirements is crucial to their competitiveness.

In the context of high cost, high complexity engineer-to-order (ETO) sector such as the upstream offshore oil and gas industry the customer often does not have clear idea of the product features and characteristics. Thus important product features that affect customer satisfaction may not be explicitly specified (Hicks et al., 2000) as of the time of placing the order for the product. The product features emerge as a result of intense interaction between the customer and the manufacturer whereby the manufacturer conceptualises the product based on the evolving customer requirements; this iterative processes is repeated until an acceptable product design is arrived at. This introduces product uncertainty in the product evolution process. Additionally the product is customer specific which yet creates additional process uncertainty. As a result therefore it is impossible to know the type and amount of resource that will be required at the product design stage (Bertrand and Muntslag, 1993). Thus the specific type of resource required is unknown at the start of the project or organising to make the product. Furthermore, there is high degree of customisation of components and the final product while the product volume is low. The business environment is also characterised by market instability and product complexity. Social, economic, industrial, political, demogr aphic, technological and environmental factors affect business operations leading to market instability (Yusuf et al., 2004). Other characteristics of the business environment includes, high safety standards and stringent requirements from authorities (Rolstad, 1991); issues concerning petroleum revenue tax (PRT) that usually affect investment in the whole industry (Bower and Young, 1995). Hicks et al. (2000) observe that bought out items and services account for 80% of the total costs thus highlighting the level of dependence on the supply chain for overall value creation. This also underscores complexity of the supply chain. Key competitive criteria of the capital goods market is cost and lead times with project based organisational management system used for the value creation phase (Hobday, 2000). Project is used due to the temporary nature of the demand and the need for creating a flexible organisational structure to enable production of the final system.

Gunasekaran and Yusuf (2002) contend that the manufacturing systems for an OKP have greater need for agility than commodity product. Agile supply chains to a great extent thrives on responsive suppliers, internal capabilities and principal customers (Little et al., 2000). Kidd (1994) contend that critical dimensions of agility are:
innovative management structures and organisation; a skill base of knowledgeable and empowered people; and flexible and intelligent technologies. Agility here will be achieved through information links to the customer to enable the management of demand and the interfaces to key suppliers to enable responsive procurement.

3 Development of Supply Chain Management

Supply chain management have been defined by The Global Supply Chain Forum as “…the integration of key business processes from end user through original suppliers that provides products, services and information that add value to stakeholders.” (cited in: Lambert and Cooper, 2000; 66). Furthermore, in tracing the evolution of SCM Lambert and Cooper (2000) observed that the term supply chain management (SCM) was introduced by consultants in the early 1980s and have since generated wide interest. Initially supply chain management was perceived as logistics that extends outside the firm to include customers and suppliers. However, SCM is now conceptualised as the integration of all the business process across the supply chain. Thus the new model of SCM encompasses logistics and all the other business functions including suppliers and customers.

Hill (2000) state that companies rarely own the resources and activities to make a product or provide a service from the beginning to the end, including the delivery of the product or service to the customers. Whereas, Richardson (1972) argues, from transaction cost economics point of view, that within organisations activities are either essentially similar or complementary. Extending the assertion further, Loasby (1998; 153) points to the fact that “all firms depend on the capabilities of their suppliers, and every firm which is not a retailer depends on the capabilities of those who provide it links to the final consumer.” Thus some activities in the value stream of the product or service delivery may therefore not be undertaken by the organisation, but rather sourced from external vendors. This brings the need to manage effectively the internal and external phases of the supply chain – both components of the supply chain – as an integrated whole. An integrated operation of the supply chain components will be achieved through coordination (Richardson, 1972).

Supply chain management holds that for the eventual product or service to be commercially advantageous to the organizations involved in its creation and provision, value must be added to the product or service faster than cost (Lamming, 1996). Therefore, this accounts for the growth in significance of the supply chain and effective supply chain management over recent years (Kehoe and Boughton, 2001). Supply chain management is different from vertical integration. Often, vertical integration implies ownership of upstream suppliers and downstream customers (Christopher, 1998). Vertical integration used to be the dominant strategy, but increasing a number of organizations are now focussing on their core competencies (Prahalad and Hamel, 1990), and everything else is outsourced, to create a more responsive supply chains.

