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Full Length Research Paper

Systematic process analysis in industrial business management: A practitioner tool kit

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The increasing labor cost had eroded the benefit of the manufacturing industry gradually. To revise the business process and to formulate a strategy in order to survival became an important lesson. Since the Supply Chain Council developed the supply chain operations reference (SCOR) model, it was widely applied by many enterprises to describe its relationship within upstream and downstream companies. The supply chain relationship could be strengthened by SCOR where the problems in the inter-organization were formulated and solved. However, the traditional SCOR model had limitation in describing detailed process (so called the third-tier process) and the way to identify the critical problem within the supply chain. This research developed a systematic methodology to evaluate the critical process which combined the SCOR model with TOC (theory of constraints) Logic-Trees. A tool kit was also designed to analyze the supply process systematically which was illustrated by a case study. The result represented that the practicability and benefit of the tool kit. It was also a reference guideline for the manufacture to refine on their business process.

Key words: Supply chain operations reference model, theory of constraints logic-trees, business process reengineering.

INTRODUCTION

The manufacture industry in Asia is facing the challenge of meager profit caused by the increasing labor cost. The companies are forced to revise their business process for better competitiveness in the supply chain. The business process analysis and the business process reengineering (BPR), therefore, become the cornerstone of whole activities (Chen and Tsai, 2008). According to the research of Zhou and Chen (2010), BPR can be decomposed into business reengineering at strategic level and tactical level and process reengineering at operational level. It is also corresponded to the conclusion made by Herzog et al. (2009) that the successful BPR should always be correlated with manufacturing strategy in the supply chain. Meanwhile, the issues in supply chain are discussed ceaselessly and they are still evolving with time. Many studies have discussed the relationship between supply chain process maturity and the ability to adapt the change (Mentzer et al., 2000; Horvath, 2001; Cassivi, 2006; Vereecke and Muylle, 2006).

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The managers also adopted large-scale information systems to solve the related issues, but the corresponding performance of the systems is limited (Chan and Chan, 2009). Some other study finds that it is critical to integrate the supply chain process and to concentrate on the core problems for better flexibility in those cases (Reutterer and Kotzab, 2000; Chan and Chan, 2009; Aghdasi et al., 2010). By doing that, company can therefore strengthen its competition in the supply chain environment (Zaheer et al., 2010). In practicality, the supply chain problems involving with process performance are usually complicated and dynamic. Managers and consultants are interested in figuring out the relationships among each component of supply chain partners, and developing a tool kit to optimize the process performance in a Business to Business (B2B) environment. A B2B supply chain is a network based operations that require timely availability of information through the system in order to streamline and to synchronize flows of materials, products, and information among all participants. Concentrating on B2B supply chain process will bring company more competitiveness (Samiee, 2008). Although the supply chain process problems are usually complicated and dynamic, there are fortunately some simple steps we can take to solve these problems.

This research mainly discusses how to use a systematic tool kit to improve supply chain processes in the B2B environment and applies it in the manufacturing industry.

SUPPLY CHAIN PROCESS ANALYSES IN B2B ENVIRONMENT

In a management context, there has been repeatedly stressed on the necessity to develop and manage the supply chain process (Sharland, 2001). Hence, companies need to strengthen their process and to reset global goals. In this purpose, Supply Chain Council proposes the Supply Chain Operations Reference model (SCOR model) in 1996. The SCOR model is able to evaluate different sets of parameters for production, inventory and transportation processes within one configuration of a certain supply chain (Röder and Tibken, 2006). The SCOR model contains five major management processes which include plan, source, make, deliver, and return. It provides criterions and metrics for companies to improve their performance by linking process elements, metrics, best practice and the features associated with the execution of supply chain in a unique format. This model is designed to aggregate a hierarchical process model and allows companies to communicate with their partners by using the common terminology and standard descriptions of process elements, therefore assisting companies in understanding the holistic supply chain process and identifying the best practices (Huang et al., 2005; Spekman and Carraway, 2006).

Companies can develop their supply chain process more effectively by using this process reference model. The elements of the SCOR model structure are shown as follows (Huang et al., 2005):

1. Standard descriptions of the individual elements that make up the supply chain processes.
2. Standard definitions of key performance.
3. Descriptions of best practices associated with each process.
4. Identification of the software functionality that enables the best practices.

The structure of the SCOR model consists of four levels (Röder and Tibken, 2006). As shown in Figure 1, level 1 provides the definition of plan, source, make, and deliver processes. At this level, a company defines its supply chain objectives. Level 2 defines 26 core process categories of possible components in the supply chain. Organizations can configure their ideal or actual operations by using one or several core process categories. Level 3 provides the required information for successful planning and goal-setting for supply chain improvement. This level includes defining process elements, setting target benchmarks, finding the best practices, and evaluating software capabilities. Level 4 focuses on the implementing activities, such as taking specific supply chain improving plans into action.

