MANAGING NON-VALUE ADDING ACTIVITIES IN A SUPPLY CHAIN BY A PRODUCT DESIGN

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ABSTRACT

There are two types of activities encountered in the supply chain- value adding activities and non-value adding activities. Examples of value adding activities are manufacturing, assembling, and disassembling of parts or materials. These activities are able to enhance product values. Examples of non-value adding activities are loading and unloading activities, inventory, inspection, material handling, rework, etc. These activities do not create values to the products but they are performed several times a day and also require labor, handling equipments, and IT system to operate them. Moreover, potential damages may be encountered during performing these activities e.g. loading and unloading activities. Non-value adding activities in supply chain can be eliminated by redesigning the product. For example, a change of product packaging is able to ease handling or inspection activities. In redesigning the product, the quality function deployment is implemented. Finally, redesign of the product is implemented in the case study. The result shows that redesigning of the existing product can be able to enhance material handling capability.

Keyword: Product Design; Material Handlings; Non-Value Adding Activities; Logistics Management

INTRODUCTION

Severe global competition and increasing trend in market complexity require business organizations to adapt themselves and come up with new strategies to compete with their competitors. One useful strategy for an individual business organization is to reduce its operating costs in its product supply chain (Lau, Jiang, Chan, & Ip, 2002; Mont, Dalhammar, & Jacobsson, 2006).

In a supply chain, materials are transported from suppliers to be processed at a manufacturing plant. After the production is carried out, finished products are transported to distribution centers or wholesalers. Then, products are distributed to several retailers located around the country. Finally, customers buy this product from retailers. For example, cane are transported from farming areas around the plant by small vehicles or trucks and be processed at the manufacturing plant. Later, raw sugar
is distributed to relevant wholesalers and retailers in the forms of sacks or small packs. Industrial plants such as soft drinks or candies buy sugar in the form of big lot while consumers are able to buy it from any convenient stores in the neighborhood.

There are two types of activities in a supply chain: value adding activities and non-value adding activities. Value adding activities refer to activities that generate values to the products. For instance, manufacturing, assembling, and disassembling of parts or materials. Non-value adding activities refer to activities that do not create values to the products. Examples of non-value adding activities are loading and unloading activities in the warehouse or distribution center. Other non-value adding activities are inventory, inspection, material handling, rework, etc. These activities do not add values to the products but they are performed several times a day and also require labor, handling equipments, and IT system to operate them. Moreover, potential damages may be encountered during performing these activities e.g. loading and unloading activities. Consequently, these non-value adding activities must be minimized.

Objectives of this research are (i) to define non-value adding activities in supply chain, (ii) to eliminate non-value adding activities by using design, and (iii) to validate the conceptual model in the actual product design case.

**CONCURRENT ENGINEERING**

Concurrent Engineering (CE) refers to the simultaneous development of product and process aims at shortening time to market, reducing the product development cost, and enhancing the product quality (Salomone, 1995; Stevenson, 2006). Tasks are carried out concurrently by team members from different departments e.g. marketing, design, production, suppliers, distributors, etc. to develop a new product (Petersen, Handfield, & Ragatz, 2005). Consequently, team members have better understanding of product and process through the information sharing and collaboration among them can be achieved accordingly.

In CE, customer requirements are translated into technical requirements. Then, downstream processes are brought earlier in the product design and overlapped with upstream processes. Multifunctional teams are involved right from the early stages of product life cycle in carrying out the product design (Petersen, et al., 2005; Salomone, 1995). Therefore, integration of different functional departments is able to respond customer requirements more efficiently.

Normally, a product design influences up to 70% of the product cost (Andersen, Khler,
& Lund, 1986; Blackhurst, Wu, & O’Grady, 2005) since materials, processing sequences, material handling equipment, packaging, etc are determined during the design phase. Different materials require different processing machines and methods as well as different material handling equipments. Hence, changes in design are able to reduce the product cost. Moreover, the right design can save costs by eliminating the chance of making mistakes, unnecessary tools, and sequences in the manufacturing and assembly process (Salomone, 1995).

