The Localized Framework of Construction Supply Chain Performance Indicators Based on the SCOR Model

by Bambang Purwanggono

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Abstract. The main problem in the production of construction projects is the scarcity of material due to the project site is far from the supplier and the ability of suppliers to supply material. Therefore, it needs performance measurement indicators in the construction supply chain to the performance of the supplier. The objective of study is to design and measure the supply chain performance measurement framework with Supply Chain Operations Reference (SCOR) model. The scope of this study is in the road project by conducting questionnaires to the contractor's project managers and steel and ready mix concrete suppliers. The results showed that the SCOR model can be used as indicators of the construction supply chain performance measurement with the adjustment of operational definitions to applications in construction. Besides, there are two indicators of additional supply chain performance measurement proposed by contractors and suppliers that utilization of information technology and supplier pro-activeness. Design of supply chain performance measurement framework construction of the SCOR model and the additional indicators is done by analyzing similar research that already exists in each of the indicators for determining the maximum value and minimum performance achieved. Scaling performance of each indicator using scale consisting of five scale, 5 scale for excellent, 4 scale for good, 3 scale for average, 2 scale for bad, and 1 scale for bad. The results of the measurement of the performance of the supply chain to suppliers reinforcement steel construction is 4 that good categorie. While the value of supplier of ready mix concrete performance is 4,23 that very good categorie.

Keywords:construction supply chain, performance indicator, supplier, SCOR

1. INTRODUCTION

Indonesia as a developing country with a population of about 240 million people strives to enhance economic growth. The construction sector is very strategic in supporting economic growth through infrastructure development. However, the construction industry has always said to be the industry that has a high level of risk (Abduh, 2012). Based on the results of a study of the Lean Construction Institute (cited by Abduh, 2011), manufacturing industries have managed to reach the level of the added value of their products by 62% and reduce by products such as garbage discharge to 26%.

The problem that frequently occurs in construction projects is the delay in the progress of the work usually caused by unpreparedness contractor in the procurement of materials (Astana, 2007). The approach is often done as a solution is supply chain performance analysis. The good

supply chain management in the construction project will facilitate the flow of resources to and from the project (Xue, et al., 2007). Vrijhoef & Koskela (2000) said that the concept of the supply chain in the construction industry in general can reduce the cost and duration of the work.The good construction supply chain is if the supply chain can be measured how it performs (Kurien & Qureshi, 2013). One model of performance measurement of construction project can use the Supply Chain Operations Reference (SCOR) model. SCOR is a supply chain performance model based on the process (Supply-Chain-Council, 2010).

Most of the road construction in Indonesia which will be using rigid pavement because of the need for durability and vehicle load are increasing (Suhardi, 2012). Therefore, the implementation of the road project will be highly dependent on primary materials which are ready mix concrete and reinforcing steel. This study will use both of materials as the material supply chain performance measurement in construction project.

2. LITERATURE REVIEW

2.1 Construction Project

Construction project activity is unique activities with limited durations (Husen, 2011). The characteristics of the construction project are aiming at goal to produce an end product or end result of the work in certain conditions, limited time, not be repeated (Soeharto, 1999). The cycle of construction project consists of conceptual, planning and development, implementation, and operation stages.

2.2 Construction Supply Chain Management

Supply chain management is a network of companies that jointly work to create and deliver a product into the hands of end users. Such companies typically include suppliers, manufactures, distributors, stores, or retail as well as companies such as logistics service company supporting (Pujawan, 2005). But other argue that supply chain is the flow of complex, dynamic, and follow the information (planning, scheduling, ordering), materials (components of the end product) and the cost of the order to use (Obrien, et al., 2009).

The research and application of supply chain concept in the construction has been done since the early 1990s. The purpose of adoption of the manufacture concept to construction is to improve efficiency, productivity, and reduce project costs. According Obrien, et al. (2009) the differences of manufacturing and construction supply chain are as following:

Table 1: Manufacturing vs Construction Supply Chains (Obrien, et al., 2009)

Characteristics	Manufacturing SCs	Construction SCs
Structure	- Highly consolidation - High barriers to entry - Fixed locations - High interdependency - Predominantly global markets	- Highly fragmented - Low barriers to entry - Transient locations - Low interdependency - Predominantly local markets
Information flow	- Highly integrated - Highly shared - Fast - SCM tools	- Recreated several times between trades - Lack of sharing across firms - Slow - Lack of IT tools to support SC
Collaboration	- Long-term relationships - Shared benefits, incentives	- Adversarial practices
Product demand	- Very uncertain (seasonality, competition, innovation, etc) - Advanced forecasting method	- Less uncertain (the amount of material is known somewhat in advance)
Production variability	- Highly automated environment (machine, robots), standardization, production routes are defined-lower variability	- Labor availability and productivity, tools, open environment (weather), lack of standardization and tolerance management, space availability, material and trade flows are complex-higher variability
Buffering	- Inventory models - (EOQ, safety inventory, etc.)	- No models - Inventory on site to reduce risks - Use of floats (scheduling)
Capacity planning	- Aggregate planning - Optimization models	- Independent planning - Infinite capacity assumptions - Reactive approach (respond to unexpected situations)

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The impact of the implementation of supply chain management in the construction has been identified and measured through a combination of field surveys and measurements model simulations (Hatmoko & Scott, 2010). Construction supply chain relationships usually are interrelated, complex, and difficult to measure quantitatively (Meng, et al., 2011). According to Emuze (2009), there are four impacts of the construction supply chain management. These impacts are good relationship between the sub contractors, an integration that minimizes waste, maximize good communication, and mutual trust.

