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A Study on the Effects of Client Company Information on the On-Site Logistics and Processes in a Supply Chain: A New Design Approach using Quality Function Deployment

Masamitsu KIUCHI[1*], Kazushi NAGAI[2] and Kenichi NAKASHIMA[3]

[1]Josai University, Japan
[2]Tamagawa University, Japan
[3]Kanagawa University, Japan

Recently, manufacturing companies have to construct supply chains considering the contingencies of global clients. In order to meet global demand, companies are required to quickly grasp the information which is disseminated in the supply chain. This study focuses on business to business (B to B) manufacturing model in a supply chain. Generally, manufacturing companies which supply the products to client companies engaged in B to B structures deliver the products according to the client companies' order. Manufacturing companies subsequently deliver the product depending on the order specifications that determine the delivery time, the order quantity, the order quality and so on. Therefore, the orders requisitioned by client companies might cause some impacts on the operations in the companies engaged in B to B structures in the supply chain. We suggest a new approach to solving the operation problems using Quality Function Deployment (QFD). QFD is a powerful methodology and is effective in organizing manufacturing information and setting the quality of design. A case study is given to show the implementation of the proposed methodology.

Keywords: *Quality Function Deployment, On-site logistics and processes, Business To Business manufacturing structure, Supply Chain, Operation Management*

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* Corresponding Author:
Masamitsu Kiuchi, Josai University, Japan

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1. Introduction

In manufacturing companies, one of the important problems affecting production strategy is to construct an efficient supply chain (Leenders et al, 2002). In developing the supply chain, manufacturing companies have to quickly supply new product to the market. This study focuses on companies located in the middle of the supply chain. The focus is on business to business (B to B) manufacturing structures (see Fig.1). For example, we consider the parts manufacturer (supply companies) in this study. The supply company starts production based on an order list of products from the manufacturer (client companies). The contents of the order list are: type of product, order quantity, delivery time, and others. For example, considering the productivity of the supply company, the producing order is Product A →Product A →Product B →Product B. Observing this, we conclude that the supply company is developing one component at a time. However, the order list required by the client company for optimal results is Product A →Product B →Product A →Product B. Therefore, the current supply company production cycle in terms of the productivity is not ideal because is slowed down by increasing the number of setup times. Accordingly, the on-site logistics and processes of the supply company will be greatly affected by the order list of the client company.

In this study, we use Quality Function Deployment (QFD) in order to evaluate and design the manufacturing systems. Generally, the quality of design is set by QFD in the manufacturing company (Ohfuji et al, 1990, Ohfuji et al, 1997, Yoshizawa et al, 2004). The basic function of QFD is to organize manufacturing information. QFD is defined by the impact of information received from the client companies. In order to control the flow of products and on-site logistics and processes, it is necessary to control the flow of information of said processes.

The purpose of this study is to develop a new approach to suggest solutions for the problems in the supply chain using a methodology that acknowledges QFD practices. We also discuss the effects observed in the analysis of client company information at the on-site logistics and processes related to the supplying company.

We first clarified the impact on on-site logistics and the processes in order to organize the requirements of client companies by using QFD. Secondly, we proposed research techniques for on-site logistics and processes in the supply chain.

