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SUPPLY NETWORK CONFIGURATION USING THE VALUE ENGINEERING BASED METHOD

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Supply network configuration considers business logistics as a whole in order to maximize enterprise economic performance. This configuration is a complex strategic decision problem involving the long-term organization of suppliers, factories, distribution centers, and manufacturing resources, making efficient decision support necessary. The study in question proposes a hybrid decision support model for supply network optimization. This model first analyzes the business process of a supply chain using Supply Chain Operations References (SCOR) models. The value of the business processes in the supply network are then evaluated using the Value Engineering (VE), wherein the key functions of the processes are chosen via function analysis with quantitative comparison and optimized configuration alternatives are created. Subsequently, the Taguchi method is applied to assess the performance of different alternatives to identify the optimum combination of alternatives. An example of application of global enterprise is elaborated using the proposed method. The results of the case demonstrate that the proposed model can effectively optimize the supply network configuration.

Significance: The proposed method offers an effective method of configuring supply network using value engineering, the Taguchi method, and supply chain operations references.

Keywords: Supply network configuration, Value Engineering (VE), Taguchi method, Supply Chain Operations References (SCOR)

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1. INTRODUCTION

Occasionally, multiple enterprises combine to form a supply network in order to survive fierce global competition. Supply network configuration concerns the long-term organization of entire supply network, thus developing an efficient methodology to optimize the configuration is desired by those enterprises in the supply network. The configuration can be classified as different network patterns, such as multi-channel or multi-stage, location decisions within the network, the structure of inter-firm coordination (Samaddar et al., 2006). Organizations test suitable configurations to maximize their economic performance over an extended period and identify key products, customer markets for those products, core manufacturing processes and suppliers of raw and intermediate materials (Stadtler and Kilger, 2008). The tested configurations should be dynamic and allow the supply network to benefit from delivering more orders while simultaneously satisfying multiple objectives (Piramuthu, 2005). Tsiakisa and Papageorgiou (2008) propose a mixed integer linear programming model for optimizing supply chain networks by overcoming operational and financial constraints. Akanle and Zhang (2008) use a multi-agent system to model resource options available in a supply network and dynamic changes at resources as to identify future chain structure. Furthermore, Li and Womer (2008) recommend a framework based on multi-mode resource-constrained project scheduling and subject to explicit resource constraints for supply network configuration. The computational results demonstrate that the existence of resource and quality level constraints significantly impacts the determination of supply network configuration. Garavelli (2003) presents a simulation model to evaluate the performance of different configurations of a supply network. Especially, given the focus on work-in-process and time performance analysis, the different configurations are analyzed for selecting suitable flexibility degrees to optimize the flexibility of the operations network. The shifting of supply network problems, using various methods for configuration adjustment still cannot solve all the problems in supply network. The supply network is so complicated that understanding the processes involved is very important.

The purpose of this study is to develop an integrated model to optimize the supply network configuration of global manufacturing enterprises. This model integrates the processes of Supply Chain Operations References (SCOR), Value Engineering (VE) as well as Taguchi Method. By this systematic approach, key functions in the global supply chains can be well identified, and then regarding the economic benefit a suitable configuration combination can be decided.

SCOR provides a framework that joins business processes, metrics, best practices and technology features into a unified structure that supports communication among supply chain partners and to improve the effectiveness of supply chain. The model itself contains several sections and is organized into five primary management processes, namely "Plan", "Source", "Make", "Deliver", and "Return". By describing supply chains using these process building blocks, the model describe supply chains, whether simple or complex, using a common set of definitions. This model has been successfully used to describe and provide a basis for supply chain improvement. The SCOR-model, however, does not provide quantitative data for making decision. The process building blocks are used to link disparate industries to describe the depth and breadth of virtually any supply chain for supply chain improvement (SCC, 2005). The SCOR model integrates the well-known concepts of business process reengineering, benchmarking, and process measurement into a cross-functional framework. Using SCOR, all functions and organizations within a company learn to understand their impact on supply/demand balancing (Zhao, et al., 2003; Todd and McGrath, 1997a). A customized supply chain configuration diagram can help upper management understand the interaction of a particular company with its allies and partners. The SCOR model also eliminates all of the challenges and frustrations associated with obtaining consensus on the definition, scope, and configuration of a given supply chain (Todd and McGrath, 1997b; Huang, et al., 2005). Although the SCOR-model contains numerous best practices for reference, it lacks quantitative analyses for making decision.

Value Engineering is an effective means of improving product or process reliability via systematic analysis of provided functions. VE can be applied wherever cost or performance improvement is required, in situation where improvement can be measured via monetary aspects or other critical factors such as productivity, quality, time, energy, environmental impact, and durability (SAVE, 2007). The implementing life-cycle of a value engineering project is called the value study, which comprises six main phases: information, function analysis, creation, evaluation, development and suggestion. During the information phase, the project team summaries the information referring on the product or service specifications, functions, costs, customer requirements, etc. The second phase, "function analysis", is the basis of value study. The function analysis helps a team understand the hierarchical relationships of functions and focus their creative efforts on finding better ways to accomplish a given function (Lewis, 2001). Within the creation phase, the VE project is executed by questioning the worth of each and any feature, after which creative techniques are applied to more cheaply generate the same value. The concept of value is not merely related to purchase price, although this may exert a strong influence (Webb, 1993a). However, VE should not become just another routine; rather the effect of VE derives from the fresh approach that team members bring to the task. When an enterprise is institutionalized, freshness and spontaneity dry up, and so does creativity. Value study is best tackled on a project-by-project basis, with a value engineer and a team specifically assembled for the job (Webb, 1993b). When facing difficult situations, VE cannot solve them in a streamline manner. Therefore, the Taguchi method is a better method of focusing on experiment design for robustness.

