Role of Flexibility in Supply Chain Management

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Abstract: Globalization has completely chained the scope of supply chain scenario in the world. Furthermore, globalization and competition require international distribution and/or procurement of products and services in less time. This leads to intense competition, which forces enterprises to simultaneously control costs, quality and speed. Apart from that, in many sectors in which the customers require wide-ranging product variety, the demand for goods is difficult to predict Flexibility is considered to be an important differentiator in the current market place. This paper presents the impact supply chain flexibility on the supply chains performance of an enterprise.

Keywords: Supply chain Management, Supply Chain Flexibility, Lead Time Performance, Simulation Modeling

Introduction:
A supply chain is a network of facilities and distribution options that performs the functions of procurement of materials, transformation of these materials into intermediate and finished products, and the distribution of these finished products to customers. Supply chains exist in both service and manufacturing organizations, although the complexity of the chain may vary greatly from industry to industry and firm to firm.
Flexibility may be defined as the ability to change or react with little penalty in time, effort, cost or performance [1]. Flexibility can improve the company's competitiveness, particularly for the decision-making process of implementing technologies. Even though there has been a lot of research on the topics of flexibility most of them are confine to inter firm flexibility. Supply chain flexibility is defined to encompass those flexibility dimensions that directly impact a firm's customers and are the shared responsibility of two or more functions along the supply chain, whether internal (marketing, manufacturing) or external (suppliers, channel members) to the firm.

Literature survey:
Most of previous literature on flexibility has focused on internal manufacturing flexibility but with the growing turbulence in the business environment and competition shifting to the supply chain level, the supply chain flexibility is emerging as one of the key competitive priorities for the future [2] .Koste and Malhotra [3] while presenting a perspective on research opportunities in manufacturing flexibility, emphasized that the presence or absence of flexibility in supply chains and its relationship with performance should be explored and the effect of supply chain integration on the development of flexibility in supply chains should be examined. Zhang et al. [4] demonstrate empirically that internal dimensions of flexibility are translated into flexible capacities (volume and mix), which in turn have a significant positive impact on customer satisfaction. Jordan and Graves [5] demonstrated that external flexibility substantially outperform internal flexibility. Olhager and West [6] have recognized the importance of extending the notion of flexibility beyond the factory floor linking it to market requirements and customer needs.

Duclos et al [7] propose a conceptual model of supply chain flexibility and identified six components of the supply chain flexibility e.g. production flexibility, market flexibility, logistics flexibility, supply flexibility, organizational flexibility, and information systems flexibility. They observes that as the basis of competition extending to supply chains and time becoming increasingly important, supply chain flexibility will be a critical issue for competitiveness. Sanchez [8]suggested a framework of supply chain flexibility dimensions that includes both process flexibility (similar to manufacturing flexibility) and logistics flexibility (not included in manufacturing flexibility).

The Simulation Model:

In order to study the performance of supply chain flexibility on system performance, we have developed a simulation model of a flexible supply chain system . At the highest level, the model comprises of a flexible supply chain system connected to the customers and the suppliers. The flexible supply chain system accepts orders from the customers source the required materials from the suppliers and fulfill the customer orders in the best possible way. The flexible supply chain system comprises of a number of supply chains Inter-connected in parallel through an order management system. The order management system accepts the orders for the entire supply chain system and depending upon the level of flexibility and the supplier. We have studied two cases of supply chain

Case I: When the supply chain system operates under no-supply chain-flexibility conditions, each supply chain will be able to handle only one type of product and accordingly the order management system does not have any role to play.

Case II : When the system has different level of supply chain flexibility. Under these conditions each supply chain will handle more than one product type and the order management system will have to take a decision on the allocation of orders to the supply chains. Under these conditions, we have followed the protocol used by Wadhwa et. al. [2]

Fig 1 : Flexible supply Chain system

(a) When the customer order is received, the order management system sends a request for bid to all the supply chains indicating the product type and quantity required.

(b) All supply chains respond to this call and submit their bids for supplying the above quantity. In case any supply chain is not in a position to supply a particular product type, it will send a regret message. In their bids, each supply chain will indicate how many orders it has pending with it.

(c) Based on the bids received from different supply chains, the order management system selects the most appropriate supplier and issues a supply request on that supply chain. In this model, the criteria for selection of a supplier is set to be the minimum number of orders waiting i.e. a supply chain with lowest number of orders waiting to be fulfilled will be selected for issuing the supply request.

(d) Upon receiving the supply request, the supply chain will backlog the order and initiate necessary action to source the materials from its supplier and this process will continue up to the end of the chain.

(e) The supply chain node at the end of the chain is called the end supplier and is modeled to deliver any kind of materials immediately. The materials thus originated travel through the chain back to the customer who placed the order and the time elapsed between the placements of an order the receipt of products is measured as supply chain lead-time performance.

In our study, we have assumed 6 types of product (P1 to P6) and each product has to pass through 4 to 6 levels of distribution channel(D1 to D6) before reaching to the customer. Processing time on each distribution channel is given in the table1 below. Total quantity of product to be processed is 1000. The table given below summarizes processing time of each type of product .Ps indicate processing station and Fig in the bracket indicates processing time.

We have considered different levels of supply chain flexibility i.e. If the part can be processed on two alternate station then, we have considered supply chain flexibility as 2 , similarly, If the part can be processed on three alternate station then, we have considered supply chain flexibility as 3 and so on.