2.3 Supply Chain Operations Reference (SCOR)

Performance measurement in the construction supply chain is needed to determine the extent of the company's operational performance in operating the supply chain. Construction project in the procurement of materials usually use Construction Logistics Planning to integrate their planning (Said & El-Rayes, 2011). One of supply chain performance measurement is Supply Chain Operations Reference (SCOR) (Supply-Chain-Council, 2010).

SCOR model provides a unique framework that links performance metrics, processes, best practices, and people into a unified structure. The framework will support the communication between supply chain partners and enhances the effectiveness of supply chain management, technology, and related supply chain improvement activities. The SCOR model will supports the supply chain supply chain improvement by aiding the capture of as-is current state form which desired to-be future state can be derived. By speeding data collection, SCOR can make it much less time consuming for managers to find answers to basic questions about how a supply chain is performing, drill down to identify contributing factors, and quickly initiate corrective actions. For example, consider Perfect Order Fulfillment. This metric provides a good indication of how well every facet of a supply chain: planning, sourcing, manufacturing, and delivery are tuned and coordinated to meet customer demand.

Supply Chain Operations Reference (SCOR) model has been integrated with software ARENA that provides the supply chain analyst with a comprehensive and dynamic tool (Persson, 2011). The other study of SCOR was compare data from a value stream mapping that the company managers will use when deciding where to allocate production resources in the international production network.

3. METHODOLOGY

3.1 Initial Research

Initial research begins the formulation of the problem into the background. After that determines the purpose of research and to study the literature about Supply Chain Operations Reference (SCOR). Then the next step is adoption of performance indicators for the SCOR model from manufacturing concept to construction.

3.2 Collecting Data

The collecting data begin with make performance measurement indicators questionnaire. This questionnaire is to be validated to contractors and suppliers. The questionnaire to contractor is validated to three projects. While validated questionnaire to suppliers are those suppliers of ready mix concrete and steel reinforcement.

3.3 Measurement

Performance measurement begins with analysis and discussion of the determination of the performance indicators taken from SCOR and local conditions. The next step is the formulation of a performance measurement framework and determine the scale of each performance of the supply chain. Afterwards, the measurement of the performance of the supply chain is conducted that could be leading to the conclusions and suggestions.

4. RESULTS

The result of this study is the results of the questionnaires to contractors and suppliers. There are different perspectives on the indicators to be used to measure supply chain performance by both sides. The results of the questionnaire as follows:

Table 2: Validation of performance indicators to contractors and suppliers

Indicators	Contractors			Suppliers	
	A	B	C	RMC	Steel
SCOR					
1. Perfect order fulfillment	v	v	v	v	v
2. Order fulfillment cycle time	v	v	v	v	v
3. Upside supply chain flexibility	v	v	v	v	v
4. Upside supply chain adaptability	v	v	v	v	v
5. Downside supply chain adaptability	v	v	v	v	v

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Indicators	Contractors			Suppliers	
	A	B	C	RMC	Steel
6. Overall value at risk	v	v	v	v	v
7. Supply chain management cost	x	x	x	v	v
8. Cost of goods sold	x	x	x	v	v
9. Cash to cash cycle time	x	x	x	v	v
10. Return on supply chain fixed assets	x	x	x	v	v
11. Return on working capital	x	x	x	v	v
Additional indicators					
1. Utilization of information technology	v	v	v	v	v
2. Supplier pro-activeness	v	v	v	v	v

Table 2 above shows the validation results of three projects that there are some indicators that cannot be measured in terms the contractor. These indicators are supply chain management cost, cost of goods sold, cash to cash cycle time, return on supply chain fixed assets, return on working capital. Meanwhile, according to suppliers of Ready Mix Concrete (RCM) and steel reinforcement all indicators of the performance of SCOR can be used as an indicator of the construction supply chain performance measurement. The difference is due to the different ability and understanding of the contractors and supplier in measuring performance. In addition, the availability of different data also makes difference.

In addition to the validation, there are additional and very local indicators proposed by contractor. These indicators are utilization of information technology and supplier pro-activeness. Additional indicators are the validated to other respondents that the results of all respondents agree that it can be used as an indicator of supply chain performance.

