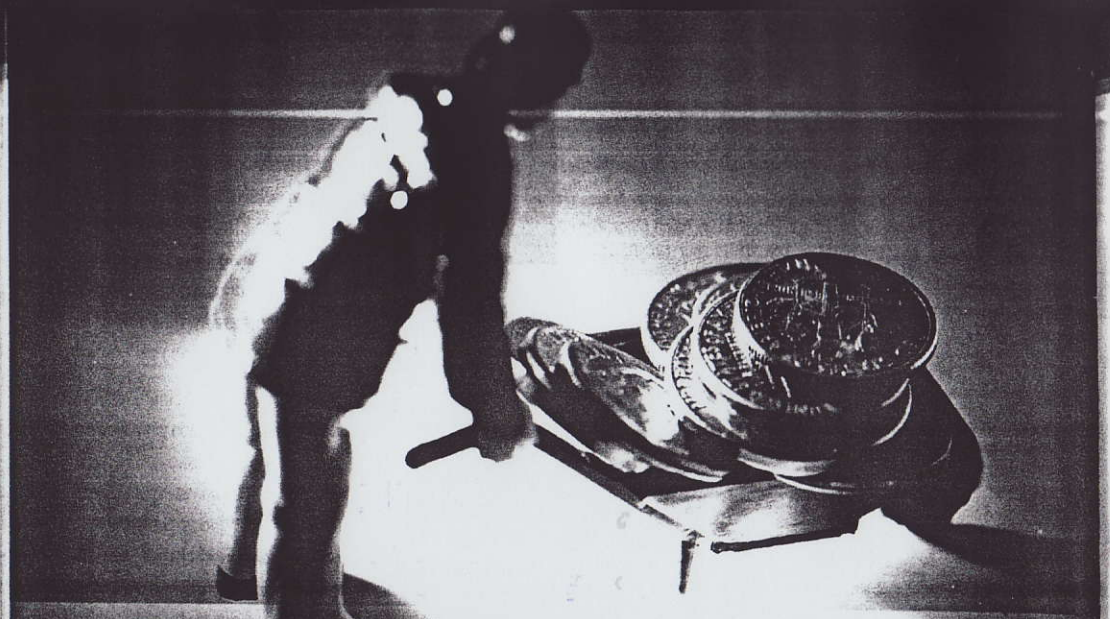

Applying the Theory of Constraints to Supply Chain Management

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Abstract

Supply chain management among independent firms often provide larger benefits from effectively satisfying customer needs and wants than working in isolation. However, many improvement initiatives often end up with devastating effects on supply chain performance. Part of the reason is sub-optimisation among the chain members resulting from a lack of awareness about the importance of the perspective of the supply chain as a whole and the existence of constraint(s). This paper applies the Theory of Constraints as a creative methodology to expose and break constraint that inhibits the chain members from progressing toward profitability. It also suggests opportunities for further research.

Keywords: theory of constraints, supply chain management, and collaboration.

Introduction

The theory of constraints (TOC) has been widely known as a business philosophy that aims to initiate and implement breakthrough improvement that significantly contributes to company profitability. Goldratt (1990) has coined the philosophy of TOC. The TOC philosophy essentially states that every firm must have at least one constraint. A constraint is any factor that limits the firm from getting more of its goal and the goal of any business entity is assumed profitability. Any improvement should be directed to manage constraint(s) and thereby increases profit. TOC comprises both the methodology to deal with constraint(s) and the applications. The TOC methodology consists of a set of tools that helps managers to identify core problems or constraints, find effective solutions, and implement the change to bring real business results. This includes the five focusing process and the thinking process. The application of

TOC initially attempted to resolve core problems in production system such as the drum-buffer-rope scheduling system, performance measurement, and controlling (buffer management) (Goldratt and Cox, 1992). Further development of TOC incorporates marketing, sales, and distribution (Goldratt, 1994), project management (Goldratt, 1997), and supply chain management (Goldratt et al., 2000). Blackstone (2001) provides an exhaustive review of the latest development of TOC.

Over the last decade the development of TOC and its applications have been exponentially grown observed from appearing a myriad number of articles, proceedings, and books based on the TOC approach (Mabin and Balderstone, 1999). Rahman (1998) reviews the TOC approach on manufacturing firms. Siha (1999) applies the TOC approach to address problems in different types of service organisations. Beyond business firms, Klein and Debruine (1995) and Dettmer (1999) used the TOC thinking process to identify core problems in public policies. Womack and Flowers (1999) applied the TOC approach to the healthcare system to improve its performance.