**NON-VALUE ADDING ACTIVITIES IN A SUPPLY CHAIN**

Non-value adding activities exist in a product supply chain. These activities do not add value to the product but they consume several resources, materials, equipments, and budgets. In order to tackle these activities properly, non-value adding activities in a product supply chain must be identified.

In this research, non-value adding activities are classified into four different types. Details of these activities are discussed as follows:

**Transportation**

A transportation activity in a supply chain refers to an activity that moves products from one location to another location. Normally, a transport activity is required to deliver products to customers or receivers. It requires vehicles and human resources to perform and it generates costs. Moreover, this activity can be performed by air, sea, road, rail, or pipeline transportation modes.

Costs incurred in any transportation modes include vehicles, labors, fuel, maintenance, depreciation, insurance, overhead, etc (Rushton, Oxley, & Croucher, 2000). Moreover, ineffective utilization of vehicles affects transportation costs as well. For instance, empty containers are carried in return trips, containers are partially filled (less than full truck load), and vehicles are unable to use due to long downtime. In order to minimizing transportation costs, vehicles must be utilized which can be done by carrying as much loads as possible or eliminating empty carriage during return trip.

**Loading and unloading**

In a supply chain, products are loaded to vehicles or places and unloaded from vehicles or places later. Normally, loading and unloading activities require labors and equipments to perform e.g. forklifts, pulleys, cranes, etc.

Different physical aspects of products e.g. size, shape, volume, dimension, weight, length, status, stiffness, temperature, hazardness, etc. are significant to loading and
unloading activities or associated handling methods such as lifting, pulling, pushing, grasping (Ciriello, Snook, Hashemi, & Cotnam, 1999). Consequently, loading and unloading time depend on physical aspects of products and equipments as well.

Costs of loading and unloading activities include labors, handling equipments, damages during loading and unloading activities. Loading and unloading costs can be minimized by selecting of proper handling equipments, redesigning of physical aspects of products to match the handling equipments or labor, etc.

**Inventory**

In a product supply chain, products are waiting for the next operations as work in process or waiting for distribution in warehouses or depots. Products in inventory are able to meet expected demands, smooth production, protect against stock out, take order discounts, etc. (Stevenson, 2006) Agricultural products are low in values but require large space to store. Also, a product life is relatively short. Hence, products must be distributed before they start deteriorating. Costs incurred due to inventory are building rental, construction, labors, system, insurance, product depreciation, damages from unexpected events.

**Inspection**

When materials or products are delivered to another party in a supply chain, they are inspected to see whether quality and quantity requirements are met. Normally, an inspection activity takes time and requires labors to perform. For example, it is tedious and time consuming to check condition of agricultural products in Figure 1.

**FIGURE 1: A PACKAGE WITH INSPECTION DIFFICULTY**

In some cases, inspection activity is performed with complex procedures. For instances, a product package must be removed before an inspection can be conducted as illustrated in Figure 1. However, it is unable to repack the product back to normal
condition. Moreover, some inspectors are not capable enough to perform the right
inspection procedures. Consequently, unnecessary procedures are taken or product
can be damaged during inspection.

**Causes of non-value adding activities**
Non-value adding activities in the supply chain must be eliminated or minimized. Hence, it is necessary to determine common causes of these non-value adding activities. The cause-and-effect diagram is used to map several sources of non-value adding activities in the supply chain as depicted in Figure 2.

**FIGURE 2: A CAUSE-AND-EFFECT DIAGRAM OF NON-VALUE ADDING ACTIVITIES**

In Figure 2, there are several sources of non-value adding activities in the supply chain. Since the product design affects up to 70% of the product cost (Andersen et al., 1986; Blackhurst, et al., 2005), thus the product is redesigned to reduce the non-value activities and product costs. In the next section, the redesign of the product is implemented in the actual case study.

