

THEORY OF CONSTRAINTS AS AN EFFECTIVE TOOL FOR SUPPLY CHAIN MANAGEMENT

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Abstract: Supply chain management is focused on achieving better results (larger benefits) for all involved parties, than achieved by working in isolation. However, a lack of awareness about the existence of constraints along the supply chain, or lack of knowledge how to overcome it, decreases the benefits of collaboration. This paper attempts to show how to apply the Theory of Constraints approach to overcome typical strategic conflicts in supply chain management. It presents how the philosophy of the Theory of constraints can be used to improve the general framework for cooperation in SCM.

Keywords: supply chain management, theory of constraints, thinking process, system approach

1. Theory of constraints (TOC) – the idea

The Theory of constraints (TOC) is a philosophy [1] that implemented significant improvement in management through focusing on a constraint that prevents a system from achieving a higher level of performance. The Theory of constraints is a concept that emphasizes the role of constraints in limiting the performance of an organization. A constraint [2] is as any element or factor that limits the system from doing more of what it was designed to accomplish (i.e., achieving its goal). A constraint can be capacity, market, or time constraint. Constraints interact to reduce throughput. Moreover, the key to the theory of constraints is to assume that any system can be presented in the form of a chain of events, or a network of chains [3]. This paper is aimed to present a system approach known as the thinking process (TP) of the Theory of constraints in order to identify constraints and critical success factors in supply chain management, and to understand causal relationships between these factors.

TOC knowledge covers the following areas of management [4]: operation (production) management (Make to Order (MTO) environment and Make to Availability (MTA)); Project Management – CCPM – Critical Chain Project Management; distribution and supply chain management (supply chain integration, inventory management, distribution, reverse logistics, just in time deliveries, storage and end user distribution, pick and pack, track and trace); finance and measurements (Throughput Accounting); sales management; marketing (developing market offers), managing people; strategy and tactics (developing a company).

In literature [5] one can find simple example that explains the idea of thinking process in the theory of constraints. Consider situation where five ships enter the port the same time. Each ship requires 5 person-days to unload the delivery. Each owner wants his ship unloaded as soon as possible. The port resources are five people to unload the ships. The simplest decision is to assign one worker to each ship, and in that case, if started right away

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each ship is unloaded on the end of the fifth day. But using TOC thinking process means putting all five resources on first ship the first day, all five resources on second ship the second day, third ship the third day etc. Table 1 shows, that the result of the process is much better.

Table 1

Unloading of ships

Ship	New (days)	Old (days)	Saved
1	1	5	4
2	2	5	3
3	3	5	2
4	4	5	1
5	5	5	0

The example illustrates the process of overcoming the constraints, and worth noticing is the fact, that it refers to situation where nobody loses, four of five clients (ships) are done sooner on zero extra costs.

Thinking process in the Theory of Constraints provides a set of holistic processes and rules, all based on a systems approach, that exploits the inherent simplicity within complex systems through focusing on the few “leverage points” as a way to synchronize the parts to achieve ongoing improvement in the performance of the system as a whole [6]. The philosophy of TOC is based on three simple assumptions [6]:

- *Basic Assumption 1:* Everything within a system is connected by cause and effect relationships. Identification of the causes leads us to converge onto an apparent core problem/contradiction/conflict.
- *Basic Assumption 2:* All contradictions can be resolved without compromise – our level of understanding and our assumptions hold the contradiction in place. A compromise is not usually a win-win solution.
- *Basic Assumption 3:* There is no resistance to improvement – people do not embrace change because we have not brought them to see the win for them.

The working principle of TOC provides a focus to ensure effective ongoing improvements. The principle consists of five focusing steps [7]. The steps are:

1. **Identify the system’s constraint(s).** These may be physical (eg. materials, machines, people, demand level) or managerial. It is important to identify these constraints and also necessary to prioritize them according to their impact on the goal(s) of the organization.
2. **Decide how to exploit the system’s constraint(s).** If the constraint is physical, then the objective should be to make the constraint as effective as possible. A managerial constraint should not be exploited but be eliminated and replaced with a policy which will support to increase throughput.
3. **Subordinate everything else to the above decision.** This means that every other component of the system (non-constraints) must be adjusted to support the maximum effectiveness of the constraint. Because constraints dictate a firm’s

throughput, resource synchronization with the constraint will lead to more effective resource utilization.

4. **Elevate the system's constraint(s).** If existing constraints are still the most critical in the system, rigorous improvement efforts on these constraints will improve their performance. As the performance of the constraints improve, the potential of nonconstraint resources can be better realized, leading to improvements in overall system performance. Eventually the system will encounter a new constraint.
5. **If in any of the previous steps a constraint is broken, go back to step 1.** Do not let inertia become the next constraint. TOC is a continuous process and no policy (or solution) will be appropriate (or correct) for all time or in every situation. It is critical to recognize that business policy has to be refined to take account of environment changes.

