

## **Design of supply chains: Unrealistic expectations on collaboration**

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**Abstract.** A major assertion in the supply chain management literature is that there is an economic rationale for integration across the boundaries of firms. The purpose of the paper is to evaluate this fundamental assumption.

Based on review of the relevant literature and the plethora of empirical evidence, two dominant models of supply chain organization have been found. Research findings from the literature for each of the collaboration models (viz. at arms length or tighter coupling) are presented. When such conceptual models are mapped to the real world and tested, it is found that what exists is an in-between state of loose coupling between the vendor and customer. We have endeavoured to determine why and conclude that it is the result of a natural equilibrium. Attempts by interested parties to push this to either end (viz. at arms length or tighter coupling) do not result in benefits at acceptable levels for both parties, and hence are unlikely to succeed.

We advocate that the business context, market forces and behavioural aspects of organizations be well understood before designing an appropriate collaboration framework.

**Keywords.** Supply chains; collaboration model; natural equilibrium.

### **1. Introduction**

Increasing global cooperation, vertical disintegration and a focus on core activities have been visible in the market place. During the past decade many firms have chosen to disaggregate their operations and shed non-core activities (Scouras 1996; Fung *et al* 1998). This strategic posture has created the challenge of coordinating effectively the entire supply chain, from upstream to downstream activities.

Today, supply chains are long and complex, because of product proliferation, multi-channel set ups, global sourcing and so on. Empirical evidence shows that the cost of materials purchased by most manufacturing companies exceeds 50% of total sales, and the amount of goods purchased by most retailers is even higher. This, in turn, has created complex

supply chains consisting of multiple layers where vendors could spread worldwide. A European survey of the supply chain and logistics sector by Kearney (2004) predicts that with increased globalization, for example, supply from Asia Pacific will triple by 2006. The World Trade Organization in its 1998 annual report provides another example of vendors spread worldwide.

In the production of an "American" car, 30 % of the car's value originates in Korea, 17.5 % in Japan, 7.5 % in Germany, 4 % in Taiwan and Singapore, 2.5 % in the United Kingdom, and 1.5 % in Ireland and Barbados. That is, "only 37 % of the production value is generated in the United States" (WTO 1998, p. 36).

It is widely acknowledged that the ability to collaborate with your trading partners across the supply chain is a prime determinant of business success. Leading practitioners like Wal-Mart and Cisco Systems have proved that effective supply chain collaboration transfers directly into superior financial performance.

Also, growth of supply chains and the demand for tighter integration have arisen side by side with the advancement in information technology. Ever-decreasing cost of computing and communication, proliferation of user-friendly PCs and spread of the internet have had a major effect on capability to integrate at different levels, and hence implicitly have enhanced the demand for integration.

However, knowing that collaboration is a worthy goal to pursue and actually setting the processes in place to achieve that objective, are two different challenges (Baiman *et al* 2002). Attempts to unify the firms and to integrate them tightly have met with minimal success in the market place. Strategic differences between companies result in misaligned goals. Manufacturers wish to cut costs of production, while retailers seek product variety and customer convenience.

Further, industry-wide efforts to exploit both economies of scale and scope in purchasing through IT-enabled web-based exchanges have faced several challenges. Covisant, a consortium including GM, Ford, Daimler-Chrysler, Nissan and Renault, like many other IT-enabled exchanges in the chemicals and electronics industries, has not taken off. Even simpler initiatives to bring products under a common codification structure have not succeeded.

Variability in demand and supply is identified as the main culprit affecting the supply chain collaboration. In addition, the bullwhip effect exacerbates it across the partner firms in a supply chain. Additional factors such as initiatives oriented towards the optimization of a sub-part of the system (i.e. JIT, VMI, TQM etc.) also make the supply chain collaboration a difficult task (Lambert 1998).

