Outbound Logistics Optimization of Manufacturing Enterprise based on SCOR Model

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BIOGRAPHY
Larry Jung Hsing Lee, CVS (Certified Value Specialist) is a senior manager in productivity enhancement division of Tatung Co., Ltd., Taiwan and in charge of management efficiency and innovation development. He received master degree in Industrial Engineering from National Taipei University of Technology in 2003. He promoted Industrial Engineering and Value Engineering since 1987 in TTIC, Taiwan Telecommunication Industry Company, a joint-venture of Tatung and NEC, Japan. After getting CVS from SAVE International, he instructs and consults VE in many organizations including private and governmental institutes for years.

He joined a VE promoting team and helped Value Management Institute of Taiwan (VMIT) to be established in 2001. As chairman of Information committee, he leads a team to form and maintain a website for VMIT. He is also invited to be a member of Standard & Certification Committee and Promotion Committee of VMIT. For promoting Value Methodologies, he has put a lot of effort for the society.

Jun-Der Leu received the Ph.D degree in Business and Management from the Technical University Berlin, Germany, in 2000 and then joined the Infineon Technologies AG, Germany and the Fraunhofer IPA-Cleanroom Manufacturing, Germany. He was responsible for global logistics, investment planning and industrial engineering. Since September 2002 Dr. Leu was an assistant professor of business administration, National Central University, Taiwan. In it, he works also mainly on global logistics, investment planning and industrial engineering for High-Tech industries.
ABSTRACT
Supply Chain Operations Reference (SCOR) model gives a framework for the business process analysis of manufacturing enterprise, wherein a supply chain is identified as four stages: Source, Make, Deliver and Return. In it, the main process Deliver describes the outbound logistics which includes the warehouse management, transportation and distribution and thus has a significant influence on the efficiency of the time-to-market of the supply chains.
This paper proposes a method for the outbound logistics optimization of manufacturing enterprise. In this method, the business process of a supply chain is described by the SCOR model firstly. Then the value of business processes refer to outbound logistics in the supply chain is evaluated by the methodology of Value Engineering (VE), wherein the concept of value and loss function of Taguchi method is applied. An experimental analysis is executed to evaluate the performance of the proposed method.

Keywords : Supply Chain Management; Outbound Logistics, Value Engineering; Taguchi method; SCOR

INTRODUCTION
Maintain highest profit is the best goal to looking for by enterprises. However, without innovative efforts would never accomplish this goal. Value management techniques have been developed for more than 50 years. From the past experiences, we found that value management is an effective tool for increasing value and promoting innovation. This paper proposes a VE-SCOR with Taguchi process model, which reviews the processes of outbound logistics by SCOR model. Then we use VE and Taguchi method to find out the best combination alternatives for the best outcome. This paper presents related literature, including supply chain management, SCOR, VE, Taguchi, etc., and powerful results of examples. The results show that the VE-SCOR with Taguchi process model can really solve the complicated outbound logistics problems.

SUPPLY CHAIN MANAGEMENT
Supply chain management represents one of the most significant paradigm shifts of modern business management by recognizing that individual businesses no longer compete as solely autonomous entities, but rather as supply chains [Lambert and Cooper, 2000]. The Supply Chain Council (2002) defines that the supply chain encompasses every effort involved in producing and delivering a final product, from the supplier’s supplier to the customer’s customer.. Supply chain management (SCM) is the task of integrating organizational units along a SC and coordinating materials, information and financial flows in order to fulfill (ultimate) customer demands with the aim of improving competitiveness of the SC as a whole. A SC can be regarded as a network of organizations with some common goals. The challenge in controlling such a network stems from the nature of relationships between SC partners. They are neither part of a single hierarchy nor loosely coupled by market relations [Stadtler, 2005].
Vendor Managed Inventory is one of the most widely discussed partnering initiatives for improving multi-firm supply chain efficiency. Popularized in the late 1980s by Wal-Mart and Procter & Gamble, VMI became one of the key programs in the grocery industry’s pursuit of “efficient consumer response” and the garment industry’s “quick response.” [Johnson, 1999].
Manufacturers and suppliers have to decide if they would like to form close relationships not to have partial solutions. Real benefits can only be attained by sincere commitment from each of the partner to use what is proposed. Sharing of information is central to the optimization of resource
allocation (i.e., product distribution) in the supply chain. The management of physical flow of products amongst the nodes of the supply chain comes under the intensive study of effective operation in SCM [Kaihara, 2001].