The Taguchi Method was developed since 1950. Numerous companies have applied this method and benefited in terms of customer satisfaction and cost reduction. The Taguchi method focuses on adjusting variation of functions for better product performance. Thus, the Taguchi method stresses identifying key factors, with the greatest impact on variation, to ensure that the settings cause least variability (Peace, 1995). The Taguchi method uses orthogonal arrays, which are specially designed for selection, to achieve easy and consistent experimental design. The orthogonal array outputs reliable results during the statistical analysis, even in situations involving numerous changing variables. Linear graphs are comprised of numbers, dots and lines in order to indicate inter-factor interaction. The graphs provide a useful tool for helping assign factors and interactions to the different columns of an orthogonal array during experimental layout (Ealey, 1994; Park, 1996; Roy, 1990). Sun, et al. (2006) proposed a method for solving a p-Hub Median problem using the Taguchi method that includes four phases. The first phase is the problem study, which includes the problem description and the noise factors selection. The second phase involves performing the Taguchi method for the GA-based software. This phase defines the SN ratio, selects the number of levels of control factors and noise factors, and also implements the experiment. The third phase is the data analysis, and involves analysis of experimental data and determination of effective levels of control factors. The final phase is confirmation of the experiment for purposes of proving the results. The Taguchi method is demonstrated to be highly efficient, and the experimental work involves considerable saving. The method can be used in various fields, including time-based economic indices of process control quality. (Mascio and Barton, 2001; Wang and Pan, 1998).VE and the Taguchi method can balance the shortcomings of SCOR.

SCOR, VE and the Taguchi method can be used separately in solving supply network problems. Yet, each of these methods has a weakness of some sort. For example, SCOR lacks quantitative analysis, VE lacks specific supply network knowledge and the Taguchi method cannot create new ideas. This study incorporates the SCOR, VE and Taguchi methods and then proposes a decision support method for the supply network optimization using a real case. First the business process of a supply chain is described using the SCOR models. VE is then used to assess the value of business processes in the supply chain. Meanwhile, the concept of quality and the robustness of the Taguchi method are adopted for finding better combinations. Through experimental analysis and confirmation, several value-added alternatives are chosen to improve supply network configuration performance. This study proposes a logical and effective model for optimizing supply network configuration. The proposed model provides a good reference for enterprises seeking to improve their supply networks.

The remainder of this paper is organized as follows: Section 2 elaborates the proposed methodology and describes its various phases in details. Next, the proposed method is applied to a manufacturing enterprise. Finally, the last section presents conclusions regarding future research.

2. THE METHODOLOGY

This study develops a hybrid research model, combining VE-SCOR with the Taguchi process model, as shown in figure 1, to improve the configuration of supply network. First, a multiple-functional VE study team is formed by various departments and external professionals. The team then implements the information phase to widely collect related information and analyzes that information. Since the whole supply networks need to be examined, SCOR is a perfect tool for identifying and comparing with related process flows. To focus on the important issues of the network, function analysis of VE is an ideal method for finding out the key network functions. Subsequently, the team generates creative ideas. Although the ideas are developed into feasible alternatives for solving the problems in supply network, the problems remain highly complex and uncertain. Thus, the Taguchi method is adopted using the alternatives processed in the development phase to arrange a suitable orthogonal array and experimental allocation via linear graphs for performing random experimentations to adjust the outcome of supply network configuration to meet targets, thus minimizing supply network losses. The best combination of factors is selected and confirmed by the Taguchi method and presented for approval by management. Following the presentation, the accepted recommendations are implemented, having been chosen to maximize supply network value. An empirical case about the configuration of global supply networks is described to verify the proposed model.