Further, supply and demand elements of supply chain are still not properly cemented with manufacturing. Nature of product demand (Fisher 1997; Ramdas *et al* 2000), industry clock speed (Fine 1998), varying product delivery capabilities required during the product life cycle (Dowlatshahi 2000), supplier capability (Sako 1992), suppliers' bargaining power (Cox 2001), length of the supply chain (Jarillo 1998), information asymmetry (Desiraju *et al* 1997), interdependency (Milgrom *et al* 1990; Lambert *et al* 1998; Simatupang *et al* 2002) and allocation of decision rights (Jensen *et al* 1992), are some of the detailed factors influencing collaboration across the supply chain.

In this paper, an unbiased view on supply chain collaboration is presented by focusing on the degree and intensity of collaboration. We raise a very fundamental question, viz. what is the level of collaboration that would be feasible and optimal? Is it the same across all firms? If not, what would be the factors which it would hinge upon? An in-depth understanding of these basic issues will help to evolve appropriate designs of supply chains in future.

## 2. Supply chain collaboration

There are many definitions of the term “supply chain collaboration” present in the literature. However, the consensus view is that collaboration means that all companies in the supply chain are actively working together in unison toward common objectives. It is characterized by sharing the information, knowledge, risk and profits (Mantzer *et al* 2000). It is joint action by original equipment manufacturers (OEM) and vendors who cooperatively perform the tasks necessary for the entire supply chain (Pinto *et al* 1990; Bonaccorsi *et al* 1994). Such joint action results in interpenetration of organizational boundaries, because personnel from the two streams share resources and responsibility as they conduct activities in highly coordinated and integrated ways (Borys *et al* 1989).

Collaboration in a supply chain can be defined in many dimensions such as data, processes, systems, policies, decisions etc. In data dimension, data structure, data exchange, data base interface/access or data base unification levels can vary. Business processes can be rationalized, intertwined or strictly sequential. Systems can be common or very different between firms. Policies relating to firms’ operations are another affected arena. Finally, firms can agree to be fully independent (at arms length) or agree for joint decisions on production, price etc (tightly coupled). It is apparent that collaboration can happen at varying levels between a set of firms.

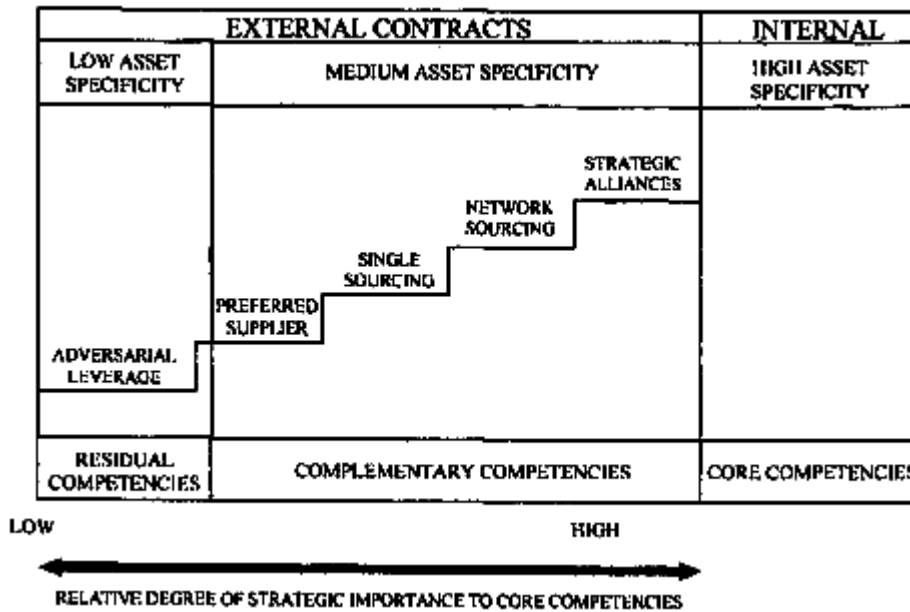
Collaborative relationships in supply chain management may correctly be delineated as “transactional,” “tactical information sharing” or “strategic” (Matchette *et al* 2004). However, our interest in this paper is to discuss different models of collaboration, independent of its level in the organization hierarchy.