Ballou et al.(2000) highlight the development of supply chain management from an “intrafunctional” vision of the channel (made up of suppliers, manufacturers and consumers) toward “interfunctional” and “inter-organizational” one. The scope of coordination associated with the preceding arrangements (intrafunctional, interfunctional and interorganizational) varies from simple harmonization of internal
processes typical of a single site manufacturing facilities – intrafunctional – to the more challenging inter-organizational coordination. Therefore determining which parts of the supply chain deserve management attention should be weighed against organisation’s capabilities (Richardson, 1972) or core competencies (Prahalad and Hamel, 1990). This is important since organisations will tend to specialise in activities for which their capabilities offer some comparative advantage.

3.1 Supply chains versus supply network

All firms participate in a supply chain, from the raw materials to the ultimate consumer (Lambert and Cooper, 2000). Furthermore, rarely do firms participate in only one supply chain; firms belong to more than one chain resulting in supply networks. Supply networks are sets of supply chains describing the flow of goods and services from original sources of raw materials or service creation to the ultimate end customer (Lamming et al., 2000). A supply chains connote linear flow or layout, while supply networks is characterised by complex interaction with other firms and organisations. Supply networks have been typified as an extension of supply chains (Harland, 1996; Lamming et al., 2000). Indeed it is stated that “the emergence of institutional or informal networks, formed by clusters, groups...of firms, appears to be the major new feature of the contemporary industrial economy.” (Belussi and Arcangeli, 1998; 415). Christopher (2000) argued that to succeed in the turbulent global markets, there is the need to harness the respective strengths and competencies of network partners to achieve greater responsiveness to market needs. Therefore, supply chain network is a form of collaboration involving (and extending beyond the traditional) supply chain members.

Bal et al (1999) observe the importance of networks in maximising the benefit of close regional contacts and strong ties between resources. Earlier Porter (1990) had pointed the benefits of close regional networks to include enhanced innovation and new product development. The benefits of regional networks are derived from the following three key attributes: Firstly, network organisations co-located in one region have the potential for enhanced personal interaction, thus leading to increased collaboration through information exchange among members. Secondly the interpersonal interaction evolves over time to engender trust between network members. Trust is crucial to improving time and quality performance (Flynn et al., 1995), and finally networks provide a knowledge base to benefit other organisations. Put differently networks stimulate interpersonal interaction leading to enhanced innovation.

Tomkins (2001) differentiates three hierarchical levels of collaboration: relationships, alliances and networks. A relationship is the bedrock of alliance formation, while a network is more than bilateral relationship or even an alliance. Rather, networks are formed from configurations of alliances and relationships that range from partnerships to simple transactions like buying and selling on a competitive basis or exchange of views or information.

Complementing the infrastructural setup of the supply chain network is the organizational aspect. In appraising the organisational restructuring undertaken as a result of changes in the competitive arena, Miles and Snow (1992) argue that organisations, in the 80s, moved away from the hierarchical centrally coordinated
structure towards flexible structures that closely resembled networks. These networks are mostly clusters of firms or specialist units coordinated by market mechanisms.

Networks consists of three basic variables: Actors, Activities and Resources (Harland, 1996; Pihkala et al., 1999). Actors – either group of individuals or firms – control activities, resources or both. Activities occur when actors combine, develop, exchange, or create resources by using other resources (Pihkala et al., 1999). Essentially, actors, resources and activities relate to different fields of operation in multiple ways. Thus bringing the dynamism of the business networks (Pihkala et al., 1999). Harland and Knight (2001) identified six generic network management roles of an actor: network structuring agent, coordinator, advisor, information broker, relationship broker and innovation sponsor.

4 Understanding oil and gas supply chains

Oil and gas supply chain consists of upstream, focal firm and downstream activities (often modelled as raw material sourcing, production and delivery of oil products undertaken by suppliers, producers and distributors). This categorisation is similar to the established supply chain model consisting of suppliers, producer and customers represented by the supply chains of manufactured goods (New and Payne, 1995; Harland, 1996; Lambert and Cooper, 2000). Although the oil and gas supply chain compares to the nominal supply chain, they are by no means the same. The oil and gas supply chain differs from the supply chain of low value high volume commodity products in the mode of its organisation upstream to extract crude oil (which is the raw material for petroleum products). Moreover studies of industrial dynamics in supply chains have concluded that upstream businesses suffer greater volatility than do downstream businesses (Harland, 1996).