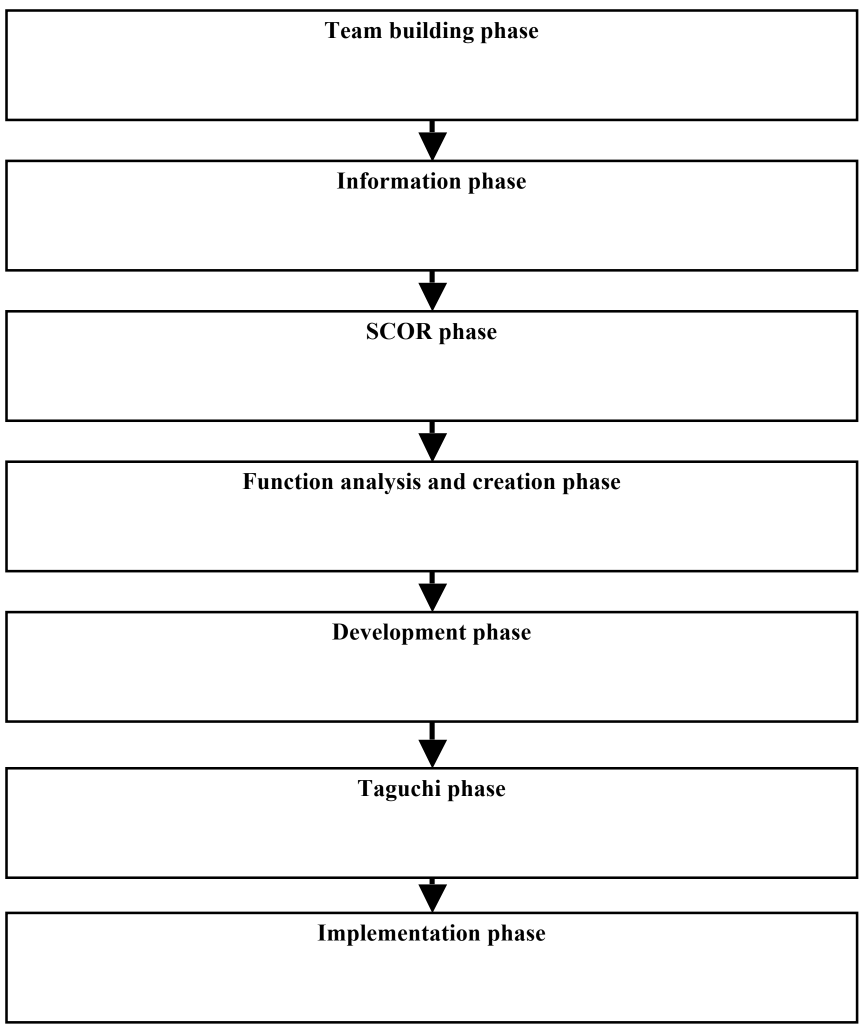


Figure 1. Framework of the VE-SCOR with Taguchi process model

2.1 Team building phase

During the first phase, a multi-discipline team of experts is built. This team contains key personnel fulfilling the functions of product design, material planning, production, industrial engineering, quality control, purchasing, financial, external consulting, etc., and can even include customers, suppliers, and third-party logistics providers.

2.2 Information phase

In the second phase, the project team has many workshops, in which part of them refer to the supply network configuration, to collect as much information and knowledge as possible. Normally the following information should be included: market demand, product specification, customer behavior, product technology, manufacturing capability, IT-capability, material supply condition, transportation and distribution condition, labor constraint, environmental constraint, trade regulation, cost, tax and tariff information. The information is analyzed in this phase.

2.3 SCOR phase

In this phase the SCOR implementation model provided by Todd and McGrath (1997b) is applied:

- Stage 1: Using the SCOR-level 2 Toolkit to define the complete "as-is" configuration of the company's supply network, from customers of customers to suppliers of suppliers.
- Stage 2: Benchmarking the "as-is" to the industry best-in-class as well as the median performance level, and thus finding opportunities for improvement. This stage quantifies gaps in current performance relative to industrial standards.
- Stage 3: Using the SCOR-level 3 to identify what to do differentiation. Based on the gaps defined during the previous stage, the team focused on using the SCOR model to find required changes in work-flow.
- Stage 4: Identifying information system functionality. The team applies the list of applications of SCOR to assess how effectively current IT systems support future supply network operations.

2.4 Function analysis and creation phase

Function analysis is designed to identify what actions are necessary in relation to the supply network and their associated cost. These functions are described in "verb + noun" form to identify the actions the supply network needs to take (SAVE, 2007), for instance, the main function of sources in supply networks is "purchase parts", and determining the value index (VI), using the formula "VI = function cost / function worth" is applied. In this formula (1), the function cost is collected and estimated by real cost during a certain period, while the function worth is defined as the least cost required for function performance. Therefore, the space for improvement increases with VI. In value study, the functional analysis systems technique can be used to evaluate existing procedures, structures or other objects to identify key functions for further idea creation.

$$VI_{ij} = \frac{w_{ij} \bullet C_i}{B_{ij}} \qquad \forall i, j \qquad \ldots \qquad (1)$$

$$\text{where } \sum_j w_{ij} = 1 \qquad \forall i$$

i	Main processes defined by SCOR, $i=1,2,\ldots,I$
j	The function of each main process, $j=1,2,\ldots,J$
C_i	The function cost of each main process
w_{ij}	The cost weight of each function
B_{ij}	The least cost required to perform the function
VI_{ij}	Value Index to find out the key functions

Next, the creation phase focuses on the key functions for accelerating as many ideas as possible by project team. This phase normally requires numerous brain-storming, in which guidelines are given, such as making change, facing unconventional, daring to be apparently illogical, and overcoming inertia, proving that insight does not necessarily flow from a plan or a logical sequence, leading to the elimination of mental blocks and inhibitions, and so on.

2.5 Development phase

The development phase identifies realizable alternatives from the selected ideas of the function and creation phases above. During this phase, each alternative has to be deeply analyzed to ensure good fit to the requirements of the enterprise supply network. The team must decide which technology is appropriated, prepare quotations, set schedules and test. The necessity and affection of changing design must also be considered. For smooth changing, good human relations with related departments are necessary. Every involved study team member must be concerned from the start of the Information Phase. The team then develops specific alternatives. The reason that the team chooses those alternatives is prepared to help persuade management. The main processes of development phase are: pilot design of selected ideas, preparing presentation materials of alternatives, providing a table of comparisons regarding strong and weak points, collecting quotations, analyzing life cycle costs, selecting alternatives, and preparing execution plans. Selecting alternatives is usually the most difficult part of the development phase, because the performance of certain alternatives affects other alternatives. Different alternatives must be combined to obtain better solutions. The Taguchi method offers a possible means of solving such situations.