## 3. Models of supply chain collaboration

As late as in the mid-nineteen eighties, transactions between buyers and sellers tended to rely on traditional arms-length agreements based on market prices. The nineties, however, witnessed the emergence of relationships based on trust derived from collaboration and information sharing. Handfield *et al* (1999) discussed the importance of trusting relationships in the supply chain and how the sharing of information and assets is essential for successful supply chains. Liedtka (1996) discussed the importance of learning through trust and cooperation but also recognized the difficulties associated with collaboration. In the next section on literature review, two of the seminal pieces of work in this area have been discussed. Different collaboration models have also been identified from the literature.

## 4. Literature review

There is a broad spectrum of collaborative relationship between the buyer and the supplier. This spectrum has been identified in two contemporary concepts: the ACR-OCR framework (Sako 1992) and Relational Competence Analysis (Cox 1996). In the ACR-OCR framework, Sako (1992) suggested there is a continuum of buyer–supplier contractual relations between the poles of ‘arms-length contractual relations’ (ACR) and ‘obligational contractual relations’ (OCR). Sako’s ACR-OCR framework describes two extremes, between which she recognized there is a ‘continuum’ of contractual relations. However, the research work failed to describe any interim relations or how one might interpolate between the two extremes.



**Figure 1.** A step-ladder of external and internal contractual relationships (source: adapted from (Cox 1996).

Cox (1996) also suggests a continuum of buyer–supplier relationships which goes further to define the boundary of the firm and a range of outsourced/quasi-vertically integrated relationships (figure 1). He suggests that this continuum is strategically aligned to the competencies of the firm and their degrees of asset specificity (Reve 1990). This is the theory of Relational Competence Analysis. It considers the total costs of ownership balanced against certain transaction risks to determine a ‘fit-for-purpose’ relationship with the supply-base. Control over core competencies/activities is advocated and those activities which are complementary or residual are outsourced beyond the boundary of the firm through an appropriate relationship with the external supply base.

Hence, two core models of collaboration emerge as we review the literature. One that can be called “at arms length” and the other “tightly coupled”. In addition, El Sawy (2003) and Hagel *et al* (2002) have described a third in-between model and they have called it as “loosely coupled”. We will explore them in detail.

#### 4.1 The “at arms length” model

Economic theory advocates an arms-length relationship between the vendor and the customer for both to get the best out of the relationship. This would be particularly true in a competitive market place, where there are many vendors and many customers and there is very little information asymmetry. Each of the firms acting in an enlightened self-interest mode attempts to provide the best products and services at the most competitive prices and this results in the entire supply chain being very effective. Under this model, the supply chain is managed (a) by building adequate buffers at appropriate stages, and (b) by objective selection and management of vendors.

Traditionally, Buffer Oriented Management (BOM) strategies have been adopted to tackle the issue of demand variance in a highly competitive environment. Increasing the safety stock level, multiple sourcing and multi echelon inventory are its strategic components. Operations research techniques have been called upon to determine the optimal stock levels, purchasing policy etc.

Vendor evaluation, selection and management have been assigned an eminent position in both theory and practice. Many a time, a two-stage process is adopted. Potential vendors are evaluated in stage 1 to identify a sub-set from which items are regularly sourced. Contractual negotiations are carried out and regular suppliers are determined. In stage 2, a separate set of criteria is used to evaluate vendor performance. Incentives and penalties are incorporated based on performance and regular feedback given to the vendors. Various surveys have concurred with this view. Depending on the type of industry and competitive pressures, factors like cycle time reduction and collaborative design have appeared as additional critical factors.

BOM and vendor management strategies are combined to handle abrupt volume changes in demand, need for competitive pricing and for technologically advanced solutions. This is very much the case for highly competitive industry where supply risk mitigation is uppermost in the minds of most firms.

The “at arms length” model calls for the simplest form of interfacing two firms which is to facilitate data transfer at boundary level transactions. Data on purchase orders, shipment and deliveries can be moved electronically from the vendor firm’s computer to the customer firm’s computer. Power of computing and ability to store and analyse mega or giga bytes of data have been exploited to evolve sophisticated forecasting models and tighter and timely management of vendors and transactions and to track shipments.