Activities at the upstream end of the oil and gas supply chain can be decomposed into two parts. The first is the fabrication of the equipment to be used in oil production and the second is production of gas and crude oil. Oil equipment is often produced by contractors and suppliers of specialised equipment; on behalf of oil operators. Project form of organisation is used in the oil equipment fabrication. The activities involved with the second part is essentially operations based that is after the equipment for the oil extraction is fabricated and installed the crude oil production will be undertaken until all the oil and the well (reservoir has been depleted). It is in this upstream oil and gas equipment fabrication and subsequent operations that we find the existing mode of classification of supply chains inadequate or in the extreme miss leading. Organising to undertake the activities of crude oil production involve three tiered players; operators, contractors and suppliers. High level of innovation is required in the activities of the contractors and suppliers in undertaking their tasks (Crabtree et al., 1997; Crabtree et al., 2000). Currently there are issues related to lowering of costs of operations associated with oil extraction, long lead time in delivering services by contractors all of which affect the competitiveness of operations of the oil and gas supply chain generally and in the North Sea oil and gas cluster in particular (Peters and Hood, 2000). Another characteristic of the offshore oil and gas production industry is the presence of all the players clustered within a defined geographic location (Hallwood, 1990; Hallwood, 1991). Hallwood (1991) found that instances arise in which oil operators refuse to transact with organisations that are not located...
close to their operations. Additionally, the international dimension of operations and players in the oil and gas industry also brings the issue of agility (particularly speed and flexibility) in their network, organisation and operations (Prater et al., 2001).

Oil and gas have been classified as commodity products as such their supply networks should focus on costs (Fisher, 1997; Miles and Snow, 1987). However the previous classification looks at the final product (for example gasoline and other refined petroleum products) at the point of consumption only, but does not consider the range of complex of activities and companies involved in the exploration and production of crude oil - which is the raw material for refined petroleum products. Indeed the gathering of crude oil is an example of heavy industrial activity in which the production method is complex. Tu (1997) observed that the production method adopted by heavy industries is known as one-of-a-kind production (henceforth OKP). We classified the oil and gas exploration to be OKP because of the similarities between characteristics of the offshore oil and gas industry operations and typical properties of the OKP. It was stated that OKP production method converts the customer’s development ideas or requirements into a product by a ‘once’ successful approach constrained by a “critical delivery date, cost and quality” (Tu, 1997: 272). High complexity and uncertainty are typical of the environment in which high value engineer-to-order (ETO) one of a kind (OKP) products are made. High value OKP are usually specified by the customer and manufactured by engineer-to-order companies where the main order winning criteria is fitness for purpose through innovative product design and development (Little et al., 2000). Little et al (2000) note the propensity for customers to change their requirements over the time of the manufacture of high value ETO product. Thus the ability to respond to the evolving modifications is a prerequisite for success in many ETO firms and requires remarkable agility in the supply chain. The main characteristics of high value engineer to order OKP are as follows (Tu, 1997):

- High customisation;
- “Get it right first time” approach on the product;
- Continuous customer influence through the production processes;
- Optimal or rational utilisation of technologies and resources;
- Prototype-based evolutionary and concurrent approach of product development and production;
- Distributed control and inter-organisational autonomy;
- Virtual company structure and global production; and
- Adaptive production planning and control.

5. Evolution of clusters and industrial districts

Wilson and Popp (2003) gave an account of the nature of cluster life-cycles, network operation and leadership in English industrial districts. There are various aspects responsible for the evolution of clusters and industrial districts. For example, military productions have been cited as instrumental in the creation of high technology firms cluster (Geiger, 2003). Lorenzoni and Ornati (1988) gave an account of the evolution of industrial districts based on firm size, network and boundaries. Porter (1998) argue that history and external factors are responsible for cluster evolution. Included in external factors are things that an organisation has no control over, such as; climatic condition, tax, high quality university or research institute and facilities of similar
characteristics. He characterise cluster development into distinct phases of; birth, evolution and decline. Carrie (1999) drawing from existing clusters contend that clusters evolve through industry participants activities. However, in other regions government seeks to lead the process. For example in Korea, the government directed certain industries to specific cities where suppliers could establish themselves close to customers. Although governmental agencies have a role to play all the stakeholders in economic development have to make their contribution. In this regard, the Scottish Enterprise – a governmental agency – is leading the effort to disseminate the cluster concept and strengthen Scotland’s clusters (Carrie, 1999).

Albino et al. (2000), based on the study of Italian industrial districts identify three main evolutionary stages of an industrial district (ID): formation, development and maturity.

The evolutionary stages are briefly enumerated as follows:

Formation of industrial districts is a result of two main processes:

1. a leading firm within or outside the district decentralises the production carried out by local firms within the industrial district. The leading firm outsource the production of subassemblies to labour-intensive small firms who also reside in the district. These firms are captive to the leading firm, because all their output (or capacity) goes to the “leader” firm, thus firm network is based on hierarchical and exclusive relationships between the craft-based firm and the leading firm. Inter-firm relationships here are stable but task specialisation is very low.

