

SUPPLY CHAIN FLEXIBILITY: THE *MAKE TO STOCK*-BASED PRODUCTION SYSTEM

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ABSTRACT

The purpose of this study is to measure and identify several factors that likely affect supply chain flexibility, so that we can know flexibility of supply chain system that may need improvement and will have considerable impact on the increased flexibility of our supply chain system. The results had showed the levels of supply chain flexibility amounted to 80.97% and the levels of the supply chain flexibility for several main dimensions were shown as follows: *Product design* (83.12%), *Delivery System* (82.80%), *Production System* (80.25%) and *Supplier System* (77.72%), respectively. And the five priorities of improvement were shown as follows: the number of products that can be manufactured without increasing the costs of the production machines (PS2); developing the high-quality product design quickly (PD1); the use of the existing production capacity for carrying out current production (PS4); the procedure that undertaken for new product design that will be issued (PD5); and repairing the broken-down of machines immediately (PS3).

Keywords: *costs of production machines, high-quality product, production capacity, new product design, broken-down of machines*

1. INTRODUCTION

Supply chain concept is a new concept for dealing with logistic problems. The management's view about the concept of logistics and logistic activities begins to change so that a company is aware that the competition that has happened is not between retailers and suppliers, but between one supply chain and another supply chain. Competitive advantages that can be reached if company applies the concept of supply chain are: (1) Having a high delivery reliability. (2) Having high response speed and high flexibility. (3) Low total costs of supply chain, and (4) Having a high *asset turns*. To improve the effectiveness and efficiency of supply chain systems, the company must improve flexibility continually so that supply chain flexibility would be better and increasing from time to time. One of the most important aspects to create a high level of the supply chain flexibility is a measurement of the supply chain flexibility.

Supply chain is an integrated process in which raw materials are subjected to manufacturing processes to be used as a final product, and then they are shipped to consumers (either through distribution, retail, or both) [1]. From this understanding develops an idea about the supply chain to analyze further supply chain, including in this case measurement of supply chain flexibility. Flexibility also means the ability to change the shape of the production objects in accordance with the existing demand [2], while flexibility is defined as the ability of organizations to meet any increased varieties of the consumers' expectations without causing a reduction in cost, time, and changes in the organization [3].

Flexibility in the manufacturing system as mentioned above is closely connected with the flexibility that existed at the supply chain. This is due to the fact that manufacturing flexibility has a very important role in the company's internal condition, while at the same time the supply chain also affects the company's condition internal, so the influence of manufacturing flexibility on supply chain flexibility is very pervasive compared with flexibility of the company's internal condition. This is caused by the extensive network in the supply chain itself. Supply chain flexibility can be used to analyze the capability of the system as a whole to cope with any fluctuations that may occur in the volumes and schedules of suppliers, manufacturers and consumers representing an assembly of the supply chain itself. Supply chain flexibility plays very essential role in the success of the supply chain itself, even more in the company experiencing a very high uncertainty.

The supply chain flexibility is highly complex and consists of multi-dimensional concepts and very difficult to be summarized [4]. But one thing that needs to be emphasized in flexibility of supply chain, namely the supply chain must have the ability to respond to both internal and external changes that may occur any times. The depiction of supply chain flexibility should basically cover the whole of the existing system in the supply chain itself, i.e. starting from the supplier to the consumer; the dimensions of the existing flexibility within a supply chain should be able to reflect all these elements [5]. Then the model and such characteristics were developed by Swafort who states that the

dimensions of flexibility that is more common but include all the elements in the Supply Chain, the dimensions are: (1) *Sourcing* is the assessment given to the ability of which is owned in terms of procurement of raw materials and is associated with the supplier system. (2) *Product development* is an assessment given to the skills to make a variety of products and carry out new product planning which is also called *product design*. (3) *Production* is the assessment given to the ability of the company from within, which in the previous section, better known as flexible manufacturing or more correctly known as the *production system*. (4) *Delivery* is an assessment given to the ability directly related to the consumer for *delivery system* [6].

Fluctuating demand from consumers combined with the necessary amount of raw materials requires the company to have high flexibility. Until now the company does not have a clear measurement system of flexibility in which the flexibility is only measured functionally and also measured from the output dimension only. Additionally, measurement of flexibility is just focused on manufacturing flexibility, while measurement of supply chain flexibility is given less attention. Manufacturing flexibility here is the ability to process a variety of objects with different shapes and in different working systems. The aims of this research are (1) to determine the level of supply chain flexibility on each dimension. (2) determine the parameters that need to be prioritized to be improved so that the supply chain flexibility of the relevant company can be enhanced in favor of the customer satisfaction, cost reduction and increased *cash utilization*.