Considering on the factors of materials and components supply, production processes, stocking, distributing, and marketing, Leu and Huang (2004) distinguish four basic types of global logistics models, shown as figure 1. Which type is the best will depend on those factors, including production base, warehouse, distributing center, material supplier, market, customer, material flow, and cash flow. [Leu and Huang, 2004]

![Figure 1 Four Basic Types of Global Logistics Models (Leu and Huang)](image)

**SCOR**

SCOR is developed by Supply-Chain Council (SCC), an independent, not-for-profit, global corporation, with membership open to all companies and organizations interested in applying and advancing the state-of-the-art in supply-chain management systems and practices. The SCC was organized in 1996 and initially included 69 practitioner companies meeting in an informal consortium. Subsequently, the companies of the Council elected to form an independent not for profit trade association. The majority of the SCC’s members are practitioners and represent a broad cross-section of industries, including manufacturers, distributors, and retailers.

The current version is 7.0, which is the ninth revision since the Model’s introduction in 1996. The SCOR-model has been developed to describe the business activities associated with all phases of satisfying a customer’s demand. The Model itself contains several sections and is organized around the five primary management processes of Plan, Source, Make, Deliver, and Return. (Shown as Figure 2) By describing supply chains using these process building blocks, the Model can be used to describe supply chains that are very simple or very complex using a common set of definitions. As a result, disparate industries can be linked to describe the depth and breadth of virtually any
supply chain. The Model has been able to successfully describe and provide a basis for supply chain improvement for global projects as well as site-specific projects. [SCC, 2005]

Harmon (2003) regards SCOR as the most important development in business process change in the last several years. In effect, it is the first Second Generation business process methodology. The various First Generation methodologies all approached business process change in a generic way, and were largely driven by concepts that came more naturally to academics than to business managers. SCOR is a methodology developed by supply chain managers for their own specific needs. It takes elements from all of the various business process methodologies and arranges them into a system that is most useful for those who have to manage real supply chains in actual organizations. It provides a generic vocabulary that anyone can use to quickly describe any supply chain. The SCOR methodology is integrated with a measurement system that managers quickly tailor according to the strategy selected. The SCOR approach reduces an analysis and design effort that might have taken days or weeks, to a matter of hours. The SCOR model takes a closer look at the procedures and operations in a supply chain as the cross-industry standard for supply-chain management. The SCOR model makes use of standardized processes in supply chains and common sets of definitions to enable common models to be used for different industries and to create the opportunity for comparisons among them. This model integrates the well-known concepts of business process reengineering, benchmarking, and process measurement into a cross-functional framework (Zhao, et al., 2003). Using SCOR, all functions and organizations within a company learn to understand their impact on supply/demand balancing – including sales, marketing, product development and management, manufacturing, customer service, suppliers, and materials management (Todd and McGrath, 1997a). The SCOR-model contains 8 basic sections: Introduction, Plan, Source, Make, Deliver, Return, Glossary and Appendices. For modeling purposes, Return is documented in two locations – Source and Deliver. Those Return processes that connect an organization with its supplier (i.e., the return of raw material) are documented as Source Return activities. Those processes that connect an organization with its customer (i.e. the receipt of returned finished goods) are documented as Deliver Return activities. This preserves the concept that Source connects an organization with its suppliers and Deliver connects an organization with its customers. The Plan and Execution (Source,
Make, Deliver, Return) sections are the heart of the Model while the Glossary provides a listing of the standard process and metrics terms that are used within the Model. Todd and McGrath (1997b) provide steps of Using SCOR as follow:

Step 1: Using the Level 2 SCOR Toolkit – The first step is using the SCOR model was to define the complete “as is” configuration of the company’s supply chain, from its customer’s customer to its supplier’s supplier.