In general terms dealing with constraints during the implementation of the five steps, requires making three decisions [8]:

1. Decide what to change – identify the weakest link.
2. Decide what to change to – design a stronger link.
3. Decide how to cause the change – operationalize this stronger link into the chain.

For each of these questions TOC thinking process offers different tools that helps to focus and reach the goal (Table 2).

Table 2

Thinking process' tools and their roles [9]

Generic questions	Purpose	TP tools
What to change?	Identify core problems	Current reality tree
What to change to?	Develop simple, practical solutions	Evaporative cloud Future reality tree
How to cause the change?	Implement solutions	Prerequisite tree Transition tree

It is not the purpose of this paper to discuss these tools in detail. For a detailed discussion readers are referred to [10], [11], [12]. The purpose of this study is to indicate areas where logistics and scheduling aspects of TOC offer tools to improve the synchronization of the flow of materials and services from the initial contact with customers through the downstream support and service activities.

2. SCM in TOC

Many attempts have been made to study factors influencing the performance of supply chains. These studies are generally quantitative and involve rigorous statistical analyses. But in general, one would agree that a supply chain has a key leverage point, the point where the potential output of the system is defined. And if, on the other hand, the system's leverage point (or points) are the critical factors in determining the rate of a system's return,

then to maximize returns, strategy implementation must be focused around maximizing the system's leverage points and their interactions with each other. The Theory of Constraints in supply chain management is a process to identify, exploit and manage a system through its leverage points and their interactions. The first areas to look for leverage points should be among the interactions in SCM framework. The SCM framework consists of three closely interrelated elements: the supply chain network structure, the supply chain business processes, and the supply chain management components (Figure 1).

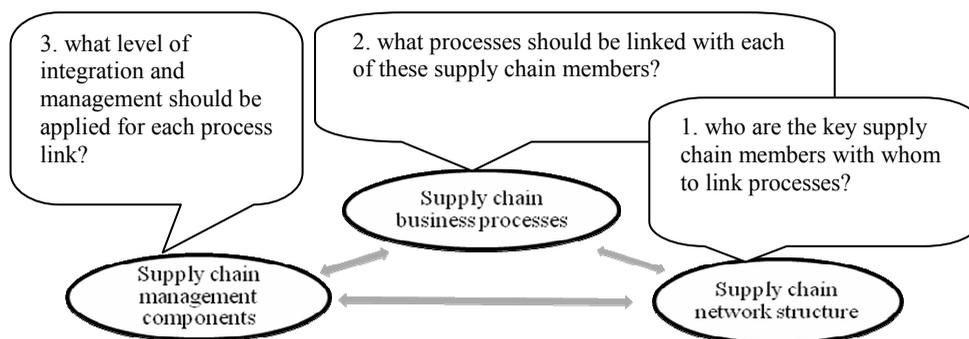


Figure 1. Supply chain management framework: elements and key decisions [13]

According to what was mentioned above at the heart of TOC is a five-step procedure that enables to plan the overall process and focus attention on the resources with the greatest potential to be affected by changes to the system. In supply chain management usually the first questions that should be asked in order to define constraints' areas on strategic thinking level are:

1. referring to supply chain network structure: who are the key supply chain members with whom to link processes?
2. referring to supply chain business processes: what processes should be linked with each of these supply chain members?
3. referring to supply chain management components what level of integration and management should be applied for each process link?

After applying TOC's thinking process tools to SCM strategy it is relevant to look at SCM from tactical point of view (Figure 2).

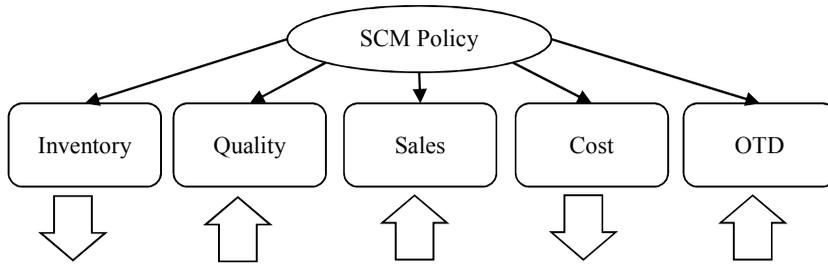


Figure 2. Tactical Objectives for SCM

It is clearly visible, that main tactical issues in SCM often come into conflict with each other. Most common conflicts are: costs reduction versus quality improvements, inventory reduction versus limitation of OTD (order-to-delivery) time. In TOC this types of conflicts are usually presented and managed with logical clouds. Figure 3 presents this sort of typical conflict of distribution systems.