2. growth of a craft-based firms specialising in a particular activity or product within a local area.

In the development stage, there are small and medium-sized firms that are highly specialised in aspects of the production process. There are one or several leading firms that have a focal position in the network. These firms develop specific production or marketing competencies and generally have direct access to the external market. Furthermore, inter-firm relations between leading firms and the SMEs are usually for capacity or specialised subcontracting.

In maturity the firm could pursue industrialisation, decentralisation or vertical integration. Furthermore, the hub firm acquire a leader position within the cluster to strengthen inter-firm relations and coordinate knowledge management processes. Specifically in this stage the leader firm undertakes growth mechanistic - hierarchical - inter-firm relationships. The leader firm could adopt integration – backward and/or forward – based growth strategy through internal investment or acquisitions to internalize competencies. Alternatively, the leader firm would adopt external growth strategy allowing it to focus on few strategic core competencies and establish close relationship with its specialised subcontractors (Albino et al., 1999; Albino et al., 2000; Carbonara et al., 2002).

Pannicia (1999) explores the measurement of performance of IDs and found that external economies of cluster formation positively affects performance. However, specialisation was found to be neither a dominant and empirically relevant feature nor a factor able to ensure the future survival of the ID. That is cluster development is linked to the absolute size of the most dominant industry or business rather than to the specialisation rate as indicated by Italian southern areas - despite the areas high specialisation it could not generate the clustering of enterprises to form a distinct
industrial district. In line with Porter (1998), Pannicia (1999) found that the evolution of industrial district can be activated only after a “critical mass” or threshold of industrial production is generated.

5.1 Clusters and Competitive advantage

The importance of where to locate a company is worth investigating. Indeed decisions about selecting the right location is facilitated by the knowledge of clusters, as multinational corporations look for the right clusters to locate plants, labs and headquarters (Tallman et al., 2004). Some researchers point to the improved competitiveness within clusters in terms of increased productivity of cluster firms and industry, the capability to innovate more, and new enterprise formation (Lin et al., 2005). Porter (1990) proposed the concept of cluster as a factor in competitive advantage. Later on he suggested that part of the competitive advantage derivable as a result of geographical proximity are reduced input costs, development of common supplier base, availability of skilled labour, spill-over of technical know-how and the diffusion of the working knowledge of a particular industry into individuals and firms (Porter, 1998). Porter’s view in part was supported by Carrie (1999) who stated that an important part of any cluster is the network of supporting suppliers. Empirically, Tallman et al (2004) used social models to demonstrate that transaction costs of exchanges are reduced when social relationships are strong among geographically close economic players.

Carbonara contend that industrial districts base their competitive advantages on two distinct aspects: 1) the inter-networking processes and 2) the speed and ease of circulation of information and knowledge. It was asserted that for competitive advantage to function at the cluster level, knowledge must be shared among the firms in the regional cluster (Tallman et al., 2004). However Tallman et al (2004) point to a paradox in clusters by stating that competitive advantage at the firm level requires some knowledge to remain private. Wilson and Popp (2003) stressed the importance of networks as key institutions of governance in clusters and industrial districts. While providing insight into several of England’s industrial districts, they contend that networking is responsible for their growth and development. Extending Wilson and Popp’s (2003) assertion, Casson (2003) identified “good” and “bad” networking in clusters and industrial districts. Good networking is “open, transparent and entrepreneurial…Bad networking is typically closed and opaque…[and] is exemplified by rent-seeking in which…weak clusters [are protected] against external competition (Casson, 2003; 24, emphasis in original ).

Critiques of clusters point to the proliferation of ICTs, and indicate the potential of ICTs to create a virtual world such that factors of production – such as capital, goods, labour – can be sourced easily (Porter, 1994). However, Porter (1994; 1998) argues otherwise and went on to assert that the economic landscape – all over the world – is dominated by what he calls “clusters: critical masses” in distinct locations showing unusual competitive success in one particular fields. For example; world-class mutual fund found in Boston, much more than in other places, Textile-related industries in North and South Carolina, High-performance automobiles in southern Germany and fashion shoe companies in northern Italy. Competitive advantage rests on making more productive use of inputs. This requires continues innovation in process and
product characteristics. It was argued that the capacity to innovate and upgrade draws on the proximate environment in which a business resides (Porter, 1994). Moreover, it is not just what happens inside a company but equally what goes on outside it play significant role in its innovativeness. The immediate business environment contributes to the innovativeness of an organisation. Firms within the cluster share resources that give them competitive advantage (Porter, 1998). Thus, innovation and competitive success is location-based. That is why you will attribute entertainment to Hollywood, finance on Wall Street or consumer electronics in Japan (Porter, 1998).