As Figure 1 shows, the detail level (under level 4) is not on the scope of the SCOR model, and the description is dependent on companies and the implementation project therefore can be unique (SCC, 2007). In dealing with company's business process, there are still some issues remaining for the manager to be solved in applying the SCOR model. The SCOR model provides the best practices for companies as benchmark to evaluate the process performance. For performance measurement, there are many available methods to analysis and evaluation (Baganha and Cohen, 1998; Persson and Olhager, 2002; Bruzzone et al., 2006; Longo and Mirabelli, 2008). Most of them, however, consider all key indicators equally important and independent. Since most factors usually have relationships with others, and each indicator also has different influence to the system or business behavior, the original assumption may need to be revised. In practices, to maintain the competency in the global marketplace, companies need to learn that how to view the geographically dispersed supply chain as a whole and understand how the links relates to the whole (Pérez, 1997; Gupta and Boyd, 2008).

Klein and Debruine (1995) firstly applied the thinking process (also called TOC (theory of constraints) Logistic-Trees), a logistic analyzing tool kit of TOC-based, for establishing management policies. Rahman (2002) also developed strategies in managing supply chain processes by the TOC Logistic-Trees. The TOC Logistic-Trees illustrate a three-phase process (Watson et al., 2007). Five logistic analysis diagrams will be used to assist managers to renovate the system or process. The first phase is to analyze what to change. After listing all undesired effects (UDEs) of the supply chain, managers can draw a relationship diagram, the so-called current reality tree (CRT), by the help of effect-cause-effect technique, a cause-and-effect logistic approach to link the correlated the UDEs.

The CRT reveals the core problems in the system. Following up, the next phase is to construct a strategy such as configuring a feasible solution for the core problem. This task is accomplished with the help of the evaporating cloud (EC) and the future reality tree (FRT). These can enable managers to show clearly how injection, of which is provided in EC to solve the core problem, can lead to the elimination of the core problem and also enable managers to identify potential, and unintended consequences of an injection, thus proactively block them. Due to not being in a habit of purposeful action, some renovating works might eventually fail. To deal with the dilemma, managers have to identify the obstacles in the course of action. The third phase in TOC Logistic-Trees accents on the tactics to reconstructing the process. The prerequisite tree (PRT) identifies the obstacles that prevent the injections from being implemented. And it also sets a series of intermediate objectives for the

