MEASURING SUPPLY CHAIN FLEXIBILITY: A CASE STUDY OF METAL CONSTRUCTION COMPANY

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ABSTRACT

Intense competitionof *the contractor and fabrication industries demands that each company has the right strategy to maintain its performance Manufacturers are exposed to consumers who understand what they need and their qualifications. Flexibility becomes one of the factors considered to improve quality and win the market competition. Flexibility itself in the supply chain is a multidimensional concept with the aim of having the ability to respond to all forms of changes that occur both from within and from outside the company. In this thesis will be conducted research to analyze whether PT. FGH is flexible enough and able to respond to consumer demand by using Analytical Hierarchy Process (AHP) method. From the results of this study obtained the greatest value of gap weight for supply chain flexibility at PT. FGH is 0.522 from indicator (DS2) with flexibility level 60% that mention about information about fleet demand easily and quickly with suggestion of new strategy that can be done by company to improve quality is performing vendor registration in the form of partners based on company need*

Keywords: *analytical hierarchy process, fabrication,flexibility, supply chain.*

Introduction

The high competitiveness in the contractor and fabrication industries requires every company to have the right strategy to survive. One way to realize that consumers will choose contractors and manufacturers who meet their qualification standards and are able to fulfill their requests. One way to become a qualified company is to implement supply chain management. According to Wang (2002) in general the supply chain offers a mechanism that regulates business processes, increases productivity, and reduces operational costs. In producing quality product, good service and still able to reduce operational cost hence very needed an integrated solid supply chain management. The supply chain system should focus on speed, quality and flexibility, creating superior customer value in response to customer needs. Companies that can run effective supply chain activities and gain not only short-term, even longterm benefits such as increased profit from prolonged cooperation with various parties, cost efficiency, market share expansion and customer satisfaction (Siagian, 2007) and this is where it develops an idea to analyze and identify supply chain flexibility. Supply chain flexibility can be used to analyze the ability of a system as a whole, so as to manage the usual fluctuating moment in material volume, lead time supplier, and consumer demand itself. (Pujawan, 2004a).

Being flexible to a company is an important thing, but having a high flexibility is also costly. So there needs to be an assessment of how much supply chain flexibility that must be owned. A company can be flexible in one dimension but less flexible on another dimension, depending on the emphasis of each company (Golden & Powell, 1999). Fisher (1997) divides the classification of a good product into two types namely; functional and innovative. Functional products are characterized by a relatively long life cycle, little product variation and easy demand estimates, resulting in an error in estimates of production processes of no more than 10%. On the other hand, innovative products are characterized by short Product Life Cycle (PLC), having a lot of diversity so that the probability of production error is high.

Supply chain has a special approach to deal with both cases above. For innovative products must prioritize everything that is responsive, while for functional production cost products that become the main focus. Based on this classification, innovative products require higher supply chain flexibility than functional products. Therefore it is important to assess the flexibility and supply chain for a manufacturing company so as to connect the demands with the capabilities possessed. So that the competitiveness of a company can be determined by the ability of the company to answer market needs that includes quality, efficiency and flexibility. But implicitly the statement has produced a statement that the company need not be too flexible if the market does not ask for and does not need it.repairing activity.

To win a job, service providers need to provide the best service. So it is necessary to do an evaluation of the company amid the increasingly competitive competition of the fabrication industry. Evaluating the supply chain is now a starting point for PT FGH. Over the last few years there have been several cases of supply chain disruptions that have an impact on the lack of performance of the company that imposes the delay in the delivery of goods to the customer to not be able to accept customer orders that are abrupt or special order. This supply chain disruption provides a domino effect on the next process that can threaten the business continuity of the company. PT FGH is a 38 years old steel structure & fabric manufacturer based in Indonesia engaged in fabrication of warehouse structures, factories, mining machinery and materials, plate work and material installation services on site. Over the past few years PT. FGH often overload production so that it cannot accept consumer demand suddenly, demand on a small scale and when forced to make an addition will be delayed delivery of goods into the hands of consumers. Actually this thing has happened to every service provider but this company wants an evaluation to be able to overcome habits that occur. So this company needs a big framework to analyze the supply chain flexibility that has been running for this and make improvements to the system so that in accordance with management expectations and market needs.