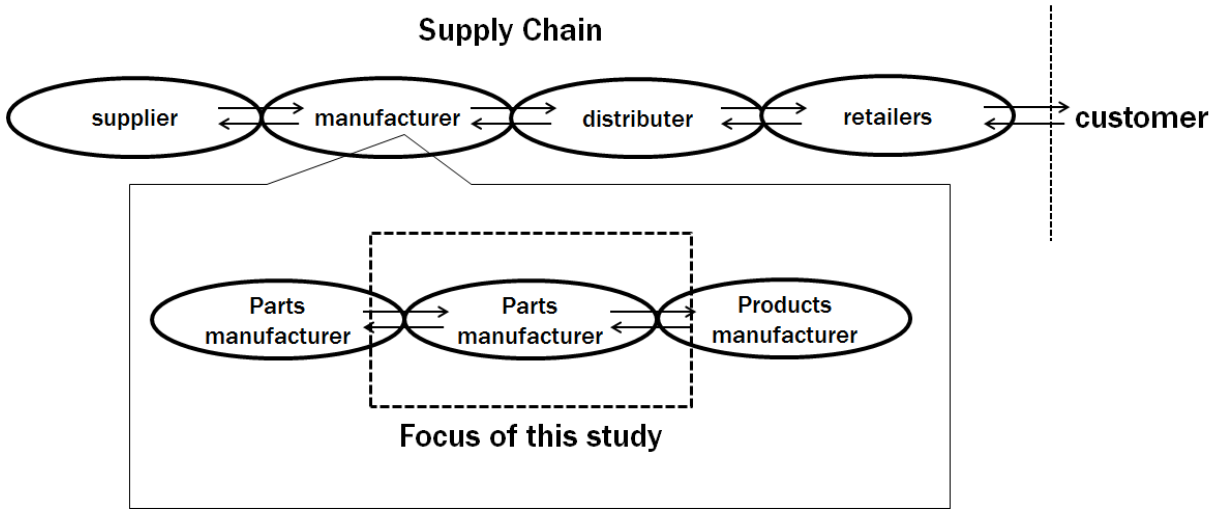

Figure 1. *Focus of this study in supply chain*

2. Literature Review

QFD was developed in 1960s in Japan. Another correlated method called Statistical Quality Control (SQC) which Japanese engineers first learned about from American professionals, helped to improve the quality in production stages at the time. SQC, however, was not adequate when it comes to product design stages. Therefore, in order to improve quality of design stages, scholars Shigeru Mizuno and Yoji Akao developed the concept of QFD. The first generation of researchers focused on quality assurance in production processes, for example the efficiency of the production lines were verified in order to maximize production

results (Mizuno and Akao, 1978). In the second generation of studies, a quality table in QFD was proposed (Ohfuji et al 1997). More recently, new studies have found that the subject of QFD was considerably expanded since its inception.

The QFD's concept and the characteristics of its studies are detailed as follows.

2.1. What Is Quality Function Deployment?

Fig.2 shows the flow of production stages, from development to manufacturing (Lertchanyakul, 2013, pp.158-173).

When considering of quality in manufacturing, there are two types of qualities. One is the quality of conformance. By this we mean the gap between the design of a product and its finished form. Let's imagine, for example, a pen. Let's suppose that the length of this pen is 150.0mm in the schematics. After manufactured, the pen's actual length is 150.2mm. This difference is what we call quality of conformance. The other type is quality of design, which refers to the gap between the voice of the customer (VOC) and the design schematics.

In the case of the pen, for example, the voice of the customer is "easy to hold". In order to satisfy it, the pen's length in the design schematics has to be 150.0mm. QFD is used to determine and set this quality of design.

On the other hand, in order to set the Quality of conformance, we usually utilize SQC to analyze the system.

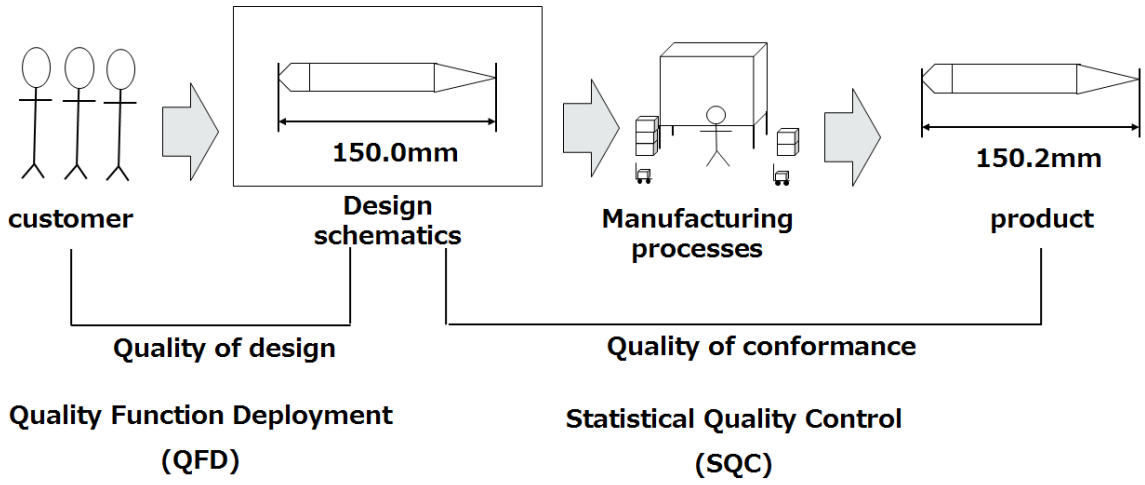

***Figure 2**. Considering of quality*

(1) Flow of QFD

QFD organizes information. As we can see below, Fig.3 shows the quality table. In the quality table, the row represents required quality and the column stands for quality characteristic.