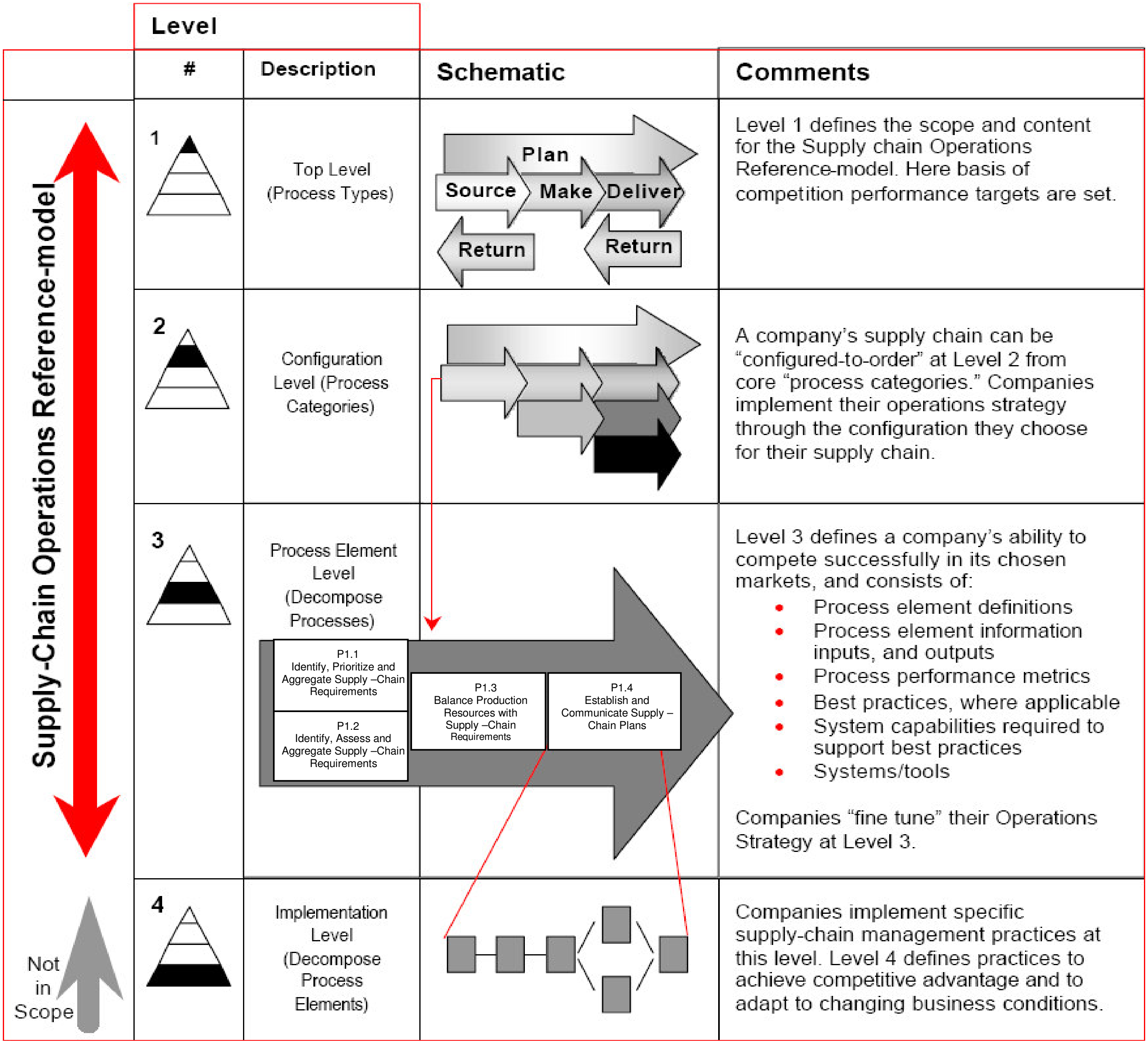

Figure 1. The SCOR process levels (SCC, 2007).

implementation. Finally, to certify the feasibility of the injection and realize possible effects that caused by actions, the transition tree (TT) canvasses effects caused by the implement actions and illustrates Figure 1.

The TOC Logistic-Trees can be used to illustrate the consequences of certain facts or assumptions in managing an organization through the rigorous cause-and-effect logic (Smith and Pretorius, 2003; Hoover et al., 2008). In order to make the whole enterprise manage-able, it is necessary for each part of organization to set up goals that contribute to the overall goal of organization. Hence, this tool kit can determine the possible factors that are related to the overall goal, and constructs a process analysis to reengineer the supply chain process.

BUSINESS PROCESS REENGINEERING IN SUPPLY CHAIN ENVIRONMENT

Since the conception of business process reengineering has been proposed in 1990 (Hammer, 1990; Davenport and Short, 1990), it is wildly considered as a management intervention tool to deal with the changes and competition in supply chain (Hammer, 1990 and 2004; Grover and Malhotra, 1997; MacIntosh, 2003; Terziovski et al., 2003; Herzog et al., 2007, 2009). Since Hammer's study in 1990, the related studies had broken through the old way of business operation (Aghdasi et al., 2010). Davenport and Short (1990) define BPR as the analysis and design of work flows and processes, within, and between organizations. As the basis of competition changes from cost and quality to flexibility and responsiveness, the value of process management is gradually being recognized. Herzog et al. (2007) recognize that BPR can play an important role in creating sustainable competitive advantage. Also, the application of BPR helps the organization to achieve the radical change in performance and to focus on the core business (Johansson et al., 1993; Groznik and Maslaric, 2010; Ozcelik, 2010). Heretofore, the most of BPR researches on this subject of integrating core ability in the business process are not yet well structured (Aghdasi et al., 2010).

Ahmad et al. (2007) indicated that most of the studies were based on specific cases or statistic surveys of critical successful and failure factors of BPR, but without a complete structure research of process analysis (Ahmad et al., 2007). With the increasing applications on BPR and the growing emphasis in supply chain process, diagnosing the business process and building corresponding implement plans become a hot topic. A lot of researches have been done in the purpose of seeking better supply chain process. Kotzab and Otto (2004) propose nine process-based principles which help enterprises to deal with supply chain problems. Hoole (2005) develops five ways to simplify the complexity of the supply chains under the SCOR model. Röder and Tibken (2006) present the modeling methodology which allows the configuration of alternative networks or supply chain structures.

Vergidis (2008) introduced some business process modeling techniques for analysis and optimization. Furthermore, Wang et al. (2010) align BPR with implementing global supply chain by the SCOR model. From these researches, we can observe that the AS-IS diagram and the TO-BE diagram practically are the popular analysis approach in dealing with supply chain process relative issues. Through the AS-IS diagram, companies can survey their own business process, and then understand the possible implement plans by the TO-BE diagram. The BPR implementation needed a systematic adoption projects for the pre-analysis of all organization activities and the business process (Wang et al., 2010). However, how to draw the AS-IS diagram and the TO-BE diagram rely on company's mangers or consultants. It still needs a systematical approach to help them to illustrate the AS-IS diagram and the TO-BE diagram.

Zhou and Chen (2008) discussed several process tools but it still remains three issues that needed to be resolved, which are: a) How to illustrate company process in detail by the AS-IS diagram, b) How to sketch the TO-BE diagram with company business goal, and c) How to realize the practicability of the TO-BE diagram. These three important issues echo the idea of Kumar (2008) who points that a detail corporate analysis is needed for a success BPR. Tanner and Honeycutt (1996) apply the TOC Logistic-Trees in reengineering and find it useful to identify the core process. Also Kim et al. (2008) conclude that the TOC Logistic-Trees can deduce the core process and contribute an implemented project. Thus, the decision makers can demonstrate both AS-IS diagram and TO-BE diagram with efficiency and effectiveness.