2.6 Taguchi phase

After development, this study finds several alternatives with the potential to disturb one another through their interactions. The processes of the Taguchi method in the present model involve identifying the factors/interactions. Team discussions help clearly picture the reality. After identifying the levels of each factor, the key functions of the VE study, can be adopted as important factors in this process and the levels can be the different methods to accomplish these functions. An appropriate orthogonal array is selected from the key functions and methods for experimenting. The factors to columns of the orthogonal array are assigned according to linear graphics. The experiments are randomly conducted to get the fair results. The optimal combination is determined after data analysis based on the formula of larger-the-better, smaller-the-better, or nominal-the-best and the results of the Signal Noise (SN) ratio. The formulas are shown in (2) and (3). Finally, the confirmation experiment is conducted to assure the optimal combination identified in the experiment is truly the optimal combination. The above Taguchi processes eliminate the weak points and increase the strong points.

$$SN = -10 \log MSD \quad \ldots \quad (2)$$

where for larger-the-better

$$MSD=\frac{1/y_1^2 + 1/y_2^2 + \ldots + 1/y_n^2}{n} \quad \ldots \quad (3)$$

where SN Signal-to-Noise
MSD Mean Square Deviation
y_k The score of each experiment, $k=1,2,\ldots,n$

2.7 Implementation phase

This phase presents the study results and execution of chosen alternatives. The processes are preparing presentation and supporting documentation, comparing the study conclusions with the success requirements established during the Information and Function Analysis Phases, offering “risk-reward” innovation scenarios to select value alternatives for implementation to management, exchanging information with the project team, ensuring management have full and objective information for use in decision-making, outlining an implementation plan, and preparing formal report.

Concrete action items based on the study outputs above are proposed during the implementation phase. Among them, first, the preliminary report is reviewed, after which accepted alternatives using the Taguchi method analysis are disposed via executable action plans and timeframe. Normally the implementation issues include the aspect of redefining the supply network model, process re-engineering of supply network, application of integrated enterprise systems, such as the ERP systems, and the organizational change. Moreover, commitments for implementation are collected from different disciplines, and the benefit achievement should be traced.

3. CASE STUDY

This VE-SCOR with Taguchi process model is applied to a global electronics manufacturing enterprise. Figure 2 illustrates the global supply network: The case study company has a complete manufacturing factory in China (T), and a front-end factory in Thailand (F). After manufacturing in the front-end factory, semi-finished products are shipped to back-end factories in Mexico (B1) and the Czech Republic (B2) respectively. Additionally, the case company has three distribution centers in China (DC1), North America (DC2) and Europe (DC3) that supply local market demand. Final manufacturing is performed in local back-end factories and the products are than transported to the distribution centers considering dynamic local market demand. The material flows are assigned to one of three types depending on product: materials sourced from Asian countries and going first to back-end factories, and then to distribution centers; materials sourced from front-end factories in Thailand and then going to back-end factories in Mexico and the Czech Republic before going to distribution centers; finally, materials sourced from local areas and then to back-end factories, before finally going to distribution centers.

In order to improve the supply network configuration, a project team was formed by multi-functional departments (Procurement, Production Control & Planning, Manufacturing, IE, QC, etc.), suppliers and external consultants. In situations where information collection refers to supply network, including suppliers, customers, orders, specifications, BOMs, processes, etc., the project team used the SCOR model to review the network. The SCOR model of the case company is presented in Figure 3. The solid line represents the physical flow and the dotted line represents the information connection. P1 stands for "plan supply chain", p2 stands for "plan source", p3 stands for "plan make", while p4 stands for "plan deliver". Furthermore, S1 denotes "source stocked product", S2 stands "source make-to-order product", M1 is "make-to-stock", M2 denotes "make-to-order", D1 represents "deliver stocked product", and D2 is "deliver make-to-order product." Figure 4 presents further details regarding level one of the SCOR model. From customer needs to finish goods, all flows are shown, where 3PL denotes the 3rd party logistics. The product SCOR model is shown in Figure 5, which illustrates detailed product flow as level two of the SCOR model. 3PL provides materials to production bases. The final goods are then delivered from production bases via 3PL to customers. All processes are monitored by the headquarters (HQ) of the case company.