As many firms seek to improve their competitiveness beyond their internal business processes, they attempt to adopt the TOC approach to guide the improvement initiatives to leverage their supply chain performance. Supply chain management is known as the integration of key business processes from point-of-origin to point-of consumption that provides products or services and information that add value for end customers and other stakeholders (Lambert et al., 1998). The application of TOC to supply chain management is relatively new. The TOC ways on supply chain management falls into two broad arenas of managing single enterprise and multi-enterprises. Umble et al. (2001) find that the TOC approach is beneficial to direct the implementation of enterprise resource planning (ERP). Gupta (1997) recognises logistics costs vary from one industry to another and hence it requires different tactics of optimisation. Stein (1999) proposes a conceptual model of locating time buffer at different positions to protect actual demand in a supply chain. Smith (2000) develops a conceptual model to resolve conflicts among different members of a supply chain. Covington (2000) applies the thinking process to identify problems in the apparel supply chain and brings managers from different firms to cooperate in improving the overall supply chain profit.

There are two shortcomings of the current studies on the application of TOC to supply chain management. First, little attention has been paid to clarify the existence of different types of constraint(s) in a supply chain. Lack of clarity of different constraints makes it difficult to identify constraint(s) as well as to devise strategies of improvement. Second, the current studies are silent about disparity of power among the chain members (Munson et al., 1999). Potential benefits of improvement initiatives are often failed to realise simply because differences in market power.

This paper attempts to address two basic questions: what types of constraints are existed in supply chain management? and how does a focal firm influence other chain members to carry out and realise the constraint based improvement initiatives? Two frameworks are suggested to answer these questions. The first framework describes the types of constraints in supply chain management. Classifying different constraints is a crucial task that assists one to identify the existence of constraint(s). The second framework describes strategies for dealing with internal and external constraints and the necessity to influence other partners to eliminate those constraint(s). It is expected that this paper stimulates practitioners and academicians to realise real benefits through applying TOC to supply chain management.

The paper begins with identifying a dilemma in supply chain collaboration and how the traditional approach addresses the dilemma. The next section presents how the constraint-based approach can be used to alleviate the dilemma. Strategies for improving the chain profitability are outlined in the subsequent section.

Discussion and further research provide limitations of this paper and several concepts that require future study. The concluding section summarises the main ideas of this paper.

A Dilemma in Supply Chain Collaboration

Supply chain collaboration can be defined as two or more independent firms jointly to align their supply chain processes that create values to end customers and stakeholders with greater success than acting alone (Simatupang and Sridharan, 2002). Those firms share responsibilities and benefits by establishing a certain degree of collaboration with their upstream and downstream partners in order to create competitive advantage (Spekman et al., 1998). Bowersox et al. (2000) estimate that as little as twenty percent of the scope of improvement initiatives is within the responsibility of focal or individual firm. The rest 80 percent often involve the responsibility of managers from other partners. Thus, joint decision-making is preferable to create competitive advantage such as market access, material sources, and cost-effective transportation.

When all the chain members in the chain integrate and act as a single entity, performance is enhanced throughout the chain because they are able to match supply and demand and hence making more profit (Fisher, 1997). Matching supply with demand means managing supply chain that provides products and service according to customers' needs and wants. Supply chain collaboration can be beneficial if chain members jointly manage a supply chain that suit to their product characteristics. Figure 1 depicts that different products require different logistics requirements (Miles, 1994). Gupta (1997) also advises that three links of logistics processes purchasing, manufacturing, and distribution - have different product cost structures from one industry to another and thereby different approach is required to maximise the benefits of collaboration. For example, fashion apparel firms are often distribution oriented where the majority of inventories are found in the distribution stage. Advanced demand planning is suggested for this industry to plan, make, and deliver the right goods at the right time.

		Process complexity: Low	Process complexity: High
Demand uncertainty	Predictable	Commodity (price) Minimising waste e.g. food, beverage	Durables (providing choice cost effectively) Manufacturing flexibility e.g. appliances, office equipments
	Unpredictable	Fashion (response time and availability) Rapid processes e.g. clothing, toys, footwear, and furniture	Capital Goods (fitness for purpose) Effective design e.g. electronics, cars, industrial machines

Figure 1 Various products with different logistics requirements

When chain members involve in supply chain collaboration, there is a dilemma between accommodating decisions that take into account the interest of other members or the supply chain and preserving decisions in the interest of individual firm. Conflict diagram can be employed to capture and describe the dilemma of supply chain collaboration between taking decisions based on individual interest and taking decisions based on the chain's interest as shown in Figure 2 (see Goldratt, 1994, and Dettmer, 1998, for further explanation of a conflict diagram). The upper path of the diagram in Figure 1 can be read as follows. In order to maximise the benefits of collaboration (O), the chain members must satisfy customers' needs and wants (R1 to O on the diagram) because satisfied end customers bring more sales that positively contribute to the chain profit and customers will only deal with a supply chain if they perceive it delivers value to them. In order to satisfy end customers' needs and wants, the chain members must take decisions in the interest of the overall supply chain (P1 to R1 on the diagram) because maximum customer value can only be created if the supply chain performs in a synchronised fashion.

