MEASUREMENT OF SUPPLY CHAIN FLEXIBILITY: AN INVESTIGATIVE STUDY

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Abstract: *For the last three decades there has been a steady flow of research on the issue of flexibility in the academic literature. However, most of the discussion on flexibility has been confined from the perspective of a manufacturing company as one of the entities of the supply chain. The objective of this paper is to explore the concept of flexibility in supply chain and to suggest a framework for its measurement. In this research, supply chain flexibility has been conceptualised as consisting of five distinct components namely, sourcing, manufacturing, logistics, information technology and organizational flexibilities. To operational this construct, a questionnaire based survey research methodology has been proposed. A survey instrument is proposed that contain the indicator variables for the measurement of the above five latent variables. Structural Equation Modeling (SEM) is proposed for data analysis for possible academic and managerial insights*

Keywords: Supply Chain Management (SCM), Flexibility, Manufacturing, Logistics, Survey research, Structural Equation Modeling (SEM)

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Introduction

In the current context of highly customer centric market place, flexibility has been widely accepted as a major dimension of competiveness for a business. In order to deal with the rapid changes in the global competitive environment supply chain flexibility has become extremely important as it directly impacts a firm's ability to produce, and deliver product service bundles to their customers in a timely and cost effective manner

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1. Literature Review

Academic literature on flexibility describes several definitions of this concept and its various interpretations. In a supply chain perspective the flexibility might be considered as the ability to react to the changes in requirements relating to customers and supplier. Viswanadham and Raghavan (1997) describe flexibility as the ability of a business process to effectively manage or react to changes with little penalty in time, cost, quality or performance. Lee (2004) explains that while speed and efficiency are the foundation, an expanded set of capabilities is required. Supply chains need to be agile and flexible to respond to the uncertain market, adaptable to systemic changes in demand and supply. Lee (2004) further articulates the flexible capability of a company in terms of three distinctive components as:

1. Adaptable: Adjust the supply chain's design to meet structural shifts in markets, modify supply network strategies, products and technologies.
2. Alignment: Create incentives along the partners within the supply chain for better overall performance
3. Agility: The ability of a supply chain to respond to short-term changes in demand or supply quickly and handle external disruptions smoothly.

Fisher (1997) classified supply chains into physically efficient and market responsive ones based on the business strategic priorities. Efficient supply chains focus on offering the product service bundle to the customers at the lowest price while market responsive ones emphasize on rapid new product and design changes, offer broad product lines and are more flexible. He further pointed out that functional products require an efficient process while innovative products, a responsive process.

Beamon (1999) presented a framework for selection of performance measurement systems for manufacturing supply chains. He observed that a supply chain performance measurement system must place emphasis on three separate types of performance measures: resource measures, output measures and flexibility measures, each of them contributing for a supply chain's success. It was maintained that resource measures (generally cost) and output measures (generally customer responsiveness) have been widely used in various models and hence he devised a model to quantify the following different types of flexibilities in the supply chain:

1. Volume flexibility: The ability to change the output levels of products produced
2. Delivery flexibility: The ability to change planned delivery dates
3. Mix flexibility: The ability to change the variety of products produced
4. New product flexibility: The ability to introduce and produce new products.

In a recent study, Swafford et al. (2006) developed a Structural Equation Modeling (SEM) framework for assessing supply chain agility and to study its impact on performance. Using empirical data they developed flexibility and agility scales related to their supply chain agility model, and then tested the model. Their findings revealed that supply chain agility of a firm is directly and positively impacted by the degree of flexibility present in the manufacturing and procurement/sourcing processes of the supply chain; while it is indirectly impacted by the level of flexibility within its distribution/logistics process. The key factors that determine the flexibility attributes of the three critical processes of the supply chain –sourcing, manufacturing, and delivery/logistics. Further, they rendered empirical evidence that a firm's supply chain agility is impacted by the synergy among the three process flexibilities in its internal supply chain.

The SCOR (Supply Chain Operations Reference) model (http://www.supply-chain.org) approach directly addresses the needs of integrated business with balanced measurements.