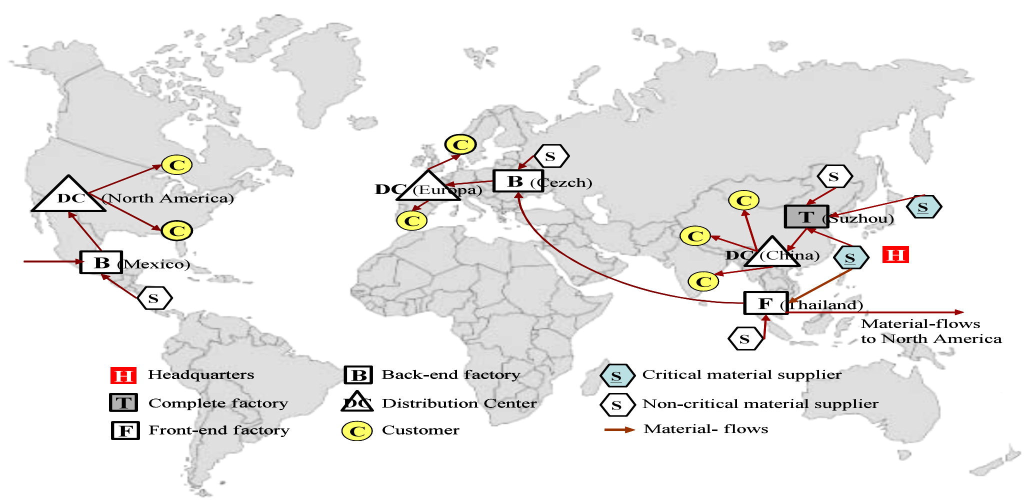


Figure 2. Global supply network of case company

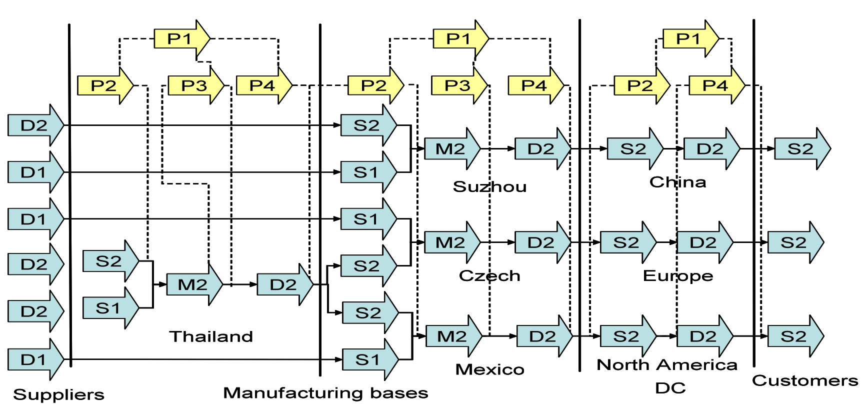
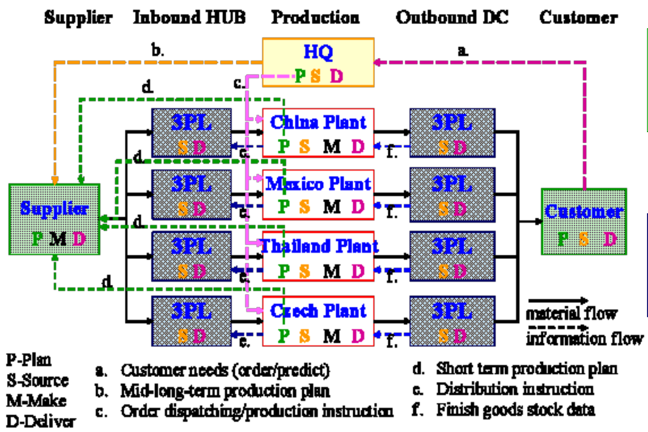


Figure 3. SCOR model of the case company



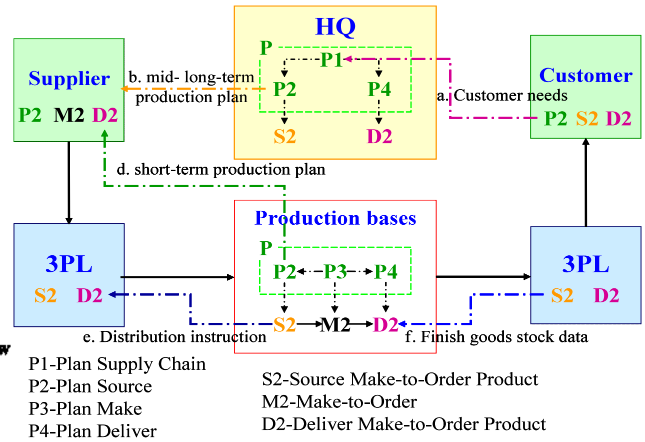


Figure 4. SCOR model of case company (Level one)

Figure 5. SCOR model of case company (Level two)

The SCOR model review provides team members with a clear picture of the network. The processes in this study focus on source, make, and deliver. The functions are generated by members, such as the main functions of source are “purchase parts”, “manage supplier”, “reduce inventory”, and “streamline communication”. The team starts to determine the initial cost of each function by calculating from past data to estimate the cost in next whole year. The worth is also set by the team to find out the least cost of each function according to the formula (1). The key functions, namely Reduce Inventory, Optimize Process, Manage Supplier, and Streamline Communication, are identified after the value index is counted via cost/worth (as shown in Table 1). SCOR contains numerous best practices, which were included in the creation phase to generate more ideas. Following the development phase, this study used the key functions and arranged a table of 4 controllable factors with 3 levels, as shown in table 2, for the Taguchi method application.