In the process of acquiring this information, first, VOC is collected, through interviews, questionnaires and others methods (Nagai et al, 2013, pp.61-70). Then, the required quality is set. After that, the quality characteristics are evaluated these required qualities are defined. Moreover, we consider the relationship between required quality and quality characteristics. The result will provide quality of design.

Accordingly, the required quality transforms quality of design.

(2) Expressing QFD

In QFD, there is a separation between function and quality, which is expressed through language data (Nagai, 2011, Scripps, 2013, pp.194-221). Function is commonly expressed through a "verb + noun" structure. For example "Displaying the time". Quality, on the other hand, is expressed through the addition of adverbs and adjectives, for example "accurately" and "exact" the complete expression becomes "accurately displaying the exact time".

2.2. QFD Research

The QFD studies can be described in two categories. The first type or category of QFD relates to its concept and it is applied to many situations presented in production development, production design etc. For example, Mohamadi (2012, pp.154-157), Kiuchi and Ngai (2013, pp143-150) and Jayarama and Pathakb (2013, pp.1958-1972) proposed researches on the relationship between customer and supply chain. Other scholars such as Chen (2009, pp1469-1484) and Kiuchi (2014, pp105-115) also researched on operation improvement. Yeh and Huang (2010, pp.125-141, pp56-62) and Yamashina et al (2002, pp.1031-1050) presented studies related to other methods, such as TRIZ (Theory of solving inventive problems).

The second category of QFD is related to its performance and is measured by quantification. For example, Yana et al (2013, pp.6336-6355), KHOOa and HOb (1996, pp.299-311) and Fung et al (2002, pp.585-599) are the proposed performances of QFD, which are achieved by applying fuzzy theory. The study we are proposing belongs to the first category. Accordingly, QFD tools in this study organize information that exists in on-site logistics and processes. Specifically, QFD expression and matrix tables are emphasized in this study.

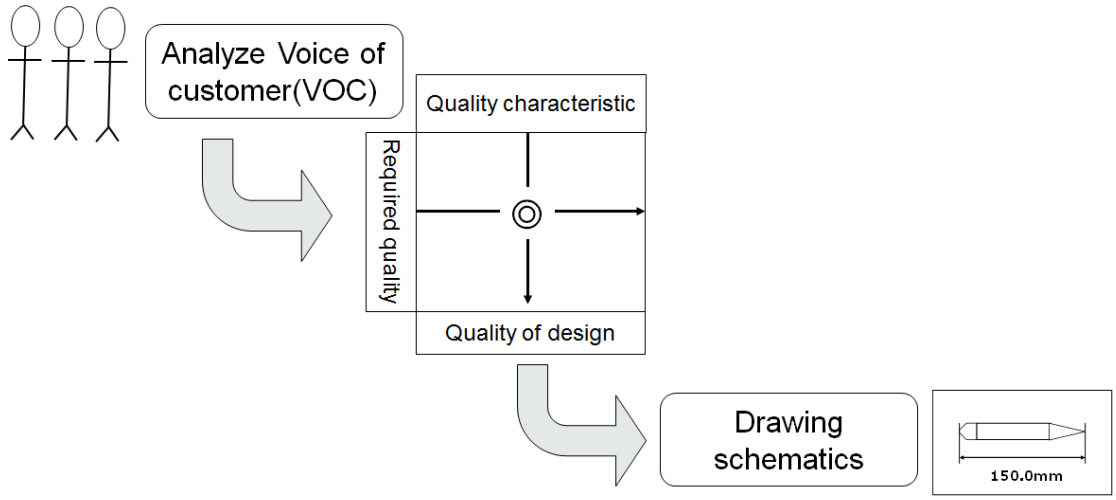

***Figure 3**. Flow of QFD*

3. Research Premises and Research Methodology

Fig.4 shows the supply chain situation of the case model analyzed in this study. Conventional approach, says that improvement activities are carried out within on-site logistics and processes. These types of approach, however, do not consider the client company effects that might occur in the operations. The model of this study is considering the relationship between the supply company and the client company. Let us consider, then, B to B manufacturing structures.