#### 4.2 The “tightly coupled” model

The rationale for this approach stems from the fact that the supply chain as a whole has to be efficient and cost effective. The competition in future is said to be not between firms but between supply chains. Given the variability in demand and supply sides, the endeavour should be to minimize variability rather than its impact, to cut inventory right across, to avoid stock-out situations and to be the most cost-efficient producer. These are achieved only by tighter integration amongst supply chain partners, across corporate boundaries, the process of producing and delivering products or services (Elmuti 2002; Duffy *et al* 2004)

While integration can happen to differing degrees between data, processes, systems between two firms, many have understood the criticality of the people dimension. They have adopted practices that call for impacting on the motivation and behaviour of vendor firms. These are called behaviour-based management (BBM) of vendors. Zsidisin *et al* (2003) advocating an agency theory of supply risk management, have noted that firms have adopted models of supplier certification, supplier development, joint quality management and even target costing.

In the tightly coupled world, SCM and CRM systems have been designed to enmesh firms at both ends with the ERP systems of the manufacturing firm. The move has been towards “Made to Order” from “Made to Stock” and to synchronize the production and purchase decisions across the supply chain partner firms. The endeavour is to share data not only of orders and shipments but on sales, production, inventory and capacity from the customer end to as many front end partners of the supply chain as possible.

#### 4.3 The "loosely coupled" model

The loosely-coupled model, also known as orchestration (El Sawy 2003), assumes a high flexibility of partner and product reconfiguration. Most loosely coupled designs employ a modular approach where the focus is on defining standardized interfaces across modules of activity. A modular structure is applied to products, processes and supply chain resources so as to enable quick integration with resources and capabilities of partner organizations (Strader *et al* 1998). Modular systems are characterized by loose component coupling. Low interdependency leads to high recombability enabling heterogeneous inputs to be recombined into a variety of heterogeneous configurations thereby increasing product variety (Schilling 2000).

### 5. Current status of collaboration across many industries

In a survey of 150 senior executives at Fortune 1000 companies carried out by the management and technology consultant Accenture, the majority have indicated that developing collaborative relationships in demand and supply planning with trading partners is "very important". Yet, a number of factors prevent executives from going to a higher level. Major impediments include budget and time constraint, information sharing sensitivity, unclear value proposition, technology and data synchronization hurdles (Cottrill 2002). It was found that, when engaged in collaborative supply chain initiatives, manufacturers have encountered several obstacles (Mounkes 2004), including lack of common understanding and buy-in of the concepts.

Also evidence suggests that the scope of collaboration is limited: based on their extensive research with over 50 in-depth interviews and a survey with nearly 600 responses within APICS, NAPM and CLM members, Fawcett *et al* (2002) report that true collaboration beyond first-tier is rare. Automotive action group observed that materials information sent to third- and fourth-tier suppliers often took four to six weeks to arrive and, when it did arrive, was often distorted (Henriott 1999). This also demonstrates the importance of efficient information transfer.

Information sharing in a supply chain faces several hurdles (Lee *et al* 1998). The first and foremost challenge is that of aligning incentives of different partners. The timeliness and accuracy of the shared information could be another major hurdle. Inability to share information between vehicle manufacturers and dealers is becoming a bottleneck in adoption of block exemption rule (BER) in Europe.

A recent study by Supply Chain Council (2002) on the use of IT in supply chain management in large US companies, mainly manufacturers, revealed that although the use of IT has progressed, companies have still far to go. Many supply chain interfaces are not tightly coupled yet, as many upstream companies do not see any use for fixed integration (tight coupling) with their clients. For example, majority of transactions are still done using phone, fax, or mail rather than through integrated systems. Although e-mail has replaced fax in many cases, many first-tier and second-tier companies still use fax and feel that it is sufficient for their coordination needs. This is especially the case when a supplier has many clients that are equal in length (Hagel *et al* 2002).

Another concern associated with information sharing is the confidentiality of information shared. Technology is another constraint in information sharing. Implementation of a cross-organizational information system is expensive, time-consuming and risky. Further it is unproven in terms of supply chain cost efficiency.