Table 1. Function Analysis of global supply network of the case company

Function Analysis Phase						Function Analysis	
Project Name: Global supply network							
Item: supply network						1 Page of 1 pages	
Sub Item	Function(1)			Initial Cost	Worth	Cost/Worth	Improvable level
	Verb	Noun	Kind	(2)	(3)		
Source	Purchase	Parts	B	$46,706	$45,300	1.0	△
	Manage	Supplier	S	17,730	12,500	1.4	○
	Reduce	Inventory	S	23,366	14,600	1.6	○
	Streamline	Communication	S	14,274	9,840	1.5	○
Make	Manufacture	Products	B	41,969	41,650	1.0	△
	Reduce	Inventory	S	69,085	48,760	1.4	○
	Optimize	Process	S	79,830	52,300	1.5	○
Deliver	Transit	Products	B	66,393	65,100	1.0	△
	Optimize	Process	S	12,088	8,430	1.4	○
	Streamline	Communication	S	38,120	26,850	1.4	○
(1)B = Basic function; S = Sub function				(2)Initial estimated cost		(3)Lowest cost	
RS = Required sub function				Improvable level： ○ best △ good × bad			

Table 2. Controllable factors and levels of the case company

Factor	A	B	C	D
Function	Reduce Inventory	Optimize Process	Manage Supplier	Streamline Communication
Level 1	Reviewed and adjusted frequently	On-line visibility	Joint Service Agreements	Digital links
Level 2	Blanket purchase orders	Process is highly integrated	CPFR	Web-based information sharing
Level 3	Vendor Managed Inventory	Continuously changeable	Suppliers share responsibility	Integration of application software

Table 3. L_9 and experimental results of the case company

Exp.	A	B	C	D	y1	y2	y3	y4	MSD	S/N
1	1	1	1	1	6	5	4.5	4.5	0.042	13.8
2	1	2	2	2	5.5	5	4	5	0.044	13.6
3	1	3	3	3	4.5	4.5	6	7.5	0.036	14.4
4	2	1	2	3	4.5	5	4	5	0.048	13.2
5	2	2	3	1	5	6	6	4.5	0.036	14.4
6	2	3	1	2	5	6.5	6	6	0.030	15.3
7	3	1	3	2	8	5.5	7.5	7.5	0.021	16.8
8	3	2	1	3	5	4.5	4.5	4.5	0.047	13.3
9	3	3	2	1	4.5	4.5	5.5	5	0.043	13.7

After setting the controllable factors, the experiments are organized according to Orthogonal Array ($L_9(3^4)$), which requires only nine experiments according to Peace (1995). Table 3 lists the experimental results. Satisfactory data is obtained via y1 to y4. Furthermore, MSD and S/N are calculated by using of formulas (3) and (2). The significant factors, A and B were determined according to the SN response table (see Table 4), where A1 equals (13.8+13.6+14.4)/4=13.9. The effect of A is 14.6-13.9=0.6. The best combination of the significant controllable factors is C_3D_2. Therefore, the best combination of all controllable factors is derived as $A_3B_1C_3D_2$. That means Vendor Managed Inventory, Optimize Process, Suppliers share responsibility, and Digital links as the first priority for implementation.

Table 4. SN response table of the case company

SN Ratio	A	B	C*	D*
Level 1	13.9	14.6	14.1	14.0
Level 2	14.3	13.8	13.5	15.2
Level 3	14.6	14.5	15.2	13.6
Effect	0.6	0.8	1.7	1.6
Rank	4	3	1	2

After performing confirming the Taguchi method by selecting the strategy combination of VMI, on-line visibility, suppliers share responsibility, and web-based information sharing, the S/N ratio increased from 13.8 to 17.6.

Based on the above results, the case company executes the following re-engineering activities: Re-engineering the business process to the VMI-model. Figure 6 illustrates the changes in process re-engineering. In the new modes, key components are sent to a VMI materials warehouse until they are needed by the case company. Meanwhile, non-key components are sent directly to the case company.

The VMI final goods warehouse keeps goods for immediate provision by retailers and customers. For on-line visibility, this study adopted e-supply-chain structure, which changes from manual handling of related information to on-line information sharing. The e-supply-chain structure of the case company includes e-production, e-procurement, e-sales, and e-logistics, as shown in Figure 7. Customers place orders to the e-sales system via a web portal. Orders are gathered to e-production system to produce production plans and schedules. Invoices are then sent to customers to confirm the sales.

The MRP in the e-production system generates material requirement information to e-procurement system for purchasing. Shipping notices are issued by the e-production system to the e-logistics system to provide timely shipment notification to LSP. Customers can use this system to track shipment information.

