SUPPLY CHAIN RELATIONSHIP STRUCTURES AS SCENARIOS FOR SIMULATION

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ABSTRACT
A supply chain can be defined as a set of relationships among suppliers, manufacturers, distributors and retailers that facilitates the transformation of raw materials into final products. As such any examination of a supply chain system cannot be divorced from the consideration of the types of relationships that exist between the players in the chain. Such strategic analysis will also help supply chain members in deciding who to partner with and what type of relationship would be most useful for the player or the supply chain. Although supply chain management principles advocate close collaboration among all supply chain players this is far from the practice especially where resources and trust are scarce and the winner takes all attitude prevails. The question of whether to integrate or not to integrate and with whom can be discussed by investigating effects and trade-offs from such a venture. Other factors like the impact of the existence and position of a powerful player in the chain can also be investigated.
This paper discusses the issues pertaining to the incorporation of buyer-supplier relationships in supply chain models and the representation of such relationships in the simulation of supply chains.

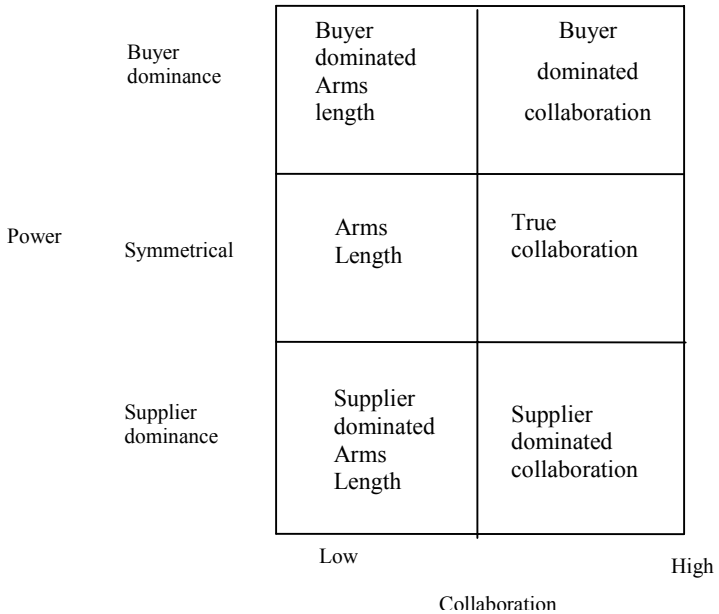
INTRODUCTION

A supply chain is made up of many players, each with specific roles in converting raw materials into finished goods to meet customer requirements. The type of relationship that exists between and among these players holds the key to the success of the supply chain. Hence supply chain management principles advocates close collaboration among all supply chain players. The practice however, is far from the theory especially where resources and trust are scarce and the winner takes all attitudes still prevails. This atmosphere of distrust and wariness among players in the supply chain is still prevalent even more so in a developing economy and in certain industries (Gules et al. 1997; Mudambi and Helper 1998). Hence the types of supply chain relationships that exist usually falls in between arms lengths negotiation to full collaboration or integration. Another development is the consideration of power exerted by certain players in a supply chain. This type of relationship is especially prevalent in the automobile industry (Maloni and Benton 2000). As such power is another variable that gives rise to yet another consideration in supply chain relationships. There is thus a need to explore the impact of such relationship profiles or relationship structures on supply chain performance.

SUPPLY CHAIN RELATIONSHIP STRUCTURES

Utilizing the concept of supply chain structure discussed in Mukhtar et al. (2001) we will now discuss the concept of relationship structure. There are of course various variables that contribute or define the type of relationship between the players in the supply chain. These include formalization, intensity, frequency, standardization and reciprocity (Chow et al. 1995). A combination of these variables will give rise to various different buyer–supplier relationship structures be it collaborative or arms length type of relationships.
Supply chain management literature abounds with evidence of how close collaborative relationships will enhance or benefit the supply chain. (Scott and Westbrook 1991) emphasize that the scope for supply chain enhancement will depend on the nature of the supplier relations in

Figure 1: Relationship Profiles



the chain of which the closeness of the relationship is one of two defining factors. (Pilling and Zhang 1992) stated that long-term cooperation appears to produce more net benefits for the exchange partners than are available from traditional competition-based arrangements. These benefits often enhanced the competitive position of both the manufacturer and supplier, resulting in a win-win situation.