The lower path of the diagram can be read as follows. In order to maximise the benefits of collaboration (O), the chain members must protect their individual profit margin (R2 to O on the diagram) because chain members only get benefits from collaboration if their profit margin (i.e., bottom line) is enhanced and they are responsible for ensuring high return to their shareholders. In order to protect the individual profit margin, the chain members must take decisions in the interest of the individual firm (P2 to R2 on the diagram) because chain members are in direct control of their individual part of the supply chain and there is lack of linkage between local performance and chain performance.

Taking decisions in the interest of the supply chain (R1) is in direct conflict with taking decisions in the interest of individual member (R2). This is because decisions based on the supply chain frequently incur additional costs that erode individual performance and there is conflicting performance criteria between decisions based on the firm perspective and decisions based on the supply chain perspective. Moreover, chain members often think that supply chain collaboration means a decrease in bargaining power to minimise costs. In many times, an individual member tends to make decision in the interest of individual firm rather than considering the whole picture of the supply chain.

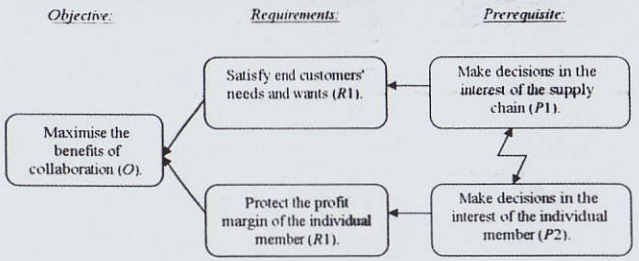

Figure 2. A dilemma of supply chain management

The traditional approach for addressing the dilemma of collaboration remains focusing on cost minimisation at each link of the supply chain and often fails to adapt to the changing demand pattern. Smith (2000) describes this situation as a zero-sum game in which each chain member bargains to save as much as possible costs that often at the expense of the other partners. Poirier (1999) found that retailers with higher bargaining power often impose their suppliers to carry out improvement initiatives such as time compression, inventory reduction, and bar coding system. Lee et al. (1997) discover that chain members suffer from the conflict of decision-making relating to long lead-times, the use of various forecasting tools, shortage game, price fluctuation, and volume and transportation discounts. As a result, decisions apparently bring gains to individual members but have devastating impact on lowered supply chain profit.

Figure 3 shows by means of the logic tree why the path to success is blocked in the traditional approach. The first reason is the flawed assumption of the purpose of the supply chain that is to maximise individual profit (see the left side of Figure 3). The source of profit is the transferring of payments from exchanging inventories among the trading partners because an inventory transaction before the consumption point is assumed to be a sale. Furthermore, the existence of individual accountability indicates a compensation policy that encourages self-optimisation. For example, perverse incentives such as periodical promotions encourage the retailer to sub-optimise its performance through diversion and forward buying at the expense of the overall goal (Buzzell et al., 1990). If the goal is to maximise individual profit and the rewards are based on individual accountability, then each member only take decisions that maximise its own performance. As a result, the individual members tend to think in terms of organisational boundaries, rather than considering the supply chain as a whole. Each firm improves individual profitability by ignoring the impact of it actions to other links of the supply chain. Therefore, in many instances the maximisation of individual performance occurs at the expense of the performance of the entire supply chain.

The second flawed assumption regards to maximising the performance of each part of the supply chain can

improve a whole performance because the prime measure is weight that reflects cost drained by each partner (see the right side of Figure 1). For example, the tendency of the retailer to reallocate inventory to upstream members is an effort to reduce inventory costs at the expense of the supplier. Focus on costs makes the firm reluctant to go beyond its boundary because the improvement effort is good enough to take place inside the firm. Because the traditional approach accepts the analytical approach of improving the individual link in isolation, it neglects the combined effect of interdependencies of the processes and variability (statistical fluctuation) within the process on the chain performance (Goldratt and Cox, 1992). In fact, the performance of each chain member in a supply chain depends on other chain members for its quality, accuracy, and productivity. Any effort to improve the individual chain may be detrimental to its dependent processes (i.e., at the expense of dependent processes) and thereby lead to sub-optimisation (Dettmer, 1998). Furthermore, the individual member spends much effort and incurs expenses (uses up resources) in order to maximise efficiency that does not directly affect chain performance. As a result, the chain members cannot quantify the effect of individual improvements on chain performance.