Supply Chain

Supply chain is a process which is started from collecting existing resources followed by management to finished-product for subsequently distributed and marketed to end customers by paying attention to cost, quality, availability, after sales service, and reputation factor. Supply chain involves suppliers, manufacturers, and retailers who work together and work together with each other directly or indirectly. (Wisner et al., 2011)

A supply chain consists of all parties involved, either directly or indirectly in the groove to meet customer demand. Supply chain does not only include manufacturers and suppliers, but also carriers, warehouses, retailers, and even customers. From each organization, such as a manufacturer, the supply chain includes all the functions involved in receiving and meeting customer demand. So it can be concluded that the supply chain is a process flow of material, information, services and finance involving many parties from suppliers, retailers, warehouses, agents and other parties included in the fulfillment of customer demand.

Supply Chain Management

In today's business world, no company could build competitive advantage without integrating it with Supply Chain Management (SCM). In a study conducted by Acenture, INSEAD and Stanford University showing the relationship between SCM and financial performance, the results of the study suggest that firms with good SCM have an effect on an annual market increase of 10-30 percent of companies with poor SCM. Supply chain is an activity undertaken by the company to organize materials and all parties involved in efforts to meet customer demand. Chopra and Waters in their respective books also mentioned the same thing that every product and company each has its own supply chain that is not the same despite having the same industry and market.

Supply Chain Flexibility

Manufacturing flexibility has become an issue that attracts a lot of attention from academics. A large literature has addressed flexibility as an important competitive advantage. D'Souza & Williams (2000) classifies manufacturing flexibility into internally driven, internally driven manufacturing flexibility where each has two elements. Externally driven manufacturing flexibility includes two dimensions, volume flexibility and variety, while internal flexibility includes process flexibility and material handling. Each dimension has two elements; range and mobility. A fairly common definition of the two elements is in the form. Range is defined as the range of output volumes where the company can run profitably Mobility on the other hand is measured in terms of cost and time implications needed to increase or decrease output volume.

Swafford et al (2000) conducted an empirical study of the relationship between business strategy and manufacturing flexibility. Six dimensions of manufacturing flexibility are used: product, product mix, product modification, volume, delivery, and service. They suggest that companies choose the right dimension of manufacturing flexibility and relate that dimension to company strategy.

However, these dimensions must be related to supply chain functions, which typically include procurement of materials (sources), new product development, production / production and delivery of finished products. Therefore, as in explained by Swafford et al (2000) that there are four dimensions of supply chain flexibility are considered in this paper: sourcing, product design, manufacturing / production, and delivery.

Measurement of Supply Chain Flexibility

Measurement of flexibility arguably remains one of the most difficult organizational tasks. There is no universally accepted measurement system for measuring different types of flexibility. This is because some methods have no strict justification, while others have a stronger theoretical base but are more difficult to apply and limited in scope (Chryssolouris & Lee, 1992)

In light of the measurement of flexibility, Gupta & Goyal (1989) have suggested that a possible and appropriate approach is to decide on the type of flexibility that coincides with a particular manufacturing strategy. Then design or modify the manufacturing system accordingly. In addition to these considerations, a critical evaluation of performance measurement systems that should be able to integrate flexibility measures needs to be resolved. That is, not only system design should be considered but also measurements to evaluate this system.

In an analysis of supply chain flexibility, what to do is to make an assessment of how flexible the market needs and how much capacity the supply chain has to meet the need for such flexibility. The assessment is carried out with reference to the above-mentioned flexibility parameters that have been adapted to the conditions of the measured supply chain (Beamon, 1999). Identify the conditions of Supply Chain flexibility as shown in Figure 1.