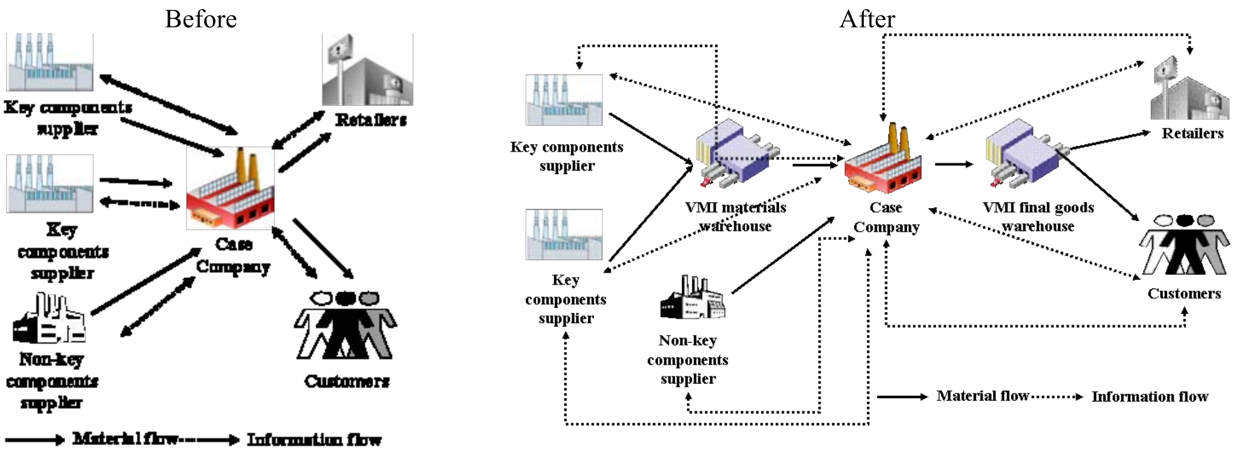


Figure 6. Process Re-engineering of the case company

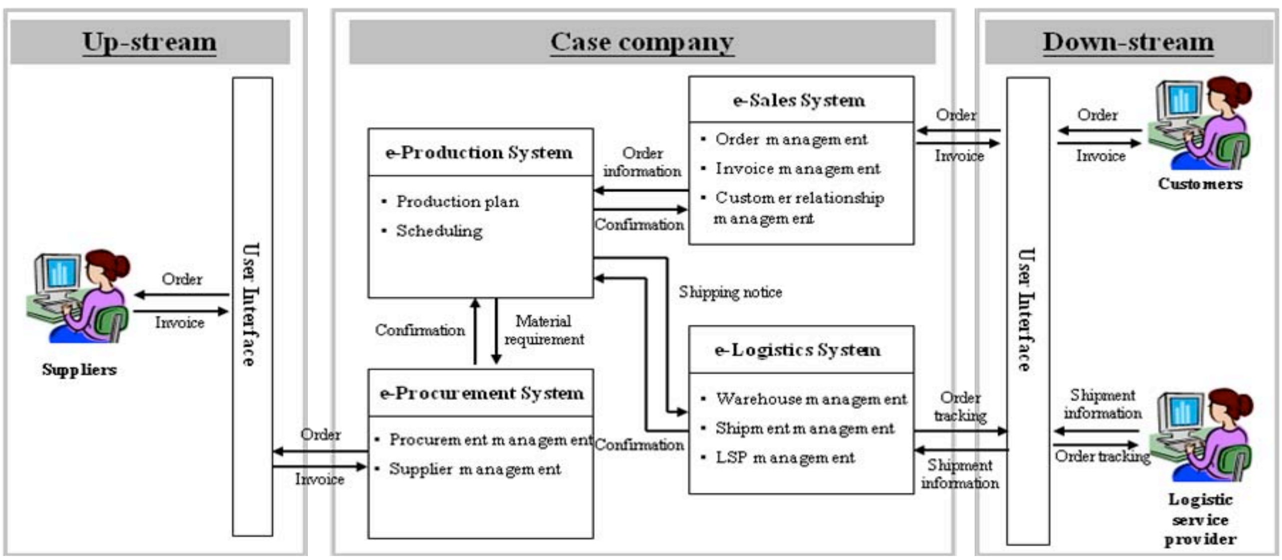


Figure 7. e-Supply-Chain structure of case company

Besides the significant upgrade in supply network efficiency, the case company reduced running costs by $26,478,571, reduced transportations and logistics costs by 16.74%, reduced material inventory costs by 17.15%, increased inventory turnover (as shown in Figure 8), and reduced warehousing spaces requirements in Mexico and Thailand by 28% and 26% respectively.

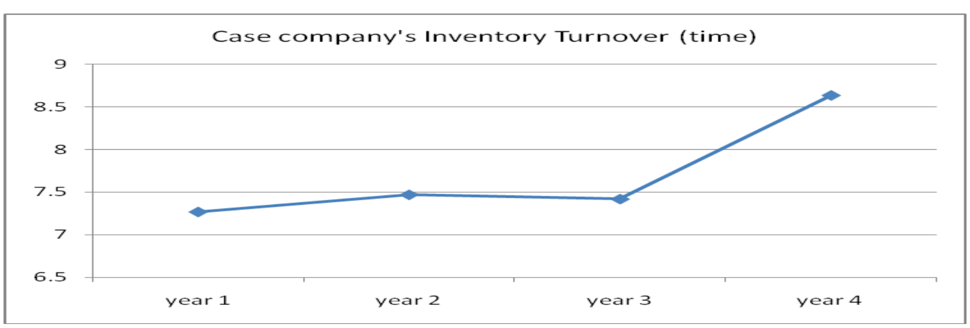


Figure 8. Inventory Turnover of case company

4. CONCLUSIONS

Supply network configuration is becoming more complicated than ever before because of continuous environmental changes. Making the right decisions no longer depends simply on working experiences. Although more and more papers propose different methods of solving configuration problems (Piramuthu, 2005; Demeter et al., 2006; Akanle and Zhang, 2008; Li and Womer, 2008; and Garavelli, 2003), this study proposes a systematic method combined with qualitative and quantitative methods and obtains a better solution for configuration problems.