First, the parts manufacturer receives the order list from a client company. Only then, the parts manufacturer begins the manufacturing process. After that, the requested parts are shipped to the client company.

This study uses matrix table and QFD expression as QFD tools (see Fig.5). Fig.5 shows on-site logistics and processes in a parts manufacturer factory. The numbering indicates the flow of research presented in this study. The complete process is described next.

3.1. Proposed Approach

The Flow of Research is detailed as follows:

(1) Determining a process chart:

Firstly, we determine a process chart to be used by the parts manufacturer (Kanawaty, 1992). There are three kinds of activities: transportation, assembly and sorting as illustrated in Fig.5.

(2) Information of final packaging that is expressed by QFD methodology:

Secondly, we focus on the symbol at the end of the process chart. That is because the client company's order affects the final shipment. For this reason, the information of the final shipment is determined by a QFD expression. For example, "ship the product as specified in the order".

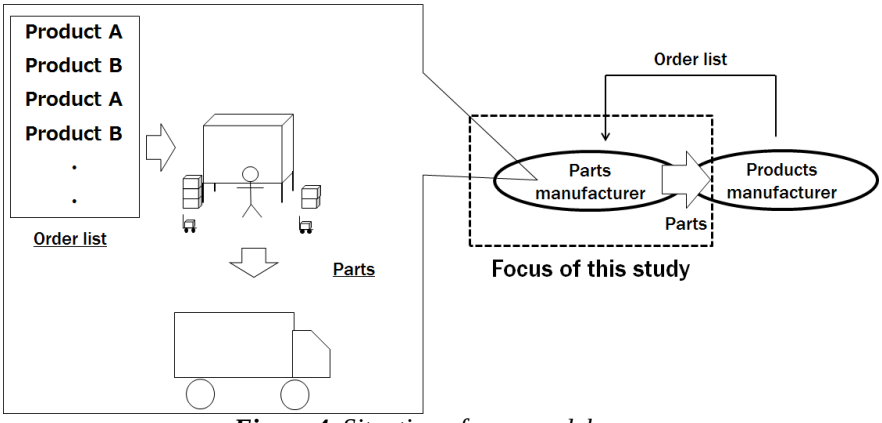

Figure 4. *Situation of case model*

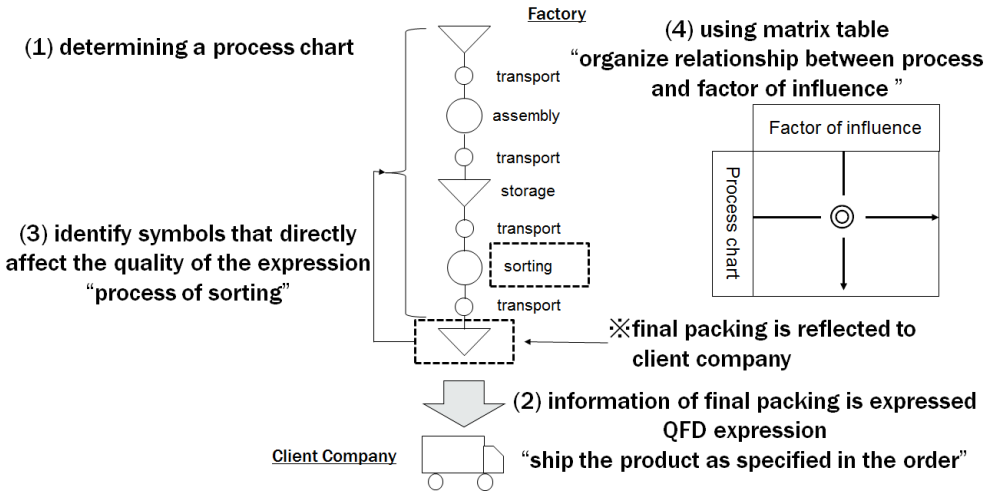

Figure 5. *Flow of research*

(3) Identify symbols that directly affect the quality of the expression "process of sorting":

Then, we identify the symbols that directly affect the system. These symbols are researched and defined according to the results of the questionnaires obtained during the quality of the expression stage. At every company, the sorting process is pointed out as the bottleneck factor in the process' operations.

(4) Using the QFD matrix table:

Finally, we organize the relationships between processes and factors of influence using a matrix table. There are factors of influence in several categories. For example, the requirements of the client company, the type of factory and the item to be produced. Parts manufacturer should consider the manufacturing system used for the sorting process as required by the client company (see Fig.6).