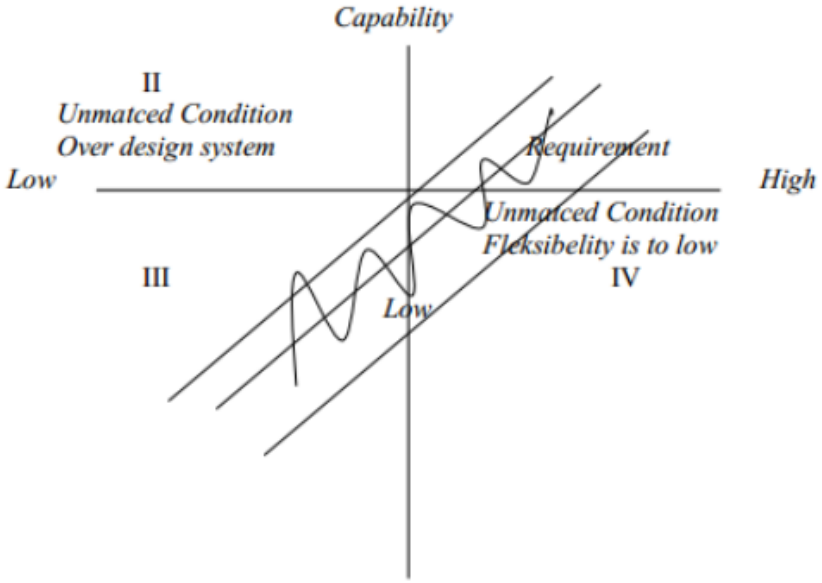

Figure 1. Square of Flexibility

Conditions I and III are balanced, that is, between the needs and capabilities of comparable versatility, the high demand being able to be met (I), and responding to low flexibility, it does not matter because the need for flexibility is also low.

Conditions II and IV are problematic and need to be handled. The second condition occurs when the need for low flexibility but the ability to be high flexibility, this is called over design. Over design leads to efficiency in the company and the amount of wasted cost. Condition IV is the opposite of the above conditions, in this condition occurs the company's inability to meet the demands for a high degree of flexibility.

This will bring up the so-called nervousness will result in a lost opportunity that is the company's uncertainty to meet the existing demand, gradually this situation can cause companies not able to compete in the market.

Drivers of Flexibility

The need for flexibility is largely determined by the work operations and environmental characteristics of a supply chain. Suarez et al. (1995) shows that the market is now experiencing instability, short Product Life Cycle, and smart buyers. All these things contribute to the emergence of a flexibility strategy that becomes as a necessity. Other aspects like the uncertainty of Koste & Malhotra (1999), and global competition are roasted as a factor behind the necessity of flexibility for a company. Vokurka et al (2001) clarified external factors in manufacturing flexibility systems in terms of environmental, organizational, strategic, and technological factors.

The market situation and Supply Uncertainty (SU) are examples of external drivers while work characteristics such as Process Similarity (PS) are internal drivers. To assess the degree of flexibility required in each functional dimension of the supply chain, one must be able to assess each driver's supply chain flexibility. A company is required to realize such an assessment, and (Pujawan, 2004a) suggests that there are seven drivers of flexibility covering the operating (internal) and environmental (external) factors as follows; product life cycle, product variety, customer requirement disparity, order stability, component commonality, process similarity, and supply uncertainty.

Calculation of Gap Score

According to Yasrin (2001), Assessment of supply chain flexibility can be calculated using Servqual Method that is from the difference between the assessment of statement pairs for requirement (requirement) and capability (ability) for each indicator of flexibility. Servqual method itself consists of two parts, namely assessment and weighting. This assessment is done by spreading the questionnaire where a correspondent represents the needs and abilities of the company. Weighting is done by distributing questionnaires in which a correspondent assigns a weight or importance rating for the four major dimensions of supply chain flexibility as well as to each parameter of the measured supply chain flexibility.

In this method servqual (terra) is used Likert scale for the preparation questionnaires distributed to correspondents. The Likert scale is one of the most widely used in attitude scale techniques in marketing research. The gap calculation or flexibility score for each pair of statements is calculated as follows,

GAP = Requirement Score – Capability Score…..……..(1)

The positive reduction results indicate that there needs to be an increase in flexibility in the indicator of flexibility in question. The results of the above calculation then on the flexible state as in the image data analysis of the results will provide input to the management of supply chain aspects that must be increased and or require investment for increased flexibility.

Data Collection

In this thesis, case study taken is evaluation of supply chain flexibility studies of PT. FGH which can be the best solution in the process of improving and doing the development of the company Data collection at this stage is done by distributing questionnaires and interviews to those who know with certainty the overall situation of the company's Supply Chain and can represent the actual situation.