Step 2: Benchmarking to Quantify Improvement Opportunities – The second step was to define how current supply-chain performance compared to industry best-in-class and median performance levels.

Step 3: Using SCOR Level 3 to identify what to Do Differently – With opportunities for improvement clearly defined, the company then focused on using the SCOR model to determine specific changes required.

Step 4: Using SCOR to Identify the Functionality of Enabling Systems – The SCOR model also provides a set of best practices in information systems functionality. Using SCOR’s list of applications that provide specific functionality, companies can assess how well their current legacy systems will support future supply-chain operations. It can also be used to determine lists of potential vendors.

By providing a complete set of supply-chain performance metrics, industry best practices, and enabling systems’ functionality, the SCOR model allows companies to perform very thorough fact-based analyses of all aspects of their current supply chain. The SCOR model also eliminates all of the challenges and frustration associated with obtaining consensus on the definition, scope, and configuration of a given supply chain (Todd and McGrath, 1997b).

The process category definition of D1: Deliver Stocked Product, D2: Deliver Make-to-Order Product, D3: Deliver Engineer-to-Order Product, D4: Deliver Retail Product, and ED: Enable Deliver is shown in Table 1.

<table>
<thead>
<tr>
<th>Processes Category Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D1</strong></td>
</tr>
<tr>
<td><strong>D2</strong></td>
</tr>
<tr>
<td><strong>D3</strong></td>
</tr>
<tr>
<td><strong>D4</strong></td>
</tr>
</tbody>
</table>
| **ED** | ED1: The process of defining and maintaining rules which affect the acceptance of an order, based on quantity, method of delivery, credit, customer experience, etc. (Include distribution channel rules)  
ED2: The process of defining the requirement and monitoring the performance of the delivery of product to a customer. When physical delivery is out-sourced the performance is passed on to source for contract administration.  
ED3: The process of collecting, maintaining, and communicating information to support deliver planning and execution processes. The information to be managed includes: order data - (customer preference, history, status, and delivery requirements, etc.), warehouse data, transportation data, and deliver data.  
ED4: The process of establishing and maintaining finished goods, inventory limits or levels, replenishment models, ownership, product mix, stocking locations |
ED5: Acquisition, maintenance, and disposition of order management, warehouse and transportation capital assets. Determine material handling (inventory) pick pack & ship methods (inventory), and equipment.

ED6: The process of 1) defining and maintaining the information which characterizes product, containerization, vehicle, route, terminals, regulations, rates/tariffs and backhaul opportunity (Characterization include information necessary to support maintenance of internal Outbound Transportation equipment – CAPITAL ASSETS) and 2) the management of transporters.

ED7: The process of defining and maintaining the distribution channel/ network for a specific product line (no capital asset or transportation management).

ED8: The process of recording and maintaining regulations and rates, which constrain the ordering and delivering of product.

The attributes and metrics of D1 to D4 and ED are shown in Table 2. The main best practices are: Rapid replenishment, VMI, EDI, Electronic Catalogues/Malls, Internet Ordering, Efficient Consumer Response (ECR); Quick Response, Demand Planning, Deployment, Scheduling, Vendor Managed Inventory (VMI), Shipment Tracking, Utilize EDI and EFT for payment to speed closing of receivables and to reduce processing costs, Provide visibility to and quickly escalate delinquent accounts for resolution, Electronic transfer of shipment information to finance, Automated pick list, Push product on trailer arrival, Labor scheduling that matches product flow, Multiple locations throughout store, Automatic customer payment, Real time package tracking, Online real-time customer entry and edit, Inventory Cycle Counting, Measure Customer Service, Removal of Obsolete Stock, Real-time Optimized Shipment Method, Real-time Shipment Tracking, (via Internet), Operations and Network Analysis, Direct Transfer of documents to Recipient and Forwarder, Ability to track component/sub-component manufacturing country of origin, etc.