Metrics in the SCOR model are intended to be decomposed from the SCOR performance attributes. The objective for the organization implementing SCOR is to understand the relationships of their defined metrics between process categories, hierarchical process levels and SCOR performance attributes. SOCR is built around five major processes: Plan, Source, Make, Deliver and Return and covers the key supply chain activities from identifying the customer demand to delivering the product to the customer. The aim of SOCR model is to provide a standard way to measure supply chain performance and to use common metrics to benchmark against other organizations. The SCOR model uses flexibility and responsiveness as one of the categories of 'SCOR Performance Attributes' for business integration.

The flexibility literature has also investigated relationships between various flexibility measures and flexibility drivers such as strategic sourcing and advanced manufacturing technologies. The positive impact of these flexibilities on business performance has also been reported (Narasimhan and Das,1999; Safizadeh et al., 1996).

Agility Vs Flexibility

Agile supply chains are flexible as well as responsive to the needs of the customer. They manage the risk of disruptions and supply shortages by pooling of inventory and other resources. Agility as reported by Yusuf and Gunasekaran (2006) requires the capability to survive in a competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets.

2. Proposed Research Construct

In this study, supply chain management flexibility refers to the latent capability of a firm to effectively configure, develop and manage its business processes to react to changes in the market place. Currently, managers view sourcing, operations and logistics/distribution functions as intimately linked parts of the supply chain, each with the ability to contribute strategically to the firm. Past literature also suggests that supply chain flexibility can be conceived as consisting of three distinct flexibilities: sourcing flexibility, manufacturing flexibility and logistics flexibility. However, in the fast changing supply chain environment, managers are beginning to realise that information technology (IT) and organization structure are the prime movers of improved flexibility as drivers of global competition. It could be strongly argued that IT and organizational flexibilities are new drivers to the mix of

flexibility capabilities that an organisation should have to manage its supply chain efficiently and effectively.

Development of SC flexibility gives firms the capability to efficiently react to the changes in the market place. In this research, SC flexibility has been conceptualised as consisting of five distinct components namely, sourcing, manufacturing, logistics, IT and organizational flexibilities. Past research has examined some of the above flexibilities s separately, as well as their strategic relationships to competitive positioning. However, there is a clear absence of the conceptualisation and examination of overall flexibilities for supply chain management. This study tries to address this research gap by conceptualising the overall supply chain management flexibility as consisting of flexibility in terms of sourcing, manufacturing, logistic, IT and organizational structure. A conceptual framework of the research construct is shown in Figure 1. To operational this construct, a questionnaire based survey research methodology has been proposed. A survey instrument is proposed that contain potential indicator variables for the measurement of the above five latent variables. The next five sub- sections present a brief description of each of the five components of flexibility and the suggested indicator variables for their measurement.

2.1 Sourcing/ Supply

The strategic reach of purchasing, its emergence as a core competence of firms and its role in developing sustainable competitive advantage have been well-documented in the literature. SCM initiatives have helped in realising the strategic role that purchasing plays in a firm's profitability and thus for enhanced shareholder value. Also the recent efforts by firms to concentrate on their core competences and to subsequently downsize the non-core areas have resulted in increased levels of outsourced parts and services. Purchasing has gained recognition from top management as a key process that contributes to sustainable competitive advantage (Easton et al., 2002).

Flexibility of the activities related to sourcing of is a key element s in achieving supply chain flexibility. Sourcing flexibility often limits the ability of a firm to respond to the rapid changing need of its customers. The following indicator variables are suggested to capture the sourcing flexibility.

1. Information sharing with suppliers
2. Collaborative supplier relationship

3. Select suppliers with variable capacity
4. Procurement outsourcing

2.2 Manufacturing/ Operations

Manufacturing/ Operations flexibility has been a topic of interest for many researchers. Flexibility literature is dominated by studies on manufacturing flexibility (Lummus et al.,2005). There has been a steady flow of research on the different components of manufacturing flexibility. Research interest has also focussed on the assertion that manufacturing lends competitive strength to business. The paradigm shift of mass production to mass customisation resulted in initiatives by manufacturing companies not only to introduce new products but also to drastically reduce the product development cycle time. Advanced manufacturing technology such as computer controlled systems and JIT systems are considered as a main antecedent of manufacturing flexibility (Narasmihan et.al, 2004). Manufacturing flexibility could be captured using the following manifest variables.