The data collected in the research was carried out by distributing the questionnaires in two stages: (1) Questionnaires to obtain qualitative (subjective) data using a scale of 1-5 for the conditions of need and capability for each flexibility of each indicator, which will be compared between the two. (2) The weighted questionnaire used to compare each dimension in supply chain flexibility and the questionnaire used to compare each indicator in one dimension within supply chain flexibility

To conduct a good supply chain flexibility assessment needs to be done assessment and analysis of appropriate and in-depth so that required appropriate resource and experts in the field which will provide assessment and weighting and conduct in-depth analysis, for the selected resource is not arbitrary there are several criteria that must be met, as follows:

a. Qualification, Every resource must have a level of education and competence in accordance with all areas that will be in the current value, so as to conduct a deep assessment and analysis.
b. Experience, resource person has had enough experience (minimum 10 years) in his field and also has often done similar work
c. Number of Resource Persons, In conducting the assessment and weighting there are at least 3 - 4 people who conduct a valuation discussion so that obtained objective results.
e. Selection, Selection of informants is based on predetermined criteria and interviews and individual health checks

The results of the questionnaire still require an input assessment from the experts who understand correctly with the environmental conditions in which the object of research conducted. Expert respondents selected for this study are those who are experienced enough and understand and directly involved in the supply chain process at PT. FGH. Respondents are responsible for each business process such as PPIC manager, Project/Installation Management, Quality Control, etc. which will provide an assessment of the consequences, occurrences, relationships, and impacts of selected mitigation actions. For the criteria of the respondent is the expert judgment or who mastered each supply chain process that has work experience of at least 5 years and become PIC manager in each stage of the supply chain process.

The data used in this study using primary data derived from the discussion on focus group discussion (expert judgment) or interview. But it will also use supporting data such as the PO schedule made by consumers as a consideration when determining the consequence and occurrence of the delay events of production process.

Data Processing

From the data that has been collected, and then analyzed based on the degree of flexibility that occurs in the dimensions and indicators studied.

Processing data relevant to the problem will be solved, before it can be known the flexibility in accordance with the company, first determine the indicators of supply chain flexibility in PT. FGH, then each indicator is observed and evaluated, how the capabilities, needs, and targets desired after that compared to what is more important according to the priority weight. To determine it is used Expert Choice program as a tool to analyze.

Result of Flexibility Supply Chain Analysis

Analysis of the value of Flexibility of Supply Chain can be calculated by comparing the value of the ability and the needs they have. A supply chain can be said to be flexible if the value of the ability is proportional to the value of the needs it has.

Table 1. Flexibility Supply Chain Level

Dimension (a)	Indicator (b)	Weight Needs (c)	Weight Ability (d)	Flexibility Level (d/c x 100%)
Delivery system	DS1	0,312	0,249	80%
	DS2	0,465	0,279	60%
	DS3	0,105	0,053	50%
	DS4	0,216	0,108	50%
	DS5	0,164	0,123	75%
	DS6	0,235	0,188	80%
	DS7	0,130	0,065	50%

Fabrication system	FS1	0,036	0,029	80%
	FS2	0,117	0,058	50%
	FS3	0,051	0,025	50%
	FS4	0,068	0,051	75%
	FS5	0,043	0,017	40%
	FS6	0,037	0,047	125%
	FS7	0,066	0,033	50%
	FS8	0,118	0,071	60%
Product design system	PDS1	0,372	0,223	60%
	PDS2	0,206	0,155	75%
	PDS3	0,093	0,069	75%
	PDS4	0,310	0,186	60%
	PDS5	0,194	0,155	80%
	PDS6	0,267	0,107	40%
	PDS7	0,068	0,068	100%
Supply system	SS1	0,113	0,084	75%
	SS2	0,057	0,057	100%
	SS3	0,120	0,060	50%
	SS4	0,101	0,050	50%
	SS5	0,148	0,148	100%
	SS6	0,063	0,031	50%
	SS7	0,134	0,080	60%

From the above calculation can be seen the level of supply chain flexibility of each dimension and its indicators.

Discussion and Evaluation

This study aims to identify how much the value of flexibility and know how the condition of flexibility that occurs so as to provide advice to manage and improve the shortage of supply chain systems in the company of PT. FGH is engaged in the fabrication and production structures. This study focuses only on companies where data is retrieved and by involving all managerial parties to obtain valid results.

Eventually all companies on the same or different line of business will produce different conclusions and suggestions for improvement. The difference is based on the needs and reality of supply chain systems owned by the company will never be the same. So this research could continue to be tried and applied to all lines of company as a goal to improve the existing system.