THE SYSTEMATIC TOOL KIT

This study proposes a systematic analysis tool kit to diagnose whole enterprise business process and to help companies focusing on their core problems. Through the help of the SCOR model and the TOC Logic-Trees, a manager can straightly pay his attention on the core process and implement the ameliorative plan in the system perspective. By applying level 1 to 3 of the SCOR model, companies can depict their supply chain flows and measure the efficiency and effectiveness of their supply chains in detailed. The gaps between company's goal and its benchmark show that there are several existent undesirable effects (UDEs) in the supply chain. The TOC Logistic-Trees, therefore, is applied to assist managers in acquainting the detail relationships between company's performance and those UDEs. There are three phases in this proposed tool kit, which includes: 1) Current analysis; 2) Process diagnosing, and 3) Corresponding plan building.

Phase I

Current analysis

The first phase is to analyze the entire enterprise current situation in the supply chain. The SCOR model is then applied to describe the supply chain where companies are positioned and to measure the current performance gap against their benchmark. Hence, the performance gaps will be decided. There are generally seven steps of the tool kit in this phase:

1. Decide critical enterprise performance indicators.
2. Compare these critical enterprise performance indicators with the best practice values which are provided by the SCOR model:

$$GAP = Target - Actual$$

3. The Gap value is equal to target value minus actual value.
4. The Gap rate also equals to the GAP value divided by target value:

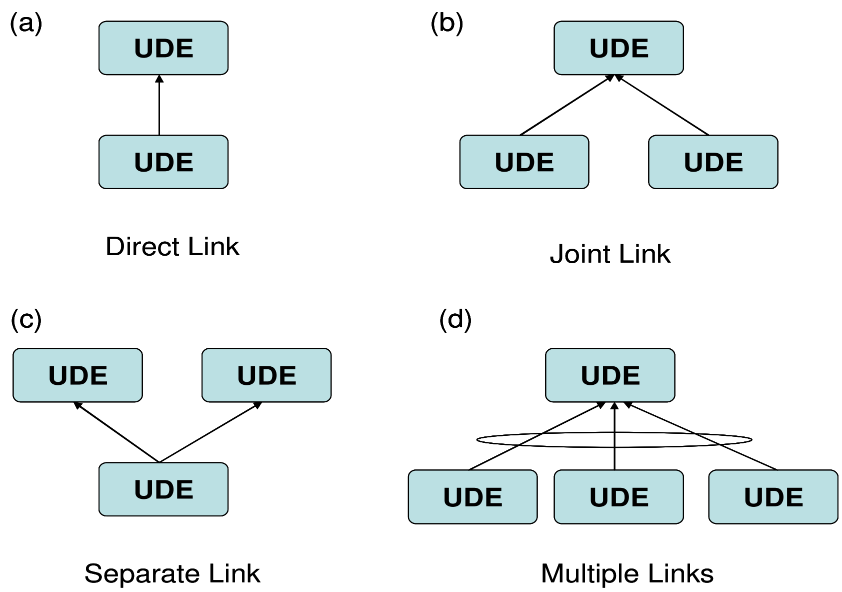

Figure 2. The categories of the UDE.

$$GAP\ rate = {}^{GAP}\!\!/_{Target}$$

5. Sort these performance indicators by the GAP rate value.
6. Arrange every GAP rate in each performance indicator in sequence.
7. Decide the UDEs in company's critical process.

In this phase, the detailed process of the company will be revealed, and the manager can make some reengineer decisions against the UDEs listing.

Phase II

Process diagnosing

The second phase is to analyze these UDEs and to make a judgment of which UDEs is the core problem in the process. There are two major tasks in this phase. One is to construct the CRT (As-Is model) and the other is to figure out which UDE is the core problem. For constructing the CRT, the UDEs should be categorized along with other current situations into several groups by their cause-and-effect relations. And then the CRT is presented by linking all pertinent groups together. There are five steps to build the CRT. The first step is to determine the scope of process analysis. Managers can decide the scope by asking themselves these questions: 1) what are the process boundaries? 2) what is company's goal? 3) what are the major measures of success? and 4) how will this CRT help managers to understand the process?

The following step is listing 5 to 10 pertinent entities which include the UDEs and some situations related to the UDE. The third step is to depict the cause-and-effect relationships that exist among the pertinent entities. Then review and revise for clarity and completeness. The final step is to apply the "so what test", which purpose is to confirm the relationships between each links. The next task is to decide where the core problem is. The principle to decide which UDE is the core problem is mainly affected by the relation value (RV). The relation value of UDEs is presented as the numbers of connecting with other UDEs, and the calculating sequence is bottom up. If there is at least two factors related to the UDEs, the relation value is one over the numbers of related factors. There are four basic linking types of UDEs as shown in Figure 2: a) Direct link, b) Joint link, c) Separate link, and d) Multiple links. For part (a) and (b), the RV is counted as one.