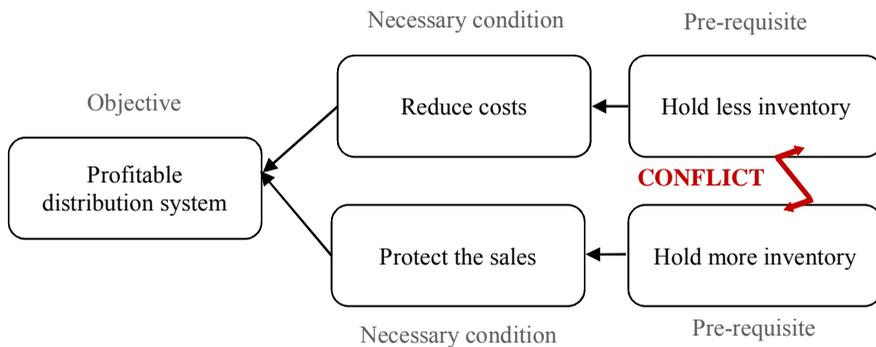


Figure 3. Generic conflict of distribution systems

The typical conflict in distribution that blocks the maximization of SC performance, is a trade-off relation between ensuring the availability of products to the end consumer while simultaneously reducing the logistics costs of these distribution systems [14]. Typical result of living with this conflict is the constant search (often solved through mathematical modelling) for better ways to predict demand, so that optimal inventory levels are maintained at each site and for each product [15].

Moreover, traditional approaches for SC performance measures fail when they assume that if each chain member is managed as a separate entity and its performance is maximized, the benefits of the chain as a whole will also be maximized. In fact, this attitude is wrong, and behind it there is another generic conflict in SCM (Figure 4).

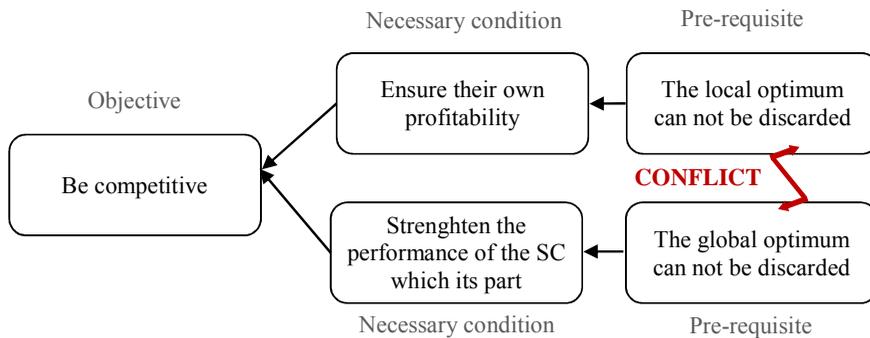


Figure 4. Conflict between local and global optimum in an SC [17]

This conflict shows, that usually incorrect performance measures are being used to evaluate each area, or that the rules that govern the business relationships between the companies are erroneous [16]. To eliminate this conflict, a fundamental question should be asked: at what moment does a sale occurs? According to TOC, a sale should only be acknowledged when the final SC customer has concluded the purchase, and creating optima measures with this simple and obvious idea in mind will significantly improve the SC performance[18]. It means that the improve of the whole supply chain management implies not only improving each company inside the chain, but in particular the cooperation between those companies.

3. Summary

In this section, to sum up TOC key principles for supply chain management authors based on Institute of Management Accountants and Arthur Andersen LLP strategic cost management study, where several guidelines for strategic approach are listed [17]. The list is formulated in the following way:

1. *Visualize processes/organizations as chains.* This is crucial to TOC, because it enables finding the weakest links, that can be strengthened then. The linkages in question can be between the different steps or activities in a process or between diverse organizations within a supply chain.
2. *Understand the conflict: local versus system optima.* Because of interdependence, the optimum performance of a system as a whole is not the same as the sum of all the local optima. A chain that maximizes the activities of every process will not perform as well as one that ensures optimization of the flow and value created through its linked set of activities.
3. *Use “cause and effect” thinking to find the constraint.* It helps to focus on significant constraints, not on symptoms only. Capturing the essence of cause and effect within the system and identifying measurements that emulate these relationships are the keys to optimizing system performance.

4. *Look for policy constraints.* Most of the constraints faced in systems originate from policies, not physical things. Physical constraints can be objectively identified and dealt with. Policy constraints are much more difficult to identify and deal with (e.g. behaviour patterns, attitudes, lack of information, and assumptions) and are potentially more damaging.
5. *Plan total system impact.* All organizations are systems made up of interdependent activities, each with its own level and type of variability. In order to optimize performance, management needs to understand and focus on the total system impact of a decision or event, not just on its local or immediate effects.
6. *Do not forget about resistance to change.* In most cases, resistance to change comes from disagreement with the initiator of the change. There are potential six layers of resistance to change: disagreement on what the problem is disagreement with the direction of solutions, disagreement that the solution will bring the desired benefits, fear that the solution will result in negative consequences, obstacles to implementation, intention of doing nothing. To implement the TOC solution successfully, the resistance to change must be overcome by TOC thinking process tools.

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