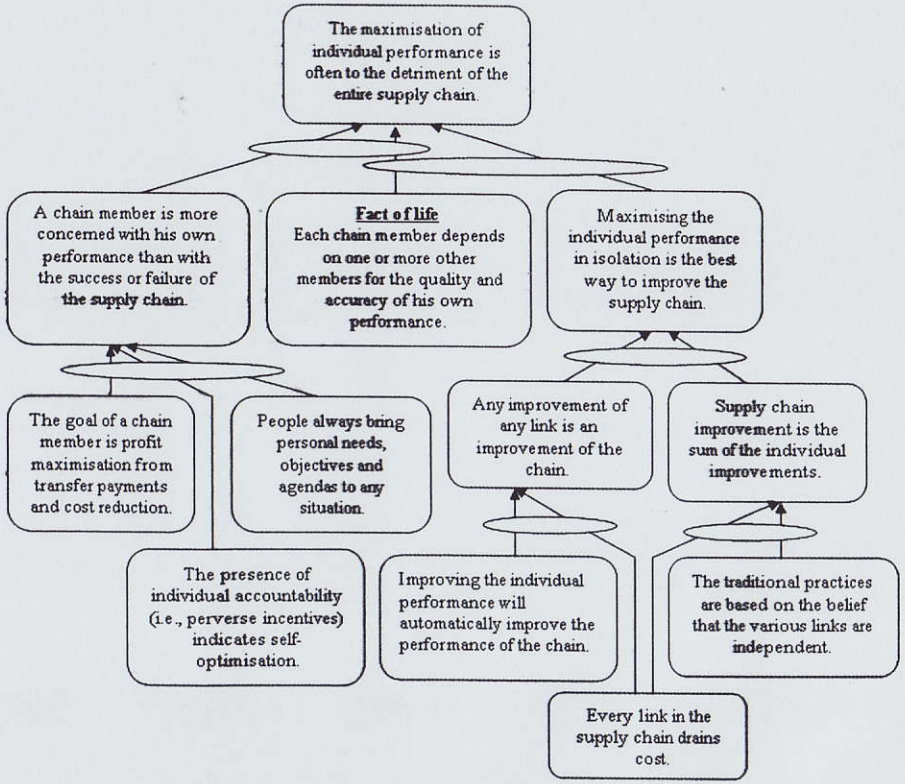

Figure 3. The logic tree of why the path to success is blocked in the traditional approach
(The tree is read IF 'tail of arrow' THEN 'head of arrow'. The oval means AND)

The traditional approach that assumes each link as a single entity fails to maximise the benefits of collaboration. Alternatively, the constraint-based approach is adopted to navigate how to identify the leverage points that need improvement in order to optimise supply chain profitability (see Table 1 for the comparison between the traditional and constraint-based approach). The next section presents this alternative approach.

Table 1. Comparison between the traditional approach and the TOC approach

Area of comparison	The traditional approach	The TOC approach
Purpose	Profit maximisation of the individual member. Source of income is transfer payment between the partners	Profit maximisation of the chain. There is only one real source of income for the whole chain (the end customer)
Customer	Customers are equal and can be served equally (one-size fits all)	Customers are not equal and should not be served equally
Measurement	Prime measurement is "weight" Every link in the organizational chain drains cost, therefore • Any improvement of any link is an improvement of the chain • Global improvement is the sum of the local improvements Result: Every link needs more resources all the time	Prime measurement is "strength" A chain is only as strong as the weakest link, therefore • Most improvements of non-weakest links do not improve the performance of the chain • Global improvement is not the sum of the local improvements Result: Resources are dedicated to the weakest link
Tradeoffs between decision criteria	Choose and accept tradeoffs Priority of decision criteria is cost reduction, whereas others have to be sacrificed	Free from tradeoffs Improving product delivery at the same time with minimum inventory, and at the lowest costs
Information	Based on order and trade deals (the withholding of private information)	Based on actual data (sharing private information among the partners)
Relationship	Push planning Production decisions are based on long-term forecasts	Integrating pull and push planning Delivery decisions are demand-driven and supply-aware (or supply constrained)