Supply networks are complex and unique to enterprises. Helped by SCOR, enterprises can easily define present processes and refer to various best practices ready for implementation. SCOR enables a value study team to easily perform information analysis and better understand the current processes. Function analysis and creation processes enable a value team to generate tremendous ideas for improvement. However, supply network environments involve complex and changeable situations. Solutions that are presently the best may not represent best practice in the future. This study established a VE-SCOR using the Taguchi process model, which can be used to deal with difficult problems of supply network. The implementation of real world examples demonstrates that the model can solve practical problems. The research demonstrates that continuous improvement is crucial owing to continuous environmental changes. However, this study also suggests that firms should adjust their management system to redesign VE-SCOR using the Taguchi process to increase market competitiveness. Owing to the continuous changes in the status quo, this model should be adopted once in a while to ensure the supply network configuration is in the utmost situation. Future research can adopt the suggestion of Montgomery (2005) by using response surface methodology to reduce the inefficiencies and ineffectiveness of the experimental processes and data analysis using the Taguchi method. The proposed model only focuses on configuration of supply network and has been approved in one company. This model can be expanded to widen areas, such as supplier selection, plant and distribution center allocation, transportation decision, to name just a few, and for application in a larger number of firms.

5. REFERENCES

1. Akanle, O.M. and D.Z. Zhang (2008), Agent-based model for optimizing supply-chain configurations, Int. J. Production Economics 115: 444– 460.
2. Ealey, Lance A. (1994), Quality By Design Taguchi methods and US Industry, Second Edition, IRWIN Professional Publishing.
3. Garavelli, A. Claudio (2003), Flexibility configurations for the supply chain management, Int. J. Production Economics 85: 141–153.
4. Huang, Samuel H., Sunil K. Sheoran, and Harshal Keskar (2005), Computer-assisted supply chain configuration based on supply chain operations reference (SCOR) model, Computers & Industrial Engineering 48: 377–394.
5. Lewis, Jay (2001), "Using Treemaps to tie QFD and 6 Sigma Concepts to Function Analysis," SAVE Proceeding 2001, pp. 254 – 275.
6. Li, Haitao and Keith Womer (2008), Modeling the supply chain configuration problem with resource constraints, International Journal of Project Management 26: 646–654.
7. Mascio, R. Di and G.W. Barton (2001), The economic assessment of process control quality using a Taguchi-based method, Journal of Process Control 11: 81-88.
8. Montgomery, Douglas C. (2005), Design and Analysis of Experiments, 6th Edition, Wiley.
9. Park, Sung H. (1996), Robust Design and Analysis for Quality Engineering, Chapman & Hall.
10. Peace, A. S. (1995), Taguchi Methods, Addison-Wesley Publishing Company, Fourth printing, March 1995.
11. Piramuthu, Selwyn (2005), Knowledge-based framework for automated dynamic supply chain configuration, European Journal of Operational Research 165: 219–230.
12. Roy, Ranjit K. (1990), A Primer On The Taguchi Method, Society of Manufacturing Engineers Dearborn, Michigan.
13. Samaddar, Subhashish, Satish Nargundkar, and Marcia Daley (2006), Inter-organizational information sharing: The role of supply network configuration and partner goal congruence, European Journal of Operational Research 174: 744–765.
14. SAVE (2007), VM Standard 2007 Edition, SAVE International.
15. SCC (2005), Supply Chain Operations Reference Model Version 7.0, Supply-Chain Council.
16. Stadtler, Hartmut, and Christoph Kilger (2008), Supply Chain Management and Advanced Planning Concepts, Models, Software, and Case Studies, Springer, Berlin, Fourth Edition.
17. Sun, Te-Hsiu, Larry J.H. Lee, and Fang-Chih Tien (2006), Solving Single Allocation Uncapacitated p-Hub Median Problem with Hybrid Genetic Algorithms, International Journal of Industrial Engineering, Volume 13, Issue 3: 280-291.
18. Todd, Pittiglio Rabin, and McGrath (1997a), INSIGHT, PRTM, vol. 9, no. 1, Spring 1997.
19. Todd, Pittiglio Rabin, and McGrath (1997b), INSIGHT, PRTM, vol. 9, no. 3, Fall 1997.

20. Tsiakisa, Panagiotis, and Lazaros G. Papageorgiou (2008), Optimal production allocation and distribution supply chain networks, Int. J. Production Economics 111: 468–483.
21. Wang, S.B., and Chin Pan (1998), Two-phase flow instability experiment in a natural circulation loop using the Taguchi method, Experimental Thermal and Fluid Science 17: 189-201
22. Webb, Alan (1993a), Value engineering Part 1, Engineering Management Journal, Volume 3, Issue 4, Aug 1993 Page(s):171 – 175
23. Webb, Alan (1993b), Value engineering Part 2, Engineering Management Journal, Volume 3, Issue 5, October 1993 Page(s): 231-235
24. Zhao, Z.-Y., M. Ball and C.-Y Chen (2003), A Scalable Supply Chain Infrastructure Research Test-Bed, University of Maryland.

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