<table>
<thead>
<tr>
<th>Performance Attributes</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Reliability</strong></td>
<td>Perfect Order Fulfillment, Shelf Stock Out %, Replenishment Accuracy, Replenishment Timeliness, Shelf Space To Market Share Ratio, # Orders requiring intervention due to rule violation, Age of data - #days since last effective use, Ratio of active customer data/inactive customer data, Fill Rate (% filled of an order), % Perfect customer order delivery, % Capacity Utilization, % Obsolete or inactive inventory, Inventory Accuracy by location (% items whose physical count, and location matched system’s count and location), % Damaged products receipts and % damaged customer shipments, Frequency of parameter updates, Number of data sources for data collection, Total distribution cost as a % of revenue, Frequency of analysis (monthly, annual, 5 year planning cycle), Compliance with multi-country government regulations, Minimized delays in-transit caused by customs intervention</td>
</tr>
<tr>
<td><strong>Responsiveness</strong></td>
<td>Order Fulfillment Cycle Time, Deliver Cycle Time, Deliver Retail Cycle Time</td>
</tr>
<tr>
<td><strong>Flexibility</strong></td>
<td>Upside Deliver Flexibility, Downside Deliver Adaptability, Upside Deliver Adaptability, Service Levels / Accuracy</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Order Management Costs as % of Deliver costs, Deliver Retail Store Cost as % of Sales, Inventory carrying cost, $ Days of inventory, Warehouse Distribution Cost, Inventory Carrying Cost, Cost of Obsolete Inventory, Cost of Damaged Inventory, Data maintenance costs, Duty tax control, Cost of compliance</td>
</tr>
<tr>
<td><strong>Assets</strong></td>
<td>Cash to Cash Cycle Time, Return on Supply Chain Fixed Assets, Days of Stock in Retail, Transportation Assets, Inventory Days of Supply, Inventory turns per year, Delivery Fixed Asset Costs, Empty-to-loaded backhaul mile index, Equipment utilization rates (hours), Equipment utilization rates (product contribution margin), Vehicle maintenance costs, Distribution capital cost</td>
</tr>
</tbody>
</table>

**VALUE ENGINEERING**
Value Methodology is pioneered by Lawrence D. Miles in the 1940's and 50's, who developed the technique of Value Analysis (VA) as a method to improve value in existing products. In the beginning, VA was used primarily to identify and eliminate unnecessary costs. However, it is equally effective in increasing performance and addressing resources other than cost, when the application of VA widened beyond products into services, projects and administrative procedures [Craig, Latch and Zimring, 2002]. Leeuw, 2001, says that VM is not a conflict-orientated design review, a cost cutting exercise, and a standardization exercise [Fujitsu, 2002]. Department of Energy, 1997, defines VM as: The statutory and regulatory definitions encompass analysis of functions performed by a team of qualified personnel directed at improving performance, reliability, quality, safety, and life cycle costs of products, systems or procedures. Caltrans, 2003 defines the purpose of Value study as the VA Study will help create new alternatives and refine existing alternatives for the environmental document. By applying the VA process before the start of the technical studies, the environmental work will be better focused. The VA team will focus on alternatives that would improve operations, maintain or improve safety, reduce costs if possible, and satisfy the local stakeholders. VM can beneficially be applied to all areas of human endeavor. The Value Methodology is applicable to hardware, building or other construction projects, and to "soft" areas such as manufacturing and construction processes, health care and environment services, programming, management systems and organization structure [Leigh et al., 1996].

**Study Processes**

Lee (1997) describes the process of VE in manufacturer according to the SAVE International standard. The Value Methodology uses a systematic Job Plan. The Job Plan consists of specific steps to effectively analyze a product or service in order to develop the maximum number of alternatives to achieve the product or service’s required functions [Department of Energy, 1997]. Follow the Job Plan will assure maximum benefits while offering greater flexibility. Lee and Leu (2005) propose a value-up model for global logistics, which use SCOR and collaborative activities to optimize global logistics management, shown as figure 3.