1. Re-configurable manufacturing
2. Process change
3. Flexible product design
4. Dynamic capacity

2.3 Delivery/ Logistics

Logistics has traditionally been defined as the process of planning, implementing and controlling the efficient flow and storage of goods services and related information from the point of origin to point of consumption. Stock et.al (1998) defined logistic flexibility as the capability of firm to structure, develop and manage the distribution/logistics network to reach the end customer efficiently and effectively. Present day firms are putting in increased emphasis on distribution and initiatives such as third part logistics have helped many companies to improve their customer service by increased flexibility at a reduced cost. The following indicators are suggested for the measurement of logistics flexibility.

1. Responding to global requirements
2. Responding to customer location changes
3. Dependable logistics system or partner
4. Design for postponement

2.4 Information Technology Systems

Firms that have information technology systems aligned with their business models are able to integrate their supply chains both internally and externally. Such integration further creates transparency of business transactions, better trust and long term relationships across the chain. The collaboration with the strategic supply chain members will result in improvements in the supply chain competences. Strategic IT planning, characterises an organisation's ability to match its IT capabilities and development goals with the changing requirements of the business scenario. Lummus et.al (2005) define IT flexibility as the ability of a firm to align information system architecture and systems with the change in information needs of the organization, as it responds to the changing customer demands. The following indicators used to capture this flexibility.

1. Information sharing with partners
2. Integration of internal processes
3. Synchronize hardware and software
4. External integration

2.5 Organizational Flexibility

Flexible organization structure enables firms to align the work force skills to the needs of the supply chain to meet customer service/demand requirements. Organization structure as reported by Stock et.al (1998) involves decisions relating to division of task, authority and set of co-ordination mechanism. Changes in organisation structure would also need to be effected when moving from traditional hierarchical structure to a more flexible one that can foster teamwork and innovation. The following manifest variables are suggested to measure organizational flexibility.

1. Organization structure
2. HR practices
3. Workforce capability
4. Change culture
5. Employee training

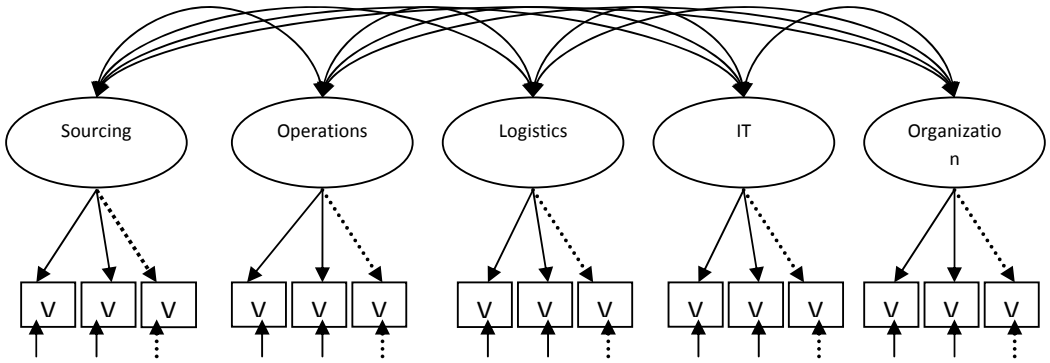

Figure: 1 Conceptual Framework

The model proposed in Figure: 1 suggests that the flexibility of the entire supply chain is a result of the characteristics of the operations systems, the logistics processes, and the supply network at each location in the supply chain. It is suggested that determining whether these characteristics actually result in a flexible supply chain is affected by the organizational design and information systems of each supply chain partner.

Conclusions

Development of supply chain flexibility will be a key determinant in gaining sustainable competitive advantage for a firm in the future. A research construct conceptualising the supply chain management flexibility as consisting of sourcing, manufacturing logistics, organizational and IT flexibilities was presented. To operationalize the construct an initial set of manifest variables have been proposed and a survey questionnaire to capture these variables is being developed. After conducting a pilot study to verify the validity of the instrument, the survey questionnaire is to be administered to a sample of senior managers from the Indian industry for their responses. A structural equation modeling approach is proposed for data analysis. Confirmatory Factor Analysis (CFA) will be carried out to test the data-model fit of these proposed constructs. The individual and the potential synergistic impact of these five flexibilities on business performance would also be explored using suitable structural models.

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