The direct and joint links stand for the former UDE is independently related to the latter. In separate link, the RV depends on how many UDEs are linked. Hence, the RV in part (c) is two. As to multiple links, due to the common effect, the RV is divided by the number of related UDEs. The calculating equation is:

$$RV = \frac{1}{Number\ of\ related\ UDE}.$$

While the relation value of every UDE is calculated, the largest RV will be considered as the core problem. Meanwhile, with the help of EC, a manager can analyze the core problem and can figure out the available injection. The EC applies equally well to dilemma and trade-off situations. Its frame is constructed as a schematic depiction of the dilemma, and the reason for conflict can be conflict can be explored by examining assumptions that underlie the relationships, described here by arrows connecting the boxes in the diagram.

The EC can provide manager a basis for understanding how insights may develop about the nature of root causes, and about the core problem identified in our illustrative CRT.

Phase III

Corresponding plan building

Once the core problem is decided and the available injection is proposed. The final phase is to build a corresponding plan. It should be developed in light of the injection. In order to understand the possible effect while implementing the injection, the FRT (To-Be model) is then proposed. The FRT is based on the injection and company's expected improving goal. There are four major elements in the FRT. The key to creating the desired FRT is implementing the injection proposed in former phase. Entities that do currently exist in the system's reality and those entities exist in the future (at least they're predicted to) are also the major elements in the FRT.

Finally, reinforcing loops are often placed in the FRT, as a means to create patterns of sustained and continuous improvement. Besides, the PRT helps the manager expend the relative projects, and maps the implementation plan of the intermediate objectives which need to be done during the project.

AN APPLICATION OF THE TOOL KIT

Background of the case

This study applies the tool kit in a B2B company which is a plastic injection machine manufacture. In life sciences industry, the plastic injection industry involves many industries including mechanic industries, electronic related industries, and materials industries. It is obvious that the plastic injection industry has a critical relationship with other industries. And due to the growing demand, many enterprises in the plastic injection industry recognize that they need to reengineer the supply chains to fit the trend of globalization. There are three major issues encountered by the case company: The market value-added service management, key shared-part logistical management, and service value management.

First of all, the management cost increases due to the fluctuated demands of customers and mass-transmission of the design information. Their sub-companies are respondent of their sales independently which leads the total demand of the customers difficult to be forecasted.

Secondly, the invalid stock increases and the on-time delivery rate decreases owing to the individual procurement plan in each sub-company.

Finally, poor performance in the customer service results in the passive service caused by the late notice of the maintenance service system. Meanwhile, the lack of the systematic planning brings high inventory cost.

Phase I

Current analysis

With the help of the proposed tool kit in this study, managers can take action to deal with these major issues and extension problems. Members in company's strategy business unit institute the business operational goals and the corresponding performance indicators by the SCOR model. And the supply chain process architecture is also illustrated. After comparing with the best practices in the SCOR model, the gap between company and its benchmark exhibits in the UDEs (Table 1), and the managers can recognize the real problems encountered in the company. From the list of UDEs, there are 15 UDEs that decline the company's performance. However, the critical factors might originate from one or two of them.

In order to recognize the critical factor, each UDE is connected according to the relationships of itself with the others (Figure 3). For example, because of the overstock (#14) and mass customization demand (#13), the turnover rate is low and receivables are high (#6). With this relation, the manager can link #14 and #13 to #6, and the CRT is, therefore, illustrated.

Phase II

Process diagnosing

As shown in Table 2, the manager calculates the RV of each UDE, and the core problem is the "Variation in customer demand (RV = 11.66)". To conquer this core problem, there are some conflicting issues about the inventory. The manager can analyze the causation by the evaporating clouds (EC) (Figure 4) where a conflict - the high stock volume vs. the low stock volume - is found. In the EC, the assumptions of this conflict are as follows:

1. If the company wants to make profits, then the customers' demands must be satisfied.
2. If the company wants to make profits, then the company needs to reduce the stock cost.
3. In order to satisfy the customers' demands, the company must keep the high safety stocks.
4. In order to reduce the stock cost, the company must keep the low safety stocks.
5. The high safety stocks and the low safety stocks are mutually exclusive. Hence, there is a conflict in dealing with this core problem.

From the statements aforementioned, the project team

Table 1. Undesirable effect analysis.

No.	UDEs
1	Company's competition decreases
2	Lack of the experience and resource in the global logistics
3	Bad intern-operational quality and process controls
4	Bad communication community
5	Less product standardization
6	Lower turnover rate of stock and higher receivables
7	Order process is postponed
8	Invalid material's supply and spare part stock
9	Price negotiation is difficult
10	High procurement cost
11	Long deliver lead time of the supplier
12	Unable to manage the stock of the spare part
13	Mass customization demand
14	Overstock
15	Variation in the customer demand