![Value-up Model for Global Logistics](image)

*Figure 3 Value-up Model for Global Logistics [Lee and Leu, 2005]*

Usually performing a Value study lasts about one week for a construction project. However, in manufacturing area, the study will last for 3 months, sometimes even longer. Lee and Lo (2004) advocate performing audit system with Value study. For effectively performing Value Management, an organization should examine the performance of all products, services, and activities once in a
while. With the audit system, value study will perform better to eliminate useless functions for reducing cost and upgrading total competitive. During the develop alternatives activity, the ideas are developed into workable, alternative solutions. Each VA alternative is a multi-page write-up of the developed idea or combination of ideas that were highly ranked during the evaluation phase of the study. The documentation includes graphics and calculations, as well as narrative descriptions to communicate the alternative concept without the reader having to refer to outside information. [Caltrans, 2003].

Function Analysis
Function definition and analysis is the heart of Value Methodology. It is the primary activity that separates Value Methodology from all other “improvement” practices. The objective of this phase is to develop the most beneficial areas for continuing study [SAVE, 1998]. Function analysis helps a team to understand the hierarchical relationships of functions and focus their creative energy on finding better ways to accomplish a given function. Typically, some functions on the FAST diagram will be highlighted as promising areas for brainstorming [Lewis, 2001].

Functions are defined in verb-noun statements to reduce the needs of the project to their most elemental level. Identifying the functions of the project allows a broader consideration of alternative ways to accomplish the functions [Caltrans, 2003]. During FAST diagramming, it is important to involve every member of the team in the functional discussions. Performance of this activity is essential especially for the inexperienced, because this activity breaks down some of the barriers that seem to exist between team members; gives them practice generating and thinking in terms of functions; and provides a complete overview of the entire problem with facts pertaining to it. It also promotes an appreciation for the many different facets of a problem that must be considered, before a realistic solution can be recommended. [Parker, 1977]

Hitch hiking on another’s idea or expression is accepted as one of the best creative techniques, and should be encouraged throughout the entire FAST diagramming activity. Team members should be encouraged to project themselves into role-playing, in order to inject different points of view on the problem [Parker, 1977]. By analyzing the results of applying the cost and performance measure weights on the FAST Diagram, the VA team is then able to determine which functions they should focus their efforts on to have the greatest impact on improving the project. This opens the door to creative solutions that would not necessarily be apparent if the approach of seeking cost reductions of project parts were used [Caltrans, 2003].

TAGUCHI METHOD
Taguchi Method was developed by a Japanese scholar, Genichi Taguchi in 1950s [Peace, 1995]. Many companies have adopted this method and have reaped the benefits of improved customer satisfaction and decreased cost of operation. The quality loss function is stated in financial terms, which provides a common language for various entities within an organization, such as management, engineering, and production. The loss function is assumed to be proportional to the square of the deviation of the quality characteristic from the target value. As the quality characteristic deviates from the target value, the loss increases in a quadratic manner show as follow formula.

\[ L(y) = k(y - m)^2 \]  
\[ k = \frac{A}{\Delta^2} \]
Where \( k \) is proportionality constant, \( m \) is the target value, and \( y \) is the value of the quality characteristic. Note that when the value of the quality characteristic is on target – the loss is zero. The constant \( k \) can be evaluated if the loss \( L(y) \) is known for any particular value of the quality characteristic; it is influenced by the financial importance of the quality characteristic. The traditional notion of the loss function is that as long as the production quality characteristic is within certain specification limits or tolerances, no loss is incurred. Outside these specifications, the loss takes the form of a step function, shown as Figure 4. [Auburn University, 2003] From the loss function curve, we can find that the best design is met the target without any deviation.

An advantage of orthogonal arrays is their cost efficiency. The design of an orthogonal array does not require that all combinations of all factors be tested. Therefore, the experimental matrix can be smaller without losing any vital information. The result is an experiment that is cost effective to perform. For example, an L8 orthogonal array can incorporate seven different factors while requiring only eight experimental runs instead of 128 runs \( (2^7=128) \) [Su, 2000]. The linear graph is a graphical systems representation of the orthogonal array for assigning factors under investigation and corresponding interactions among these factors (see Figure 5).
There are three types of analysis: Larger-the-better, Smaller-the-better, and Nominal-the-better. The formula for the signal-to-noise ratio for the larger-the-better quality characteristic is also a logarithmic function and can be written in exactly the same form as the smaller-the-better SN formula. [Su, 2000]

\[ SN = -10 \log MS\]  
Where  
\[ MSD = \frac{1}{y_1^2 + 1/y_2^2 + ... + 1/y_n^2} \], for larger-the-better \hspace{1cm} (4)  
\[ MSD = \frac{y_1^2 + y_2^2 + ... + y_n^2}{n}, \text{for smaller-the-better} \hspace{1cm} (5)  
\[ MSD = (\bar{y} - m)^2 + s^2, \text{for nominal-the-better} \hspace{1cm} (6)  