It is evident from the above-mentioned cases that technology is not the panacea for all problems – it comes back to the trust issue. There is still some fear in lower tiers that customers only want to look at their systems and methods to take advantage of them.

Often firms unsuccessfully adopt strategic cost management and target costing (Ellram 2000) in their relationship with suppliers. An industry example of this finding is the American adoption of collaborative relationship. In this case collaborative relationship is not based on a handshake, but on technology (Lee *et al* 1998). A study by researcher John Henke Jr. concluded that supplying a component to the Big Three costs 8 % more on average than supplying a similar part to Toyota Motor Corp. or Honda Motor Company, even when it is the same supplier. Higher administrative costs, executive time spent in resolving issues etc. are the culprits.

In some cases (i.e. highly competitive industry), the manufacturer, after implementing systems focused on tighter coupling, employs sophisticated forecasting techniques to mitigate the supply risk without worrying about the cooperation with logistics processes (Pagh *et al* 1998). Ironically, such initiatives end up being the worst alternative since they pile up the costs.

Based on their industrywide survey Elmuti (2002) stress that supply chain integration is critical to success but admit that lack of trust and cooperation among partner firms have resulted in loosely coupled supply chains. In most networks, the loosely coupled structure is found to exist in practice.

Loose coupling is varied in size and scope across firms and industries. It is nowhere near the robust model suggested by El Sawy and others (El Sawy & Omar 2003). Be it in data, processes, systems, policies or people or tactical versus strategic, no single (or common) solution can be identified.

## 6. Analysis and proposition

There is no doubt about the benefits associated with successful collaboration across the supply chain. In the personal computer industry, for example, where collaborative manufacturing processes have evolved rapidly, total productivity growth has averaged a staggering 4.6 % per year for 15 years (O'Marah 1998). However, as discussed earlier, how to set the processes to achieve a successful collaboration model is a major challenge.

There is growing recognition throughout the world of purchasing and supply that there is no single optimum buyer–supplier relationship and that a “horses for courses” approach to employ the most “fit for purpose” relationship is required (Cox *et al* 1997). No strategy is generally superior to the others. Dominance of a particular strategy depends on the specifics of the case; mainly cost distribution and length of terms negotiated (Peleg *et al* 2000). While a more cooperative approach to buyer–seller relationships is on the rise, the more adversarial model still predominates. To be sure, a number of purchasing decisions involve buying commodity like goods, and, for these goods, a more adversarial approach might be more appropriate (Spekman 1988).

Our analysis suggests that there is a trade-off in adopting a particular collaboration model. It has been established that there is little or no trust in the “at arms-length” leveraged contractual relations, leaving the parties vulnerable to the risks of opportunism. The maxim: *caveat emptor* (‘let the buyer beware’) prevails (Sako 1992).

Similarly, though tightly coupled relationship may contribute to higher profitability and greater competitive advantage, for the purchasing manager, risks remain and doubts persist

(Spekman 1988). Buyers at times experience frustration due to loss of flexibility in purchasing. These are exacerbated in times of crisis. Problems with key suppliers – for instance a plant fire that forces unanticipated delays in the shipping of products – can be crippling. Companies with tightly coupled processes can re-source production, but not quickly – and only at considerable expense (Hagel *et al* 2002) due to often inflexible nature of tightly coupled processes and its higher interdependency. At the same time, it demands resources, the attention of management, lengthy negotiations, detailed contracts, and extensive monitoring of performance of the trading partners. In short, the coordination costs are steep and risks are high in case of any eventuality.

It is observed that in real life, tight coupling has been an elusive goal to achieve. In spite of internet and the associated technologies playing a strong facilitation role, firms at both ends have remained stubborn and have limited the extent of cooperation. We should note that information sharing is only an enabler for better coordination and planning of the supply chain. Further it is unlikely that trading partners would be willing to voluntarily place them in a position of dependency and there is little evidence to suggest this is the case. Although trust may be volunteered and reciprocated, there is the risk that it can be revoked on an equally voluntary basis, potentially leaving one party in a position of dependency and vulnerability (Cox *et al* 1997).