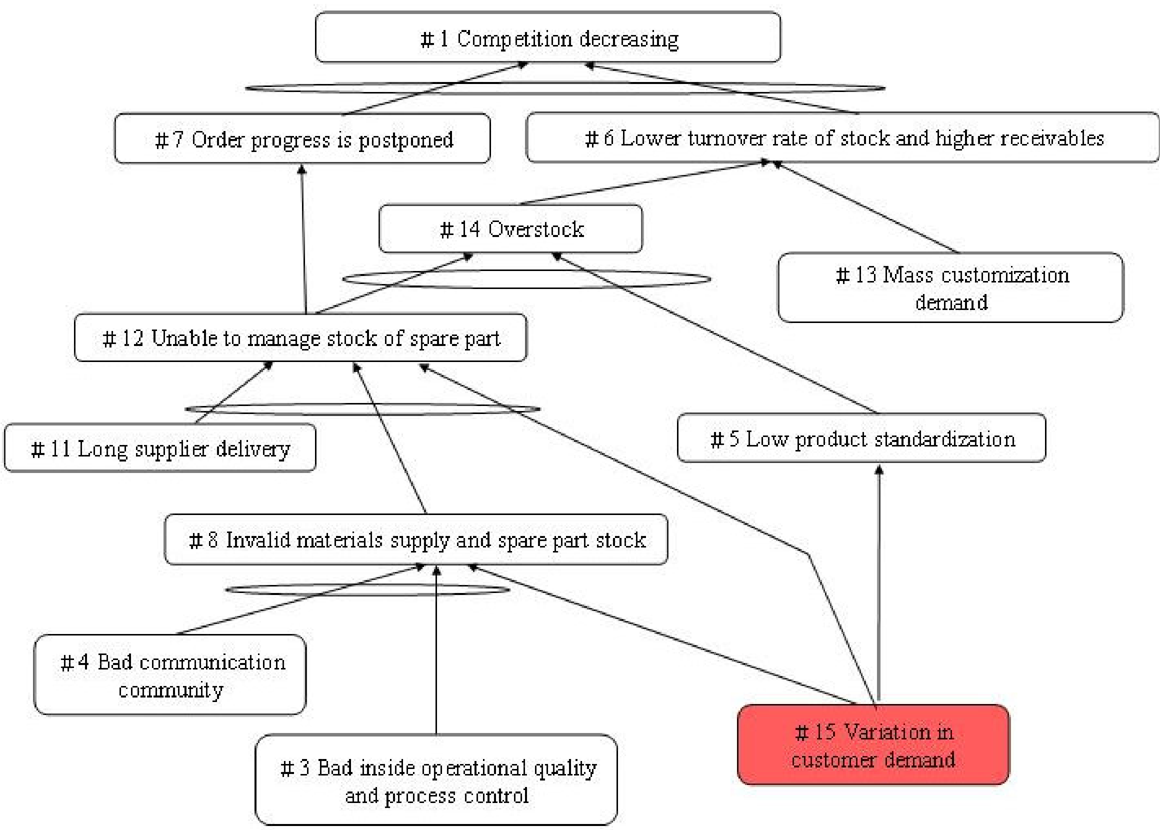

Figure 3. Current reality tree.

members examine each assumptions and check for its validity. In Figure 4, the assumption four, the arrow CD', assumes that the company reduces the stock cost if the company keeps the low safety stocks. This assumption can be reexamined and explored. Through brainstorming with the project team members, it comes up with an injection, which is to increase the turnover rate of the stock to break up this conflict. If the turnover rate of the

Table 2. Undesirable effect relation value.

No.	UDEs	Relation value
1	Company's competition decreases	0
2	Lack of the experience and resource in the global logistics	-
3	Bad intern-operational quality and process controls	4.33
4	Bad communication community	4.33
5	Less product standardization	2
6	Lower turnover rate of stock and higher receivables	0.5
7	Order process is postponed	0.5
8	Invalid material's supply and spare part stock	3.83
9	Price negotiation is difficult	-
10	High procurement cost	-
11	Long deliver lead time of the supplier	3.83
12	Unable to manage the stock of the spare part	3.5
13	Mass customization demand	1.5
14	Overstock	1.5
15	Variation in the customer demand	11.33

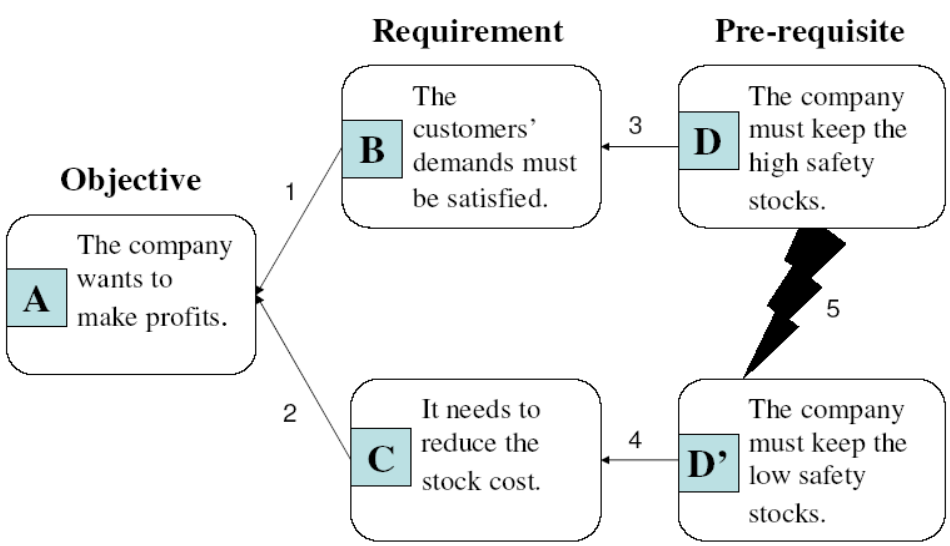

Figure 4. The EC tree of the case company.

stock increases, the case company reduces the stock cost, even though it keeps the high safety stocks.