Conducting a confirmation run and compare the actual results to the predicted results is the last step of Taguchi method. After completing the confirmation run, the result should be computed and compared to the predicted value. If the derived result is close to the predicted value, the recommended settings can be implemented.

Tien and Lee (2003) proposed a method of experimental design, which is divided into four phases. The process of proposed method is shown in Figure 6. The first phase is the problem study, which includes the description of problem and the selection of noise factors. The second phase is to perform the Taguchi method for the GA-based software. This phase include the determining the definition of SN ratio, selecting the number of levels of control factors and noise factors, and the implementation of experiment. The phase three is the data analysis, in which the experimental data must be analyzed and effective levels of control factors need to be determined after experiment. The final step is the confirmation of experiment for proving. If the purpose of the experiment is exploratory, two levels are usually adequate for screening designs. Using suitable orthogonal array to design experiment can shorten the total experiment time drastically because the design of an orthogonal array does not require testing all combinations of factors. Therefore, the experimental matrix can be smaller without losing any vital information. [Peace, 1995].

![Figure 6. Taguchi Method Process](Tien and Lee, 2003)

METHODOLOGY
For optimizing the outbound logistics, we create a VE-SCOR with Taguchi process model, shown as figure 7. A multiple-functional VE study team is formed by various departments as well as outside professionals. Then the team proceeds information phase to collect information and analyzes the information. Since we examine outbound logistics, SCOR is the perfect tool for use to distinguish and compare with our processes flows. To let us focus on the important position, function analysis and FAST diagram are the ideal methods to find out the key functions of the outbound logistics. Then creating ideas are generated by the team. Even though we have narrowed the problems, they are still very complicate with uncertainty. We adopt Taguchi method to adjust outcome of outbound logistics to meet target. That will be the least loss, such as the best production base, distribution center, material supplier, market customer, material flow, and cash flow. The best combination of factors will be selected by Taguchi method and presented for approval by management. After the presentation, the accepted recommendations will be implemented, which will be the best value of outbound logistics.

Figure 7 VE-SCOR with Taguchi Process model

**CASE STUDY**

T Company has a production base in Czech, Europe called TCZ. The supply chain of TCZ shows as figure 8. Vendors A, B, C, located overseas, transport materials and components through ocean and air directly or indirectly (3PL and Hub in EU), local EU vendors through land to TCZ for inbound logistics. For outbound logistics according to SCOR model, there are four types of distributions as D1: Deliver Stocked Product, D2: Deliver Make-to-Order Product, D3: Deliver Engineer-to-Order Product, and D4: Deliver Retail Product. The products can be distributed directly and indirectly (Hub/DC) to customers. Li (2005) suggests that for better management of logistics integration, the following items are needed to be well take care: WW Logistics RFQ, AVL Management, Freight Management, Route Management, Exception Management, LSP Performance Review, Shipping Order System Implementation, and WW Logistics Insurance Program (STP). The outbound logistics map of TCZ is shown as figure 9. Located almost in the center of Europe, TCZ might be a perfect location as a production base as well as a distribution center in Europe. Almost 85% of EU can be reached within 48 hrs and the rest EU can be covered within 3~5 days. [Li, 2005]
Figure 8 TCZ Supply Chain [Li, 2005]