Yet researchers continue to stress the need for integration and their efforts are directed towards how to make this happen. Implicit is the assumption here that the vendor expectations are a mirror image of customer firm expectations. We submit that this is an incorrect assumption. Inventory minimization, low cost of manufacture and high quality supply of goods are common goals in general. Vendors no doubt seek to provide high quality products and services at a competitive price. They look for long-term relationships and commitments. They aspire for financial stability. Yet there are factors in which their interests are at variance with the customer firms. For example, they do not wish to share information about their suppliers or material composition; they are uncomfortable when their functional autonomy is curtailed by constant supervision by the customer firm. Vendors seek to de-risk by maintaining functional autonomy, diversifying their customer and industry base and being profitable to spur investments in innovation.

They abhor any attempt by the customer to manage their costs. Sun Beam Corporation and General Motors attempted aggressive cost-cutting with suppliers to improve their bottom line. Jose Lopez de Arriotura, VP Purchase at GM resorted to severe measures of target costing with his suppliers in the early nineties. Yet exactly the opposite results were achieved. GM lost billions of dollars in quality issues, delayed production and lost sales. Even after a decade of this disaster GM could not recover the trust of its suppliers fully.

Michael Porter, through his seminal works, has provided an appropriate framework through which the competitive dynamics of the market place is well understood. The framework identifies the five competitive forces that determine industry competition. These are rivalry amongst competitors, bargaining power of suppliers, bargaining power of buyers, threat of new entrants and threat of substitutes. Hence, the need to study the vendor–customer relationship in a holistic context. Cox (2001) focus on the procurement and supply management space and articulates the need of the power perspective in dealing with challenges faced in supplier management, and distinguishes between “attributes of buyer power relative to supplier” and “attributes of supplier power relative to buyer”. Neither total dependence or independence but interdependence is the solution according to Cox. Certainly “one size does not fit all” (Shewchuck 1998) is a reasonable summary of both theory and practice. It is evident that failure in the market place of acceptance of the tightly coupled solu-



tions can be directly traced to lack of understanding of the market dynamics of the solution architects.

Let us review this from the modelling perspective. As stated earlier, the coupling strength weakens as one move from tier 1 to tier 2 and beyond. No two sequential partners in the supply chain want a solely one-to-one business relationship. Both aspire for a many-to-many relationship as it is fundamental to each party's de-risking strategy. Hence, the supply chain in reality will not look like one single strand linking a set of suppliers but will reveal a complex set of many-to-many relationships. Such a chain can be optimized only by recognizing and optimizing a loosely coupled structure.

## 7. Our proposition

Hence our proposition that supply chains in the real world are far more dynamic and complex to be trapped into either of the models, viz. at Arms Length or Tight Coupling. The loosely coupled structure accommodates the differences in market places, supplier customer power dynamics and behavioural aspects and thus balances between the forces that tend to push it to one extreme or the other.

## 8. Conclusion

The benefits of co-operative efforts are not questioned, but integration is also about trade-offs and tolerance of disharmony. A fully integrated supply chain sounds impressive but is yet to be proven to be the best solution from the perspective of all players. In this paper we have mapped theory and empirical data to show that what exists in reality is a loosely coupled supply chain. In terms of its integration level it varies considerably from one industry to another, even between any two firms within a supply chain. We aver that this is a result of multiple market forces and hence at a natural (and dynamic) equilibrium. As a corollary we advocate that supply chain management research in future be adequately focused on arriving at an appropriate design framework recognizing the economic and human dimensions of the many-to-many relationships inherent in its structure. The loosely coupled structure can be understood in terms of its dimensions and optimality be derived within the specifics of each industry and set of firms. In this context, we further assert that investment in information technology as a solution to integration issues be tempered with appropriate responses to the basic query, viz, "Is it justified in economic and behavioural dimensions?" Only then will the economic rationale reign supreme at the design stage and success be assured during the implementation stage.

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