3.2. A Case Example

Furthermore, after organizing information by QFD, we can propose an improvement plan for on-site factory operations (see Fig. 7). First, the operation of sorting is improved by on site work-study. As a result, sorting time becomes shorter than the previous one. Additionally, we introduce different types of transportation to harmonize the system as the proposed second action. Then, we apply QFD methodology, as part of our improvement plan in order to make the operation targets clear, by considering the effects observed in the client company. According to our observations in this study, the improvements achieved by QFD methodology might lead up to a 20% reduction in the whole operation time.

As a result, by laying out the existing manufacturing process we can determine the steps involved in fulfilling the orders made by a client company (see Fig. 5). QFD methodology tells us the exact expression for these required orders. The proposed process chart allows us to easily identify the steps that directly influence the final shipment as required by the client. With our matrix table we can determine the exact order in which the process best suits the required shipment.

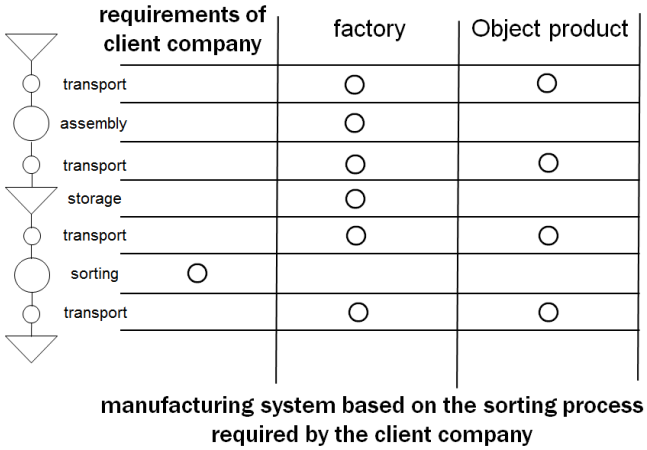

***Figure 6**. Matrix table*

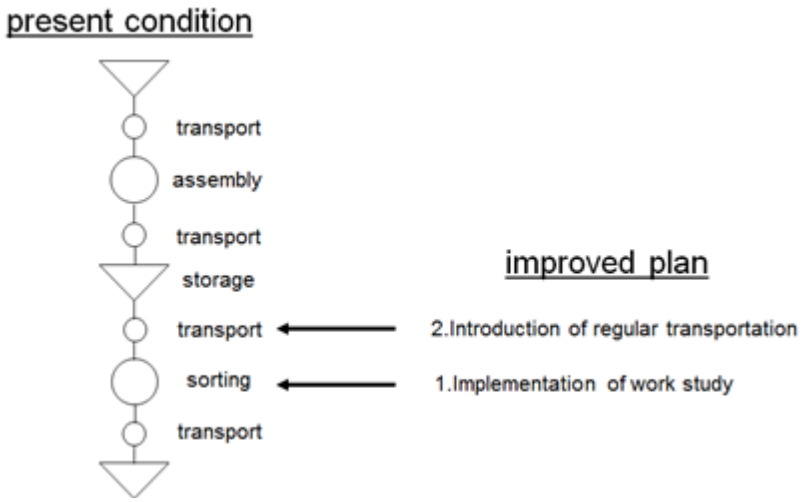

***Figure 7**. Considering of improved plan*

4. Discussion and Conclusion

In this study, we dealt with the supply chain operation problem in the B-to-B model. We proposed the new approaches to minimizing the negative impacts of the client orders on the on-site logistics and processes of its suppliers and how to organize the requirements of the client company using QFD methodology. Moreover, we developed the procedure for evaluating the effects of our improvement plan on the suppliers' manufacturing processes, as determined by the client's orders. The application of the proposed procedure is limited within the condition of this case model, which also defines the scope of this study, and it is characterized mostly by the B-to-B manufacturing structure and the discrete manufacturing structure processes analyzed specifically in this case study. However, this case study gives us the implementation of the suggested the methodology. We can extend this basic methodology to the various types of the manufacturing models with appropriate parameters.

In a future research, we expect to improve the different types of supply chain model such as B-to-C and show the effectiveness of this procedure when applied to other cases. We can also consider not only how to apply it to quality function deployment, but also how to use the methodology proposed with other methods

as well. Finally, we will suppose a total management procedure that suggests the coordinating process between quality function deployment and general industrial engineering methods.

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