The constraint based approach

A flawed assumption underlying the purpose of maximising the performance of each member is that the supply chain performance is the sum of the individual improvements. Due to interdependence of logistics processes along the supply chain, the change of most initiatives will have only a small impact on the supply chain profitability. Only those initiatives that focus on the constraint(s) result in a change in individual performance will have significant change in supply chain performance. Goldratt and Cox (1992) define a constraint as anything that prevents the system from doing more of what is was designed to accomplish. For a supply chain, it would be whatever keeps the chain members from generating more profits. Every supply chain has at least one constraint otherwise it can create infinite profit. Thus the dilemma of supply chain collaboration can be solved if the chain members can identify and focus their decisions on managing few constraints that prevent them from making more profit now and in the future.

Although the theory of constraints recognises the importance of identifying the constraint(s) that prevent the chain members from satisfying a necessary condition or reaching the overall profitability, there is little attention to clarify the existence of potential constraint(s). Agreement about the types and locations of the constraint(s) is crucial to initiating supply chain improvement. Considering the nature of constraint ether physical or non-physical and its location either internal or external, Figure 4 depicts a framework for identifying potential constraints in the supply chain. Physical constraints can take the forms of raw material shortages, limited capacity resources, lack of customer demands, and so forth. Non-physical constraints include obsolete rules, procedures, measures, training, and operating policies that guide the way in which decisions are made. The location of constraint can be either internal or external. Internal constraints are located inside the firm's authority. External constraints can be located before the firm (the supplier constraint), between the firm and the market (the distribution constraint), and in the market (the market constraint).

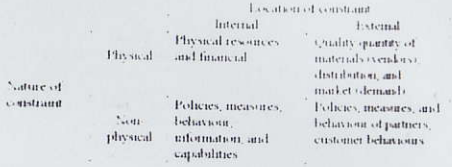

Figure 4 A framework for describing potential supply chain constraints

ways in which the constraint-based approach can help managers improve the supply chain: (1) focusing improvement efforts that have dramatic impact on the chain performance, and (2) providing a reliable change process that ensures the realisation of change initiatives.

Different types of constraints are interrelated with each other. Figure 5 depicts the interrelations among managerial constraints (e.g., policies and measurements), constraints driven by human behaviour (i.e., habits, decisions, and actions), mental models, capabilities and training, and resource constraints. When the goal of the organisation is created, the management creates policies that regulate and guide the behaviour of the firm including measurements to assess the attainment of the goal. However, with changes in the environment around the firm, these policies and measurements are outdated to moderate the behaviour of the system and result in negative impact on system performance. Because people are comfortable with regular habits and predictable outcomes, they still use outdated policies and measurements in making decisions even the business environment has changed. Besides managerial constraints, flawed mental models and past training can also be the constraints that affect human behaviour. Counterproductive decisions and actions cause resources are being used not for maximising profitability. It is very often that physical constraints reflect obsolete policies and inappropriate measurements.

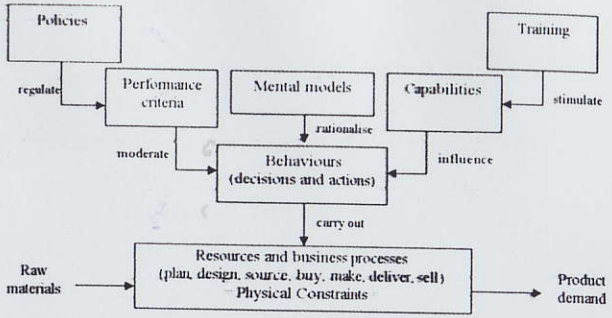

Figure 5. Interdependencies of different types of constraints

The constraint-based approach can be defined as a way of realising productive change that alleviates the detrimental impact of the constraint(s) on chain profitability. The productive change means that the focus on actions of managing constraints(s) can directly leverage the supply chain profitability. There are two

Focusing improvement efforts can be divided into two categories: tactical and strategic initiative. Tactical initiative attempts to solve physical constraints and create effective solutions to supply chain operations. Strategic initiative deals with non-physical constraints such as policies, measures, beliefs, and human behaviour that hinder a firm from improvement of tactical initiative. Tactical and strategic initiatives involve a process of ongoing improvement for any supply chain. This process can be described as follows: (a) the current supply chain profitability is determined and dictated by the constraint that exists within it, (b) the profitability can only be improved if the constraint is permanently removed, and (c) when the constraint is removed, the supply chain moves to higher level of profitability, and immediately encounters another constraint. This process continues again to find and manage a new constraint.