**CASE STUDY: A SUPPLY CHAIN OF SUGAR INDUSTRY**
The supply chain of sugar starts at cane farms. Matured canes are cut and transported by trucks to the sugar plant. In the manufacturing plant, canes are shredded and
extracted in order to obtain sugar contents or sucrose. Output from the sugar manufacturing process is raw sugar powder which is stored in the warehouse and waiting for orders. Sugar powder is then transported to domestic and international consumers. Main customers are household and industrial consumers such as soft drink, canned fruit, or chocolate factories. The overview of the sugar supply chain is illustrated in Figure 3.

FIGURE 3: THE SUPPLY CHAIN OF SUGAR

In sugar manufacturing, there are five processes in transforming cane into raw sugar. These five processes are juice extraction, clarification, evaporation, crystallization, and centrifugal as illustrated in Figure 4.

FIGURE 4: SUGAR MANUFACTURING PROCESS
In Figure 4, canes are cut and extracted by shredders. Then, mixed juice obtained is clarified by filters. Later, clear juice is boiled in evaporators. Outputs obtained from this process are raw syrup. Raw syrup is then crystallized in crystallization process and results in massecuite. Finally, massecuite is centrifuged and raw sugar is obtained in centrifugal process.

Simulation model

In this research, AweSim® simulation software is used (Pritsker, & O’Reilly, 1999) to measure the existing behavior of the sugar manufacturing process. The simulation model of the current sugar process is depicted in Figure 5.

FIGURE 5: THE MODEL OF SUGAR MANUFACTURING PROCESS

The result from the simulation model indicates that the sugar manufacturing cycle time per ton is 8.75 hours.

Design of sugar product

Raw sugar is used as the raw material in soft drink production. By consuming time and energy, raw sugar is dissolved and transformed into syrup. Later, syrup is used as the mixture in the soft drink production process.

In order to tackling non-value adding activities, different team members from both sugar and soft drink manufacturers collaborate and share their knowledge. Consequently, better understanding of sugar and soft drink manufacturing can be achieved. Also, quality function deployment (QFD) (Russell, & Taylor III, 2006) is employed as a tool to determine customer requirement for sugar. The result from QFD analysis can be illustrated in Figure 6.
In Figure 6, design characteristics that have estimated impact higher than estimated costs should be considered. In this case, energy use, heating time, and bag packaging are concerned. The design team came up with the redesign of sugar product by selling sugar in the form of syrup in stead of the form of powder.

**Results**

The sugar manufacturer delivers raw syrup directly to the soft drink manufacturer instead of raw sugar. Raw syrup has a lower cost than raw sugar powder since it does not consume energy in crystallization and centrifugal processes. Packaging costs can be reduced since delivery in liquid form does not need time to pack into a bag. The
result from the simulation analysis indicates that the sugar process requires 7.913 hours to produce 1 ton of syrup. Hence, the production time can be shortening at least 50 minutes from centrifugal process and packaging. On the other hand, the soft drink manufacturer can also save their production costs since no energy is needed to dissolve raw sugar into syrup. Raw syrup can be mixed in the soft drink production process directly and soft drink production time can also be shortening. Moreover, several testing and inspection activities can be performed easier since some sugar properties such as sweetness must use raw syrup rather than raw sugar.

Additionally, the sugar manufacturer is able to sell raw syrup at higher price than selling raw sugar and the soft drink manufacturer is willing to buy raw syrup because they can save energy cost and production time from dissolving raw sugar into syrup.

**CONCLUSIONS AND DISCUSSIONS**

In this research, concurrent engineering are carried out in the sugar supply chain and customer requirements are translated into new product design using quality function deployment. These new products are able to remove non-value adding activities in supply chain and reduce product costs.

However, a change in a product design results in changes in manufacturing equipments and sequences of operations. Modifications of manufacturing processes are inevitable. Consequently, these modifications generate additional costs to the manufacturers. Hence, costs and time savings as well as environmental impacts from the new product design must be compared to the costs of the existing product which inherits non-value adding activities.

**REFERENCES**