2. METHOD

Data used in this study were collected using a questionnaire instrument designed in three phases, namely: (1) questionnaire employed to acquire quantitative data (objective data) was developed from the interview process with the head of each department in associated with dimensions of supply chain flexibility. (2) questionnaire employed to acquire qualitative data (subjective data) was developed using a 1-5 point scale for the conditions of requirement and capability for each parameter of the flexibility, which will be compared between the two. (3) Third questionnaire was a weighting questionnaire. The data collected were then analyzed by (a) calculating a weight of parameters used to determine the level of the importance and the role of each dimension and each parameter of supply chain flexibility; this process is called *Analytical Hierarchy Process (AHP)*. (b) determining a gap in the level of flexibility based on the pairing of statements on requirement and capability for each parameter of the flexibility. (c) Graphing of the gaps in requirement and capability of the parameters. (d) Calculating the weighted gaps and determining priority of improvement by multiplying gaps obtained from weights of parameters. (e) Graphing of the requirement- and capability-weighted gaps of the parameters. (f) Mapping of the flexibility quadrants based on values of the weighted gaps into four quadrants of supply chain flexibility assessment model. (g) Calculating the level of supply chain flexibility and graphing of the flexibility level.

In a study of supply chain flexibility, the flexibility is reviewed in terms of four dimensions: Delivery System, Production System, Product Design and Supplier System. Several parameters of the supply chain flexibility based on 4 dimensions are shown in Table 1.

3. ANALYSIS AND DISCUSSION

The supply chain flexibility for each dimension of the flexibility is shown graphically. Figure 1 shows a level of supply chain flexibility for every dimension and parameter. Regarding the main dimensions, the levels of supply chain flexibility in descending order are shown as follows: Product Design (83.12%), Delivery System (82.80%), Production System (80.25%), and Supplier System (77.72%), while flexibility of the main dimension is recorded at 80.97%.

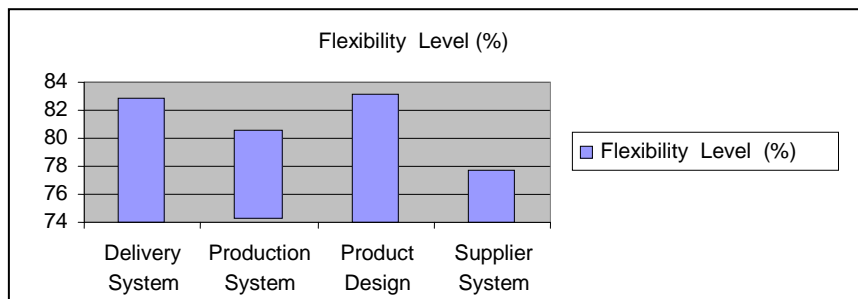


Figure 1. Graphical Representation of the Supply Chain Flexibility for Main.

Regarding the flexibility level of *Delivery System* subdimension, the flexibility of the parameters in descending order is shown as follows: Sending a request inquiry easily (89.83%); scheduling of delivery request information from customers (87.5%); fulfillment of request from more than one distributor (81.19%); combining different products in one type of conveyance (80.70%); using various means of transportation for product delivery (79.67%); and product delivery in accordance with the needs (requirement) or request (76.12%).

Regarding the flexibility level of *Production System* subdimension, the flexibility of the parameters in descending order is shown as follows: Manufacturing many types of products (85.76%); repairing the broken-down machines immediately (85.59%); the use of the existing production capacity for carrying out current production (78.81%); the number of products that can be manufactured without increasing the costs of existing production machines (76.83%); and the use of the same components in a type of products manufactured (68.59%).

Regarding the flexibility level of *Product Design* subdimension, the flexibility of the parameters in descending order is demonstrated as follows: Authority to make a decision on new design (91.89%), the capability of searching for suppliers to provide raw materials for manufacturing new products (84.59%); developing various designs (82.37%); developing the high-quality product designs quickly (81.99%); and procedure performed for new product design that will be issued (79.7%).

Regarding the flexibility level of *Supplier System* subdimension, the flexibility of the parameters in descending order is displayed as follows: Number of goods delivered by suppliers for fulfilling the company's demand (81.54%); times that are required by the suppliers starting from demand to acceptance of the goods by the company (78.33%); number of suppliers belonging to the company (76.74%); means of transportation used by suppliers to fulfil the company's orders (76.19%); and total capacity of the suppliers (71.42%).