A reliable change means the use of methodology and generic solutions of TOC to carryout out three processes of change: diagnosis of identifying core problems, response of finding effective solutions, and

implementation of ensuring real results (Goldratt, 1990). The TOC methodology consists of the five-step focusing process applied to manage physical constraint(s) and the Thinking Process dealing with non-physical constraint(s) (Dettmer, 1998; Goldratt, 1994). The five-step focusing process comprises steps of identifying, exploiting, subordinating, elevating, and repeating without causing inertia. The Thinking Process consists of a set of techniques to answer questions of what to change, what to change to, and how to cause the change (Goldratt, 1990). Generic solutions include the Drum-Buffer-Rope planning system, the Buffer Management control system (Goldratt and Cox, 1992), the critical chain method (Goldratt, 1997), continuous replenishment (Goldratt, 1994), and performance measurements (Smith, 2000).

When devising improvement initiatives of breaking the constraint(s), managers should evaluate the impact of these initiatives on chain profitability. There are three basic operating measures in TOC that can be used to judge success of optimising chain profitability: Throughput (T, the rate at which the supply chain generates money through sales), Investment (I, all the money the supply chain invests in things it intends to sell), and Operating Expense (OE, all the money the supply chain spends in turning Investment into Throughput). The common measures used to evaluate progress can be in the forms of the chain net profit (T-OE), the chain productivity (T/OE), the chain return on net assets ((T-OE)/I), accuracy of demand forecast, the chain service level (e.g., product availability, fill rate, on time delivery, and stock-out), chain inventory level, and utilisation of the chain constraint.

The constraint-based approach also proposes that both understanding and dealing with the root causes of uncertainty of matching supply and demand are imperative in conjunction with applying information technology to accelerate the improvement process. The idea is that profitability will increase if what the chain members produced should replenish what the market has consumed. This begins with understanding customer behaviour and product life cycle. Customers need to be segmented along different dimensions such as product features, availability, delivery time, quantity and price discounts, and credit terms. Customer segmentation helps managers prioritise orders based on their profitability, key customers, and operational requirements. The entire supply chain then can be categorised into different clusters according to the priorities of the potential orders. In doing so, the mismatch of supply and demand can be balanced. When demand exceeds supply, order commitment can be stimulated by the use of differential pricing for customers who are willing to pay for different products or services and potential orders can be ensured by the use of capacity management for order promising. When supply exceeds demand, ongoing improvement can be carried out to exploit constrained resources and subordinate non-constraint resources to stimulate demand.

Several examples of supplementary tactics can be implemented to increase supply chain profitability when supply exceeds demand. First, compressing the length and variations of total lead-times should be based on different customer segments that want to pay for faster delivery time (Blackstone, 2001). Second, the DBR distribution system that includes replenishment pull signals from the distribution centres and demand risk pooling to lower inventory levels and shorter lead-times in protecting real demand from delivery variability (Goldratt, 1994). Third, the chain members can apply the concept of postponement - that is, to design the products to commit to final product differentiation nearer to the time of purchase in order to reduce costs from risk of inventory and demand uncertainty (Lambert et al., 1998).

Strategies for implementing initiatives

The distinctive feature of the constraint-base approach is that any improvement initiative should be based on the knowledge of constraints because the constraint dictates chain profitability. Constraints can be either internal or external. When the constraint is internal, the

firm can develop improvement across functions to eliminate both physical and non-physical constraints. When the constraint is external, the firm can persuade other partners to carry out the change by presenting the current reality of problems and providing proposed solutions to eliminate the constraint(s). Solving partner's problems means solving problems for the entire supply chain. Blackstone (2001) suggests that the focal firm needs to eliminate external constraint in order to bring back the constraints to inside the firm because internal constraint can be always managed under the authority of the firm.

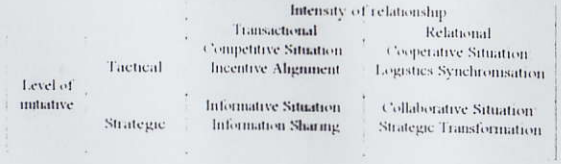

Figure 6 Predominant strategies for dealing with supply chain constraints

However, the implementation of improvement initiatives depends on the intensity of the relationship with the partners. There are two attributes of the relationship intensity: transactional and relational. Transactional relationship refers to independent decision-making among the chain members. This is characterised by clear and high organisational boundaries between the firm and the partners, market driven exchange of goods and money, the market power of economies of scale and customer access dominates the relationship, competition among chain members, one way direction of information. Relational relationship refers to joint problem solving through sharing resources and risks. This relationship is characterised by cooperation in customer focus, exchange of resources (ideas, knowledge, and employees), utilisation of teams, blurred organisational boundaries, and bi-direction of information.