Figure 9 TCZ Outbound Distribution Map [Li, 2005]
During the SCOR model review, we found that there are 54 best practices in D1, 48 best practices in D2, 29 best practices in D3, and 27 best practices in D4, totally 158 best practices. After Function Analysis phase, the team distinguished key functions for outbound logistics as “handle goods”, “Exchange Information”, “Transfer cash”, and “Better Strategy”. Then some best practices related these functions are picking out and arranged a table of 4 controllable factors with 3 levels, shown as table 3, for Taguchi method.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Function</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Handle Goods</td>
<td>Carrier/Route</td>
<td>Cross-Docking</td>
<td>Merge-in-Transit</td>
</tr>
<tr>
<td>B</td>
<td>Exchange Information</td>
<td>Single point of contact</td>
<td>Shipment tracking</td>
<td>Utilize EDI and EFT</td>
</tr>
<tr>
<td>C</td>
<td>Transfer cash</td>
<td>Electronic transfer</td>
<td>Credit Checking</td>
<td>Value Pricing</td>
</tr>
<tr>
<td>D</td>
<td>Better Strategy</td>
<td>Postponement</td>
<td>Partnership</td>
<td>VMI</td>
</tr>
</tbody>
</table>

After setting up the controllable factors, and noise factors, the experiments are arranged according to the orthogonal Array. The higher the satisfactory of combination will get the higher score, which is the larger-the better. Table 4 shows the experimental results.

<table>
<thead>
<tr>
<th>Exp.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>y1</th>
<th>y2</th>
<th>y3</th>
<th>y4</th>
<th>S/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>80</td>
<td>90</td>
<td>82</td>
<td>85</td>
<td>0.000142 38.48602495</td>
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<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>83</td>
<td>80</td>
<td>73</td>
<td>82</td>
<td>0.000159 37.9738745</td>
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<td>3</td>
<td>1</td>
<td>3</td>
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<td>3</td>
<td>82</td>
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<td>87</td>
<td>91</td>
<td>0.000135 38.69661796</td>
</tr>
<tr>
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<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>83</td>
<td>88</td>
<td>88</td>
<td>100</td>
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<td>0.000144 38.42852102</td>
</tr>
</tbody>
</table>

The significant factors, A, and B were determined according to SN response table (see Table 5). The best combination of the significant controllable factors is $A_2B_3$. Therefore, the best combination of all controllable factors is derived as $A_2B_3C_1D_1$.

<table>
<thead>
<tr>
<th>Exp.</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Effect</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38.39</td>
<td>38.68</td>
<td>38.63</td>
<td>38.48</td>
<td>0.49</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>38.87</td>
<td>38.27</td>
<td>38.47</td>
<td>38.54</td>
<td>0.38</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>38.43</td>
<td>38.74</td>
<td>38.59</td>
<td>38.67</td>
<td>0.21</td>
<td>3</td>
</tr>
</tbody>
</table>
In this case we chose cross docking, Utilize EDI and EFT, Electronic transfer, and VMI as alternatives, shown as table 6. After verification, the cost and satisfactory level were performing the best.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Function</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Handle Goods</td>
<td>Carrier/Route</td>
<td>Cross-Docking</td>
<td>Merge-in-Transit</td>
</tr>
<tr>
<td>B</td>
<td>Exchange Information</td>
<td>Single point of contact</td>
<td>Shipment tracking</td>
<td>Utilize EDI and EFT</td>
</tr>
<tr>
<td>C</td>
<td>Transfer cash</td>
<td>Electronic transfer</td>
<td>Credit Checking</td>
<td>Value Pricing</td>
</tr>
<tr>
<td>D</td>
<td>Better Strategy</td>
<td>Postponement</td>
<td>Partnership</td>
<td>VMI</td>
</tr>
</tbody>
</table>

CONCLUSIONS
Value Engineering has been proven as an effective tool to solve not only hardware but also software problems. Through function analysis and FAST diagram processes, a value team can generate a lot of ideas for improvement. However, in Supply Chain environment, the situations are complicating and changing all the time. Today’s best solution can not assure that it can maintain the best practice. This paper set up a VE-SCOR with Taguchi process model, which can be used to deal difficult problems of supply chain. With the real case example shows that the model can really solve the problems. From the research, we find that continuous improvement is very important, because the environment changes all the time. We should adjust our working methods once in a while. So we have to perform VE studies from time to time to maintain sustainable competition.

REFERENCES
[1]. Auburn University, 2003, Taguchi Designs, Auburn University.