Phase III

Corresponding plan building

To assure that the injection can work effectively, the company collaborates with its suppliers and customers together to organize a supply chain management project team, to execute this injection and to formulate a collaborative improving project. The FRT depicted in Figure 5 is further used to achieve the desired effects under company's strategies and to prevent possible obstacles which might impede this injection. After depicting the TO-BE model, the manager should consider how to implement the injection to the process. With the help of the PRT in Figure 6, the case company continuously implements the improving project. The injection, increasing stock turnover rate, goes along with two tasks, to unite the procurement plan and to manage global vender manage inventory. The PRT reminds the manager to aware that "system fitness" and "coordination between local supplies" are the mainly obstacle to the process, and increases the possibility to success.

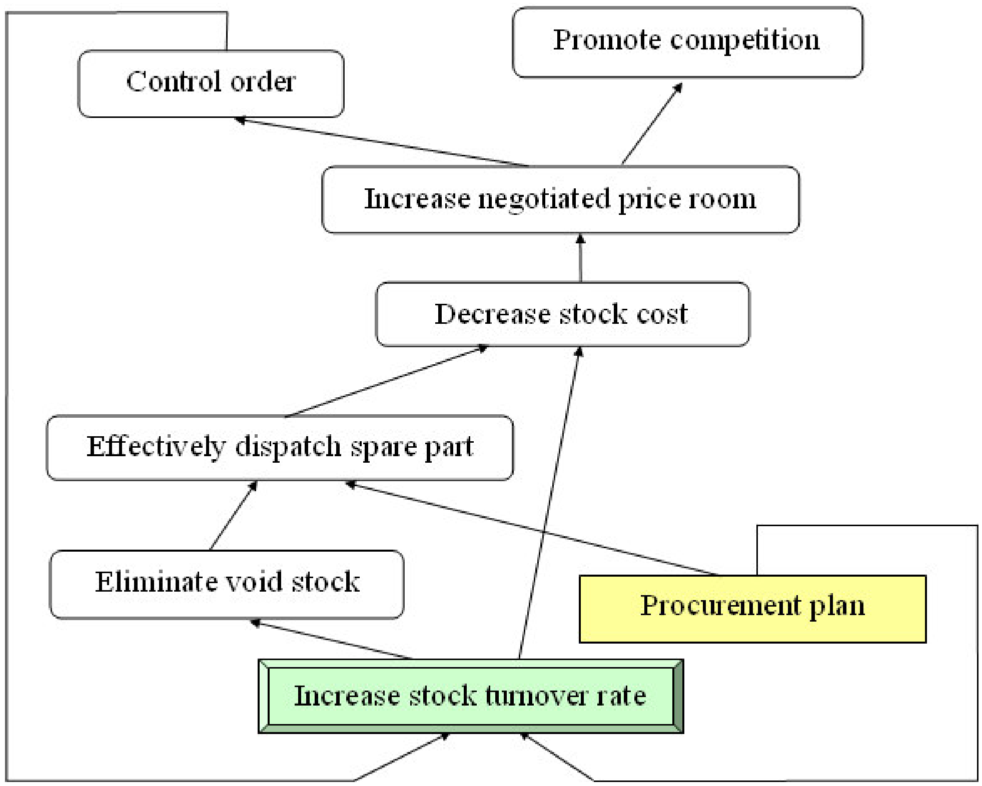

Figure 5. The future reality tree.