Productivity affects competition much more than the access to inputs or the level of integration of an organisation (Porter, 1998). In other words, how companies compete affects productivity, but the specific industry in which the competition is taking place is immaterial. For example companies can be highly productive in any industry – automotive, oil and gas, electronics – if they employ advanced manufacturing technology and offer differentiated products and services. But the former is not unique as all industry can access technology or means of differentiation – indeed services can be outsourced to distant suppliers or technology licensed or sourced elsewhere. What is unique is the local business environment, because the ability of a location to have the infrastructure to support a particular production technology differs. For example companies cannot employ advanced logistical techniques without a high quality transport infrastructure. Nor can companies compete in knowledge intensive product or service without well-educated employees. The ability to source these critical inputs depends on locational attributes. Therefore clusters affect competition through (Porter, 1994; Porter, 1998):

- increasing productivity of companies based in an area – local sourcing of inputs reduce transaction costs (Hallwood, 1991). Indeed even where inputs are sourced from a distance, clusters offers advantage (Porter, 1998) as a result of prevalence of complementarities (Richardson, 1972) in the cluster. It is the difference between firms in the same trade that cause them to be complementary in developing capabilities of the industry to which they belong (Loasby, 1998).
- driving the direction and pace of innovation (Carbonara, 2004) which underpins future productivity growth – clusters make innovation opportunities visible and provide capacity and the flexibility for time-based competition (Gehani, 1995) at lower cost. Furthermore, competitive pressure, peer pressure and constant comparison which occur in clusters all spur innovation (Porter, 1998)
- stimulating the formation of new businesses which expands and strengthens the cluster itself – new suppliers thrive within clusters to take advantage of the concentrated customer base which lowers risks and makes it easier for them to spot market opportunities (Porter, 1998). The business risk in this case is mitigated by the level of demand for an innovation as a result of concentration of potential users in a specific location.

Lublinski (2003) contend that innovation performance and productivity can be higher among firms that are geographically proximate compared with geographically dispersed firms. The innovativeness and productivity of firms located in a cluster is derived from the frequent face-to-face contacts which may prove critical to business success.
A summary of advantages of being in clusters and industrial districts is shown in table 2.

Table 2: Advantages of clusters and industrial districts (Source: Lublinski, 2003: 456)

<table>
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<tr>
<th>Marshallian externalities</th>
<th>Porter’s market conditions</th>
<th>Transportation and transaction cost advantages</th>
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<tr>
<td>2. Accessibility to a great variety of specialized intermediate goods and services:</td>
<td>5. Rivalry</td>
<td>8. Trust:</td>
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Marshallian externalities

1. Labour market pooling: Labour costs savings due to a privileged access to specialized skills especially in an environment where firms have non-positive correlations in the temporal variations of their demands.

2. Accessibility to a great variety of specialized intermediate goods and services: Access to a local supplier base that has great product variety and a high degree of specialization.

3. Knowledge (Tacit) spillovers: Access to tacit knowledge in geographic proximity by means of both formal transmittal-processes and informal channels such as knowledge leakages made possible through processes such as inter-firm interactions, workers changing jobs etc.

Porter’s market conditions

4. Demanding customers: Existence of a demanding customer that may lead to higher competitiveness on distant markets.

5. Rivalry: Intense competition within the cluster region leading to better benchmarking opportunities.

6. Complementary services: Sales opportunities for high quality suppliers and related vendors specialized in offering services for the relevant type of business.

Transportation and transaction cost advantages

7. Transportation cost advantages: Transportation cost savings due to geographic proximity especially in the case of Lean (just-in-time) supply contracts.

8. Trust: Transaction cost savings due to a geographically proximate environment that enhances trust-building processes.

Conclusions

This paper attempts to provide the basis for inter-cluster competition. The paper proceeded by reviewing extant literature on supply chain management. It then enumerated the currently established agility attributes, also current supply chain practices in the oil and gas sub-sector was reviewed. Finally, it then explores aspects of the cluster concept that can enhance supply chain agility.
Reference


Lin, C.-H., Tung, C.-M. and Huang, C.-T., (2005), 'Elucidating the industrial cluster effect from a system dynamics perspective', *Technovation*, Article in press.