Recent research (Maloni and Benton 2000; Cox 2001) uncovers the role of power and how it affects the relationship strengths and hence the performance of the supply chain. Hence, power is a variable that cannot be ignored in the consideration of buyer-supplier relationships in the supply chain. With this in mind, and taking note of the fact that a supply chain relationship might be anywhere in the continuum of arms length to full collaboration, the two variables i.e power and degrees of collaboration, can give rise to particular relationship structures as shown in Figure 1.

RELATIONSHIP MODELLING CONSTRUCTS

The relationship structures described in the previous section are abstract qualitative concepts. It would be beneficial if such concepts could be interpreted or expressed in quantitative terms. This would enable us to then investigate the tradeoffs or effects of such types of relationship structures on supply chain performance. With this in mind, in this section we will propose a stylised method of interpreting and incorporating the relationship profiles into a simulation model.

Simulation is one of the most popular tools employed in the operational analysis of supply chains. The existence of various supply chain simulation studies (Hieta 1998; Bagchi et al. 1998;Ingalls and Kasales 1999; Archibald et al. 1999; van der Vorst et al. 2000), are testimony to this effect. This type of analysis is valuable as companies and supply chains are always trying to continually improve their performance. In addition to this type of analysis we feel that simulation can be used as a tool to investigate or corroborate the claims made by the conceptual literature for example (Piling and Zhang 1992 and Spekman et al. 1998), purporting the benefits and tradeoffs of the different types of buyer-supplier relationships. In this respect the conceptual literature can be used as a source for indicators that characterize certain types of relationship. For example, Spekman et al (1998) listed high levels of information sharing together with trust and commitment as indicators of a close collaborative relationship.

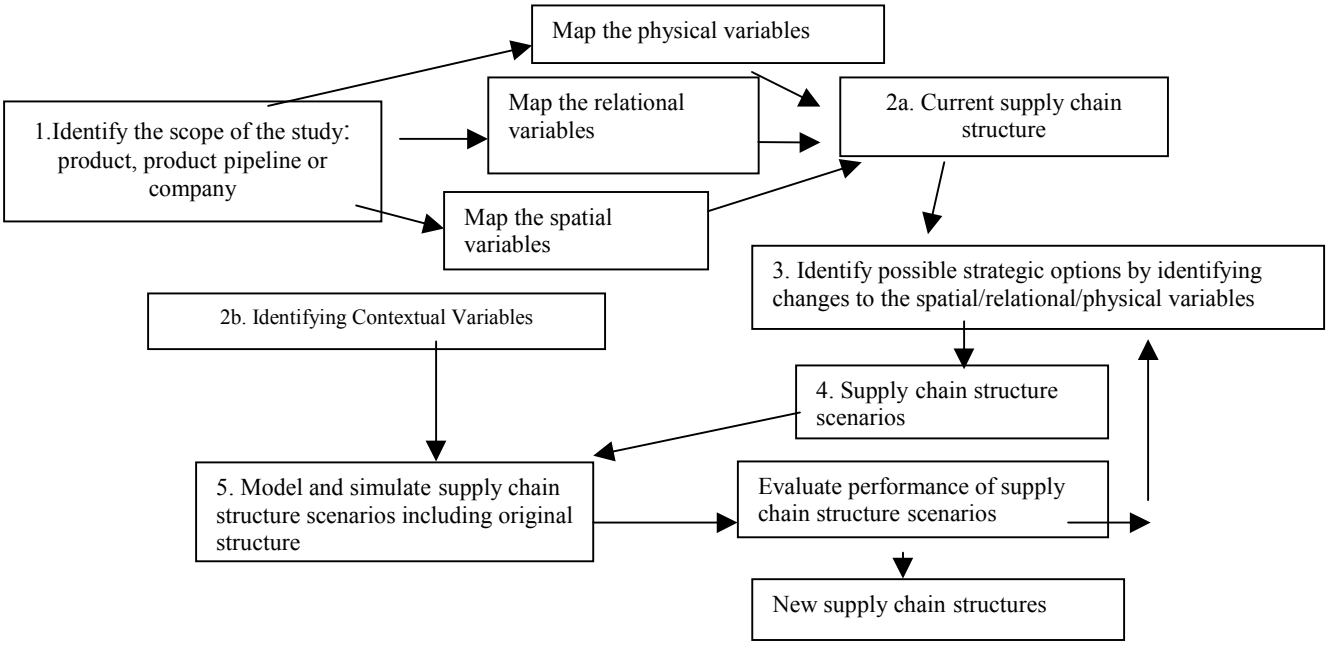
This is utilised for example, by Gavirneni (2001) who used information pertaining to inventory levels and the willingness of the retailer to transfer its inventories as indicators of cooperative behaviour. The author considered three models, which represented three levels of cooperation. In the first model of no co-operation, he assumed that, there is no information sharing between the retailers and the supplier. In this case the only information available to the supplier is via the orders placed by the retailers. In the second model the author assumed that there is some cooperation in the supply chain. Here, in addition to the orders placed by the retailers, the supplier also received information on the current inventory levels of the retailers. In the third and final model, the author further extends the assumptions made in the second model to include the possibility of transfer of inventory from one retailer to another. This they contend represents complete cooperation in the supply chain. Xu et al (2001) contends that a successful implementation of a coordination program means that the manufacturer gains equal access to the retailer's actual demand information, adopts a one forecast policy for both parties and determines the order releases for both parties. This is in contrast to the case where there is no collaboration. In such cases the manufacturer relies on historical order data from the retailer to predict both future ordering patterns of the retailer and true demand patterns of the retailer's customers.