After evaluation of supply chain flexibility. Then the company will have a tool that can be used to improve and improve the quality to be able to compete in the current trade competition. The table below will show more detailed evaluation results:

Table 2. Results of Supply Chain Flexibility Evaluation PT.FGH per-indicator

Dimension	Weight Dimension	Indicator	WGjk	Priority	Flexibility Level (e/d x 100%)
Delivery system	0,356	DS1	0,175	4	80%
		DS2	0,522	1	60%
		DS3	0,148	5	50%
		DS4	0,304	2	50%
		DS5	0,115	7	75%
		DS6	0,132	6	80%
		DS7	0,182	3	50%
Fabrication System	0,124	FS1	0,058	7	80%
		FS2	0,47	1	50%
		FS3	0,204	5	50%
		FS4	0,137	6	75%
		FS5	0,207	4	40%
		FS6	-0,075	0	125%
		FS7	0,266	3	50%
		FS8	0,38	2	60%
Product design system		PDS1	0,456	2	60%
		PDS2	0,158	4	75%

	0,326	PDS3	0,071	6	75%
		PDS4	0,38	3	60%
		PDS5	0,119	5	80%
		PDS6	0,492	1	40%
		PDS7	0	0	100%
Supply system	0,194	SS1	0,145	5	75%
		SS2	0	0	100%
		SS3	0,308	1	50%
		SS4	0,26	3	50%
		SS5	0	0	100%
		SS6	0,162	4	50%
		SS7	0,276	2	60%

The results of the evaluation in Table 2 show the results of improvement priorities and the degree of flexibility of each indicator in percentage. The dimension of the delivery system shows the unique fact that the small degree of indicator flexibility is not necessarily a priority for the company to fix. It can be seen that DS2 is the most important indicator to be fixed with a value of 0.522 and a 60% flexibility rate. On the other hand, DS3 with a flexibility level of 50% becomes the priority to 5 of 7 priorities in the delivery system dimension.

In the dimension of the fabrication system, there is one indicator, FS6, which shows a flexibility level above 100% that is 125%. Being in a flexible overhead condition or being able to accept more jobs than a competitor does not mean that the indicator is in good shape. The demand for products produced by these machines is relatively small resulting in the frequency of use is quite minimal, but the cost of maintenance and repair of large companies resulting in quite impaired.

In the dimensions of product design system and supply system there are indicators that are said to be able to meet the company's flexibility standards PDS7, SS2, and SS5. It shows the needs of the company and the current conditions are at a balanced point. So what the company needs to do is just keep the indicator to be able to be at a flexible point.

CONCLUSION

From the study result done within this thesis, it can be concluded as follows:

1. The greatest and smallest gap weight indicator value of each dimension in the supply chain system PT. FGH as follows;
   - Delivery system: 0.522 (DS2) vs 0.115 (DS5)
   - Fabrication system: 0.47 (FS2) vs -0.075 (FS6)
   - Product design system: 0.492 (PDS6) vs 0 (PDS7)
   - Supply system: 0.308 (SS3) vs 0 (SS2)
3. The smallest level of flexibility of each dimension that occurs in the supply chain system at PT. FGH as follows;
   - Delivery system: 50% on 3 indicators (DS3, DS4, and DS7)
   - Fabrication system: 40% on 1 indicator (FS5)
   - Product design system: 40% on 1 indicator (PDS6)
   - Supply system: 50% on 3 indicators (SS3, SS4, and SS6)
4. Suggestions to improve flexibility in supply chain system PT. FGH as follows;
   - For indicator DS2 of the delivery system & indicator SS3 of the supply system, the company must perform vendor data collection in the form of partners based on the needs of the company. After that is done also a system which can be said as commercial agreement between company and vendor. In the system will bind a vendor's basic price to the company for 3 months, which will update the base price at the end of the period prior to the agreement of the next period
   - For indicator FS2 of the fabrication system, the way of generating multiskill human resources by providing learning and training facilities to every worker who wants to grow. It will be the company's current assets until the future.
   - For indicator FS6 of the fabrication system, remapping where the company can know where the market requires the product of the machine. It has become one of the ways companies can maximize their machine investments and as a way of upgrading corporate quality.
   - For indicator PDS6 of the product design system, by providing training and knowledge of current conditions so that the team is able to understand the current needs.

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