The combination between the level of improvement initiative to deal with supply chain constraints and the relationship intensity among the chain partners suggests four different situations of implementing the solutions. Figure 6 shows the situational matrix that suggests different predominant strategies for dealing with the supply chain constraints. For each situation, a specific strategy is required to influence other parties to realise the desired results.

A competitive situation occurs when a focal firm want to implement tactical initiatives that remove the operational constraint(s) in the supply chain that consists of independent decision-makers intending to maximise their own profits. The chain members relate with each other through market exchange relationships. The predominant strategy of implementation is to influence the partner to synchronise decisions that improve chain profitability through incentive alignment. Incentive alignment refers to the process of designing incentives that stimulate the partners to carry out productive decisions that improve chain profitability. This process also includes identifying and eliminating counterproductive or perverse incentives that negatively affect profitability. The basis of new incentives is the linkages between individual or local performance criteria where the constraint is and the chain profitability.

The aim of incentives is to motivate the partners to relate near-term operations improvement efforts to long-term profitability. While focusing on decisions of exploiting the constraints, the focal firm influence other partners to support the utilisation of constrained resource through exercising dynamic pricing, inventories, delivery times, and channel control (Munson et al., 1999). For example, Wal-Mart realises that end customers appraise product availability and lowered price and cross-docking is an operating tactics at distribution centres that move items from receiving dock to shipping dock without putting them into storage. This tactics significantly improves transit time and transportation cost with lowered inventory at these centres. Wal-Mart imposes its suppliers to provide reliable just-in-time delivery to support cross-docking.

When the market is a constraint, retailers often use transfer price, allowances, ordering schedule, delivery time, product assortment, shelf space allocation, and credit to influence their suppliers to carry out improvement (Ailawadi, 2001). In dealing with external constraints, manufacturers can employ dynamic pricing, revenue management, and brand equity to stimulate demand. For example, manufacturers usually provide various types of concessions such as discounts, inventory, credit, and price protection to influence retailers to hold adequate amount of their brands (Stern et al., 1996).

An informative situation refers to a focal firm that wants to remove non-physical constraints while market transaction dominates the relationship. This relationship often occurs among partners that involve in long-term or repeated business deals. The predominant strategy of implementation is information sharing that is to persuade the partners to share sensitive information used to optimise the supply chain operations. For example, Wal-Mart shares its POS data including sales and inventory levels to its key suppliers. Key suppliers are required to reduce inventory levels, whereas Wal-Mart concentrates on improving customer service. Sport Obermeyer, a skiwear manufacturer, persuades its retailers to reveal POS data especially early sales data after the selling season. This demand visibility helps Obermeyer to improve demand forecasting and create accurate response to changing demand over the short selling season with lowered inventory (Fisher, 1997).

A cooperative situation occurs when two or more firms are committed to realise a quantum improvement in the supply chain's operations, often by improving forecast, increasing speed, improving quality and service, reducing inventory levels, and reducing product development time. Improvements are achieved by implementing logistics synchronisation that streamlines logistics processes to remove constrained resources, restructuring roles and responsibilities, and redefining performance measurements and standards. Typically, chain members encourage their employees to work in teams, work across organisational boundaries, and play a larger role in identifying and resolving core problems. For example, the drum-buffer-rope scheduling system can be used to manage and control the demand, capacity, and material supply of the supply chain (Smith, 2000).

A collaborative situation enables the chain members to regain a sustainable competitive advantage by redefining business objectives, removing non-physical constraint(s), creating new capabilities, and harnessing these capabilities to meet market opportunities. Strategic transformation of cultural change is a predominant strategy in this situation because competitiveness depends on new skills and behaviour that must be infused into the chain member organisations. Strategic transformation means devising initiatives that institutionalise the behavioural change required for long-term financial success (Goldratt et al., 2000). Success depends not only on management's skill in leading a change process but also on how accurate the diagnosis is, which operational or strategic issues to attack, and whether the new behaviours are appropriate for achieving the new supply chain's objectives. Walker et al. (2000) observed world-class firms such as Apple, Dell, and Zara that had succeeded to break non-physical constraints. The managing firm transforms the supply chain into a value net that starts with customer priorities and aligns the firm operations and supplier relations to satisfy real customer demand. Values flow to customers, who receive a faster and tailored offering, to the partners, who have a more accurate reading of real demand, and to the firm managing the network, in the form of a differentiated competitive position, which generates greater profits and market capitalisation. For example, Dell transforms its supply chain to apply customer focus principles and the share of the risks and benefits with partners.