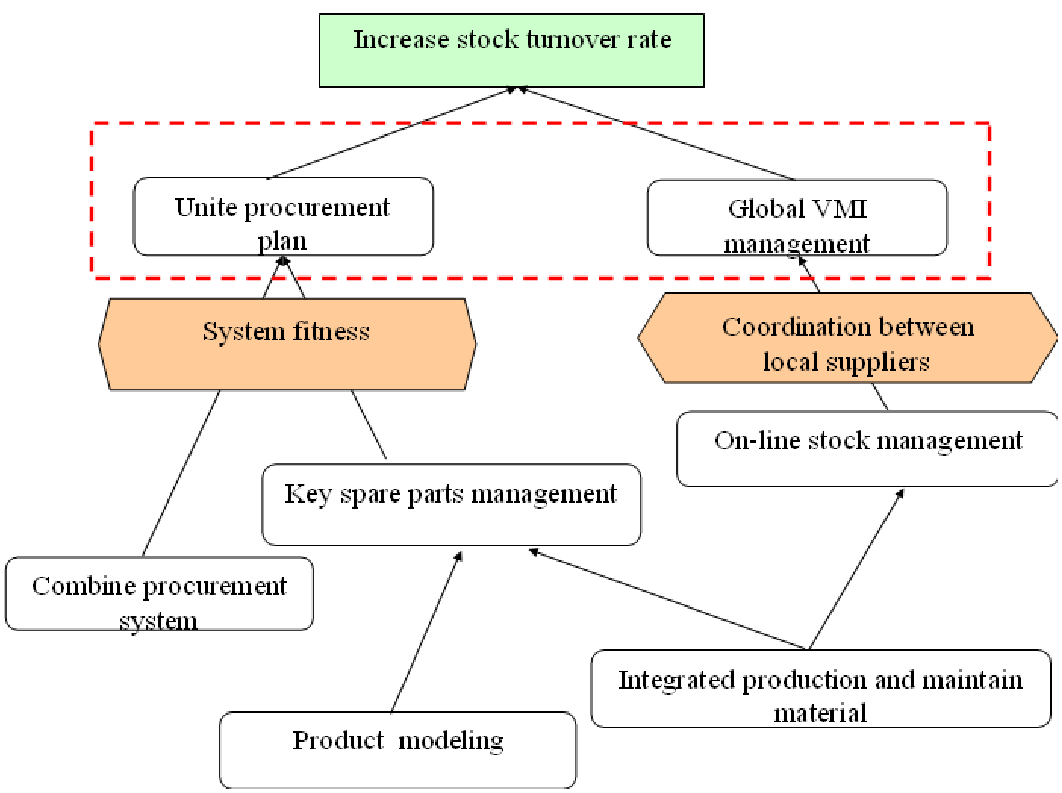

Figure 6. The prerequisite tree.

Table 3. Performance gap analysis.

	KPI	Current situation	Target value
Local logistic management	The ratio of product increasing (%)	5	20
	Turnover rate (times)	2.1	2.7
Product stock management	Supplier on time delivery rate (%)	85	90
	Retailer on time delivery rate (%)	85	90
	Prediction on time delivery rate (%)	3.3	25

Application remarks

This study proposes a supply chain process diagnosing tool kit for companies to reengineer their business process. The tool kit use the rigor of cause-and-effect thinking following strict logic rules, could be applied to any kind of problem situation if combined with the intuittion and knowledge of the managers owning, or intimately involved with the problem. Through analyzing and understanding the process, the case company sets up its key performance indicators and finds that the weakness of the process is caused by the customer end.

Through focusing on the core problem, there are evident effects (Table 3) that promote company's business performance. In local logistic management, the turnover rate has obviously increased from 2.1 times to 2.7 times. And in product stock management, the on-time delivery rate of suppliers and retails are both increased. As shown in Figures 5 and 6, the turnover rate is the injection of the project. To achieve this injection, implementing the strategies of the unite procurement plan and of the global VMI management made great progress on prediction on-time delivery rate which increased from 3.3 to 25%. It also reflects on the business process flexibility and the order response ability.

The result shows that the tool kit can assist mangers to overcome the core problems, and to benefit the company.

CONCLUDING REMARKS

Facing the fierce global competition, most industries take the global logistic management and e-business as the most important thing. However, the goals, such as strengthening competitiveness, reducing cost, and shortening response time, cannot be achieved with satisfaction by only relying on the regular operational model for today's enterprises. While many enterprises regard e-business as the total solution, Davenport and Short (1990) propose an opposite opinion that enterprises should firstly measure entire demand of their own, and then widely consider the possible application of information technology. In other words, information technology is just a powerful tool for an enterprise converting its process into an automatic process. The fundamental of the enterprise rearrangement should still accord with the enterprise's goal. As the mention in the study of Ozcelik, the changes in business process may cause an organization instable and may lead to the reengineering project failure (Ozcelik, 2010).

The desired BPR performance should be considered the business strategy and the readiness of company business flow. Due to this concept, this study proposes a logistic tool kit which can be utilized to diagnose the supply chain maturity and to avoid overvaluing the local performance, of which might lead to the loss of the system (or supply chain) benefits. Moreover, the tool kit with the consideration of business strategy and ability can be applied to the companies who attempt to focus on their core business process. The three-phase tool kit depicts the detail process in B2B supply chain, and help the manager keep their eye on the core problem. And once managers concentrate on their core problems, the process performance can be enhanced significantly. Overall, many studies in relation to the supply chain performance are concerned about the systematic analysis and performance measurement. A potential extension of the proposed tool kit is to employ optimization techniques so managers can make a better supply chain decision. But before initiating any supply chain improvement project, it is necessary to describe the process and capability of the companies in the supply chain.

A possible future research is to apply this tool kit to the manufacture servitization issue. For those companies with the increasing labor cost, the revolution of manufacture business can be no turning back. How to identify the core ability of the company and utilize it effectively is a lesson for the mangers.

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