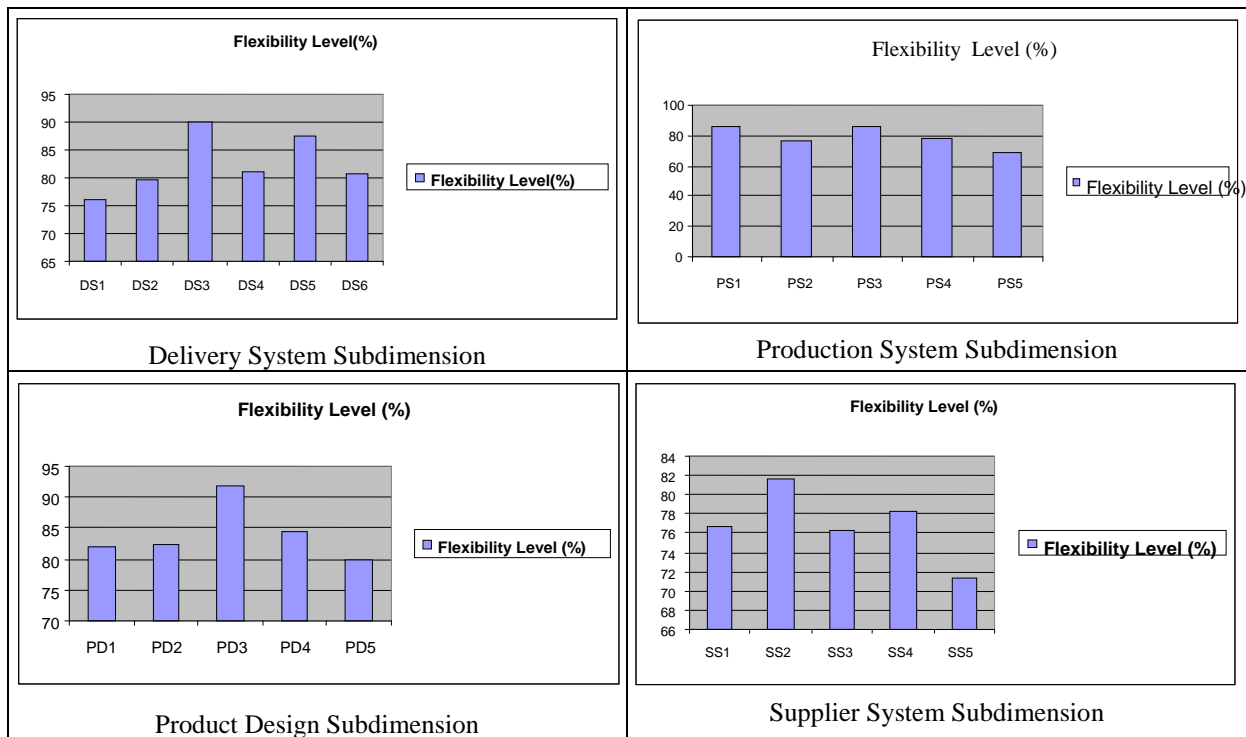


Figure 2. Graphical Representation of the Supply Chain Flexibility for each Subdimensions

The levels of flexibility measured here have not reached the highest flexibility (100.00%). This is because there is a significant gap in dimensions or their parameters. Therefore, they need to be improved further. The following priorities in descending order should be taken into account:

1. The number of products that can be manufactured without increasing the costs of existing production machines (PS2)
2. Developing the high-quality product design quickly (PD1)
3. The use of the existing production capacity for carrying out current production (PS4)
4. Procedure undertaken for new product design that will be issued (PD5)

5. Repairing the broken-down machines immediately (PS3)
6. Developing various designs (PD2)
7. Capability of searching for suppliers to provide raw materials for manufacturing new products (PD4)
8. Manufacturing many types of products (PS1)
9. The use of the same components in a type of products manufactured (PS5)
10. Product delivery in accordance with the needs or request (DS1)
11. Using various means of transportation for product delivery (DS2)
12. Number of goods delivered by suppliers for fulfilling the company's demand (SS2)
13. Combining different products in one type of conveyance (DS6)
14. Fulfillment of request from more than one distributor (DS4)
15. Scheduling of delivery request information from customers (DS5)
16. Number of suppliers belonging to the company (SS1)
17. Total capacity of suppliers (SS5)
18. Means of transportation used by suppliers to fulfill the company's orders (SS3)
19. Sending a request inquiry easily (DS3)
20. Times that are required by the suppliers starting from demand to acceptance of the goods by the company (SS4)
21. Authority to make a decision on new design (PD3)

4. OVERALL CONCLUSIONS

Supply Chain is fairly flexible with respect to every dimension and parameter at 80.97%. Levels of the supply chain flexibility for the main dimensions can be shown in descending order as follows: *Product design* (83.12%), *Delivery system* (82.80%), *Production system* (80.25%), and *Supplier System* (77.72%). Priorities of the improvement that should be carried out are as follows: (1) number of products that can be manufactured without increasing the costs of existing production machines (76.83%); (2) developing the high-quality product design quickly (81.99%); (3) the use of the existing production capacity for carrying out current production (78.81%); (4) Procedure undertaken for new product design that will be issued (79.7%); and (5) repairing the broken-down machines immediately (85.59%).

5. ACKNOWLEDGEMENTS

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7. REFERENCES

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