Discussion

The constraint-based approach attempts to apply TOC to supply chain management in order to remove both internal and external constraints that prevent the chain members to optimise chain profitability. Any improvement initiative should be based on the knowledge of constraints because the acts of removing the constraint bring the supply chain closer to its profitability. Since any supply chain has different nature and location of constraint, the improvement initiative should be tailored to suit to supply and demand conditions. The implementation of initiative also depends on the intensity of relationship among the chain members. Different level of initiative and the intensity of relationship suggest different types of relationship situations. In each situation, the focal firm should devise a predominant strategy to influence other parties to carry out productive change.

This approach can be used to aid the market power approach to employ instruments that have significant impact on removing the constraint(s). Appropriate use of power instruments such as economies of scale, prices, market access, and information superiority can motivate other partners to focus on the real leverage points of improvement. Future study can be proposed to apply the TOC approach to align incentives that have significant impact on profitability. Furthermore, while the escalating number of research of supply chain collaboration often regards enablers and impediments (Mentzer et al., 2000) and a technique of collaborative planning, forecasting, and replenishment (Ireland and Bruce, 2000), the constraint-based approach propose a novel proposition that the improvement must be based on constraint(s). In other words, supply chain collaboration can take advantage of the TOC methodology of wide-system perspective to match supply and demand. Its primary contribution is to identify the constraint(s) with effect-cause-effect logics and suggest steps to implement the change. However, the TOC methodology only aids in devising tactics to guide dramatic improvements and lacks techniques of improvement such as the principles of capacity management, time compression, forecasting, pricing, and revenue management. Further research is required to combine the TOC methodology and techniques of logistics management.

The TOC methodology falls into functionalist thinking that assumes the agreement on the common goal (Mears-Young and Jackson, 1997). A health care system such as a hospital, for example, consists of multiple stakeholders who have different perspectives of the common goal. In this system, the constraint(s) are extremely difficult to identify and the constraint-based approach thereby has little impact to help improve performance (Foote et al., 1999). A focal firm also often face resistance to change because of contradictory goals and performance criteria with other partners. Further research is important in order to be able to apply TOC to overcome resistance to change against improvement initiatives.

The TOC approach to supply chain management currently focuses on the forward supply chain. Generic solutions include the Drum-Buffer-Rope method, continuous replenishment, and the critical chain method for new product development. Yet, there is no report on the effectiveness of the approach when applied to reverse logistics. Reverse logistics deals with managing both return products heavily driven by customer returns, and product packaging that involves recycling product such as plastic and cardboard to reduce disposal costs. Nowadays, reverse logistics is becoming more important because of liberalised returns policies and a growing emphasis on customer service and part reuse especially for automotive spare parts and perishable products (Carter and Ellram, 1998). The route of the supply chain has been widened to accommodate the backward flow of goods from the customers to the suppliers. The combination of fast response on forward logistics and proactive reverse logistics leads to a unique capability of the supply chain. This is worthy of future research.

Conclusions

This paper has provided the conceptual framework for using the TOC approach to improve supply chain collaboration. The goal of any collaboration is to increase profitability and at the same time reducing inventory and operating expense. As a prerequisite to ensuring profitability, the focal firm must be able to quickly identify and remove the constraint(s) and effectively collaborate with the best partners to ensure they can continue to meet the changing customer requirements.

Based on the level of improvement initiative and the intensity of relationship, four types of situations of implementing improvement in a supply chain can be identified: competitive, informative, cooperative, and collaborative situations. Each situation aims to remove the constraint and requires different implementation strategy. Instead of using power to manipulate behaviour, the strategy is use power to make change that creates profitability.

The TOC approach consists of various techniques such as the thinking process, the five-step focusing process, and generic solutions to solve problems of matching demand with supply. These techniques help the chain members to identify the root causes of undesirable business effects, expose flawed assumptions, and implement productive change. This approach is useful to enable firms to devise road maps of how to navigate real improvements for the synergistic supply chain. However, the application of TOC should be adopted with care due to its intensive training requirements and functionalist thinking that assumes agreement on the common goal. Further research is required to refine the TOC approach in dealing with contradictory goals and asymmetric power, misaligned incentive problems, and reverse logistics.

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