However, besides inventory levels and demand information, other types of information can be shared in the supply chain. Lee and Whang (2000) described various types of shared information including: Inventory levels, sales data, order status for tracking, sales forecast, production/delivery schedule, performance metrics and capacity information. Besides information, speculative and postponement behaviour can also be considered when modelling supply chain relationship behaviour. Postponement and speculative supply chain strategies (Pagh and Cooper 1998) can be used to represent power variables in a supply chain (Mitra 1997). In addition we can also consider five areas where power can be exercised in a supply chain namely pricing control, inventory control, operations control, channel structure control and information control (Munson et al. 2000). Incorporating these considerations we could then develop various constructs to represent the different relationship profiles. For example, we can represent the types of relationship in Figure 1 by using sharing of demand information as an indicator of collaborative behaviour and the choice of postponement or speculation strategies as an indicator of power. An example of these types of constructs is depicted in Figure 2.

Figure 2:Relationship Constructs

Relationship profile	Sample Constructs
• Collaborative (supplier dominance) (*)	• Sharing of demand information Supplier uses the information to forecast, speculate and push products to buyer
• Collaborative (buyer dominance)	• Sharing of demand information Supplier forecast based on information; makes product; delivers product on signal from buyer (logistic postponement)
• True Collaboration	• Sharing of demand information; buyer and supplier conducts joint forecasting and decides jointly on time and size of delivery
• Arms Length	• No information sharing; production based on orders

Figure 3: Supply Chain Structure Scenarios Simulation Framework



The choice of constructs is obviously not unique or exhaustive nor is it intended to be. For example we would model (*) by further assuming that there is a sharing of inventory information as well as demand information and the supplier would only delivers its products at certain fixed truckloads at its own convenience. The level of detail or rigour or abstraction in representing a particular relationship would certainly depend on the objectives of the study. The supply chain relationship modelling constructs, together with the supply chain structure concept (Figure 3) presents a new approach in supply chain analysis.

CONCLUSIONS

This work provides a way of quantifying the buyer-supplier relationship concepts found in the conceptual supply chain literature. Via the relationship constructs we propose a method of incorporating such concepts into simulation models. As the work is preliminary in nature, further refinements in the methodology are needed in order to make it more comprehensive. However we believe that this approach in modelling supply chain relationships in particular and in supply chain analysis in general is worthy of attention and research.

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