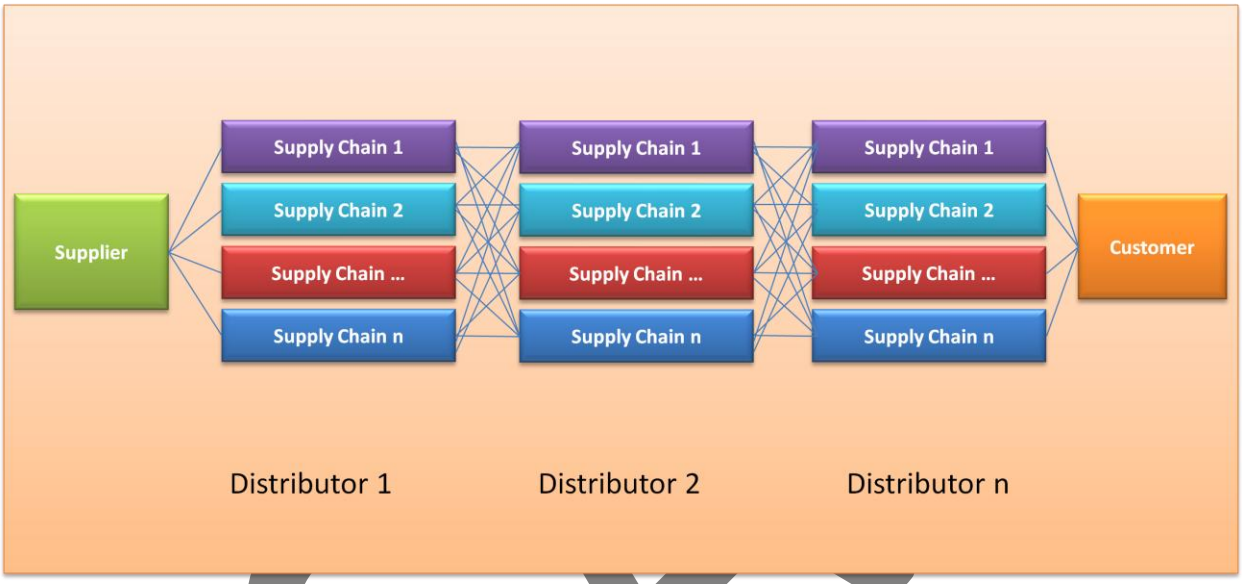

Fig 2 : Flexible Supply Chain system

Table 1: Lead time at Different processing stations

	D1	D2	D3	D4	D5	D6
P1	PS1(40)	PS3(50)	PS4(60)	PS6(70)		
P2	PS4(40)	PS2(55)	PS 6(54)	PS5(80)		
P3	PS5(60)	PS1(45)	PS 3(45)	PS2(65)	PS4(75)	
P1	PS2(40)	PS5(50)	PS 6(50)	PS3(45)	PS2(85)	
P1	PS6(49)	PS4(45)	PS 2(45)	PS5(40)	PS1(55)	PS3(100)
P1	PS3(35)	PS5(45)	PS 4(55)	PS 1(50)	PS6(52)	PS2(70)

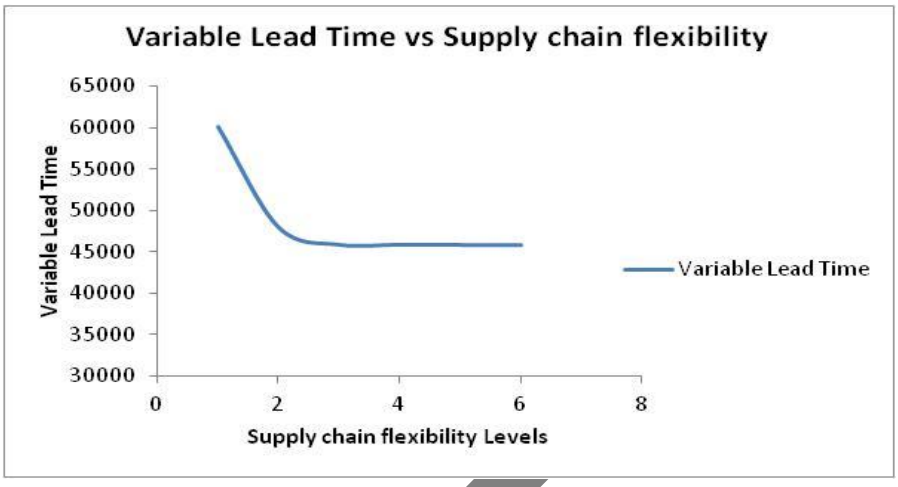

Fig 3 : Variable Lead time vs supply chain flexibility

Effect of Supply chain flexibility on supply chain lead time performance:
From above simulation results, it may be It may be analyzed that

1. Supply chain lead-time decreases with increasing levels of supply chain flexibility. This indicates that supply chain flexibility improve the supply chain lead-time performance of the system.
2. Maximum Benefit of supply chain flexibility may be obtain up to level 2, thereafter, it start giving diminishing returns.

Conclusions:
The paper discussed the development and study of a hypothetical enterprise model. The objective of the study is to understanding the impact of flexibility on the lead time performance of the supply chain. The impact of supply chain flexibility on the lead-time performance of supply chain has been studied with the help of simulation experimentation. For this purpose a simulation model has been developed based on the supply chain operations reference model. The studies indicated that supply chain flexibility positively influence lead time performance of the system. Maximum Benefit of supply chain flexibility may be obtain up to level 2, thereafter, it start giving diminishing returns.
These observations are important for designers and decision makers of flexible supply chain systems to arrive at judicious levels of flexibility to attain better lead-time performance. Further work may be done to take different performance parameters with different dataset.

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