5. DISCUSSIONS

The validation results are then extrapolated to determine the scale of the performance of each indicator. A scaling is done to measure the performance of the supplier of ready mix concrete and reinforcing steel in supply chain performance to the construction project. A scaling is done by reviewing some previous studies of its kind.

Value chart on reinforcing steel supplier performance is as in figure 1. The figure shows the value of each indicator is described in spider web diagram. There were categorized as excellent, good, and average. Total value of the reinforcing steel is 52. The average value is 52/13 = 4. While the value chart of performance of ready mix concrete supplier is shown in Figure 2. Total value of ready mix concrete is 55. The average value is 55/13 = 4,23.

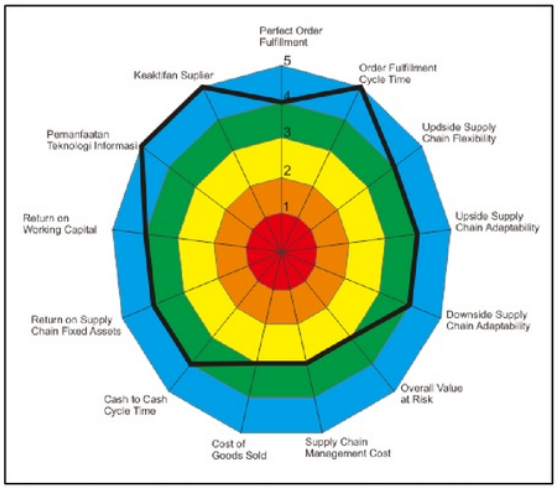

Figure 1: Supply chain performance value of reinforcing steel

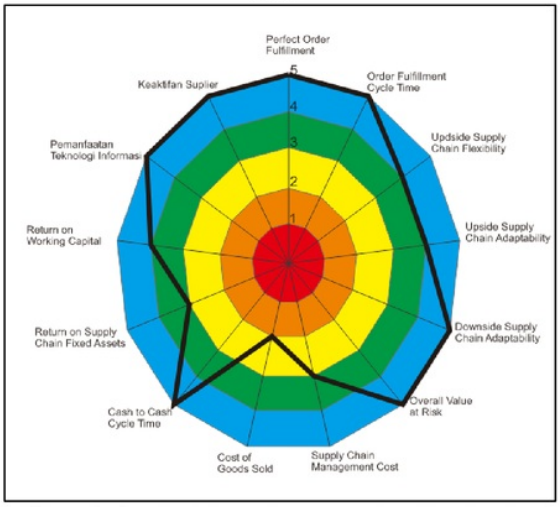

Figure 2: Supply chain performance value of ready mix concrete

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Based on the Likert Scale, the scaling of supply chain performance is divided into 5 scale is a scale of excellent, good, average, bad, and very bad. The highest scale is 5 and the lowest scale is 1 as in the Table 3 below.

Table 3: The scale of supply chain performance

Scale	Category
4,01 - 5	Excellent
3,01 – 4	Good
2,01 – 3	Average
1,01 – 2	Bad
0 – 1	Very bad

If the value of the performance of reinforcing steel and ready mix concrete supplier is shown in the form of figure that refer to the Table 3 above as follows:

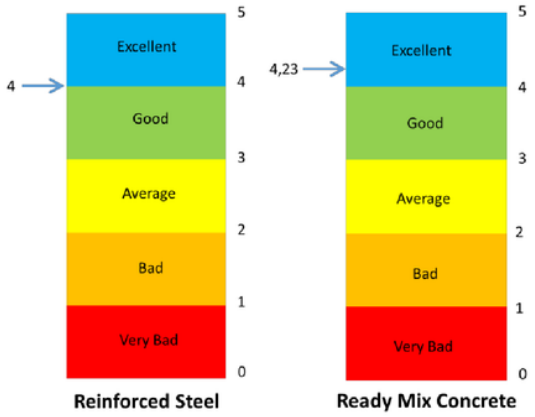

Figure 3: Supplier performance value of reinforcing steel and ready mix concrete

6. CONCLUSIONS

Based on the discussions above, it was concluded that Supply Chain Operations Reference (SCOR) model can be used an indicator of the construction supply chain performance measurement with the adjustment of operational definitions to applications in construction. According to the contractor, 5 of the 11 indicators are not suitable when used as an indicator of performance measurement due to the unavailability of data and more suitable if measured at the supplier. This indicator is a supply chain management cost, cost of goods sold, cash to cash cycle time, return on supply chain fixed assets, return on working capital. According to suppliers 11 indicators of SCOR can be used. As the result of study, there are two additional indicators proposed, utilization of information technology and supplier pro-activeness. A total of 13 existing performance indicators are presented.

The design of supply chain performance measurement framework construction of the SCOR model and the additional indicators is done by analyzing similar research that already exists in each of the indicators for determining the maximum value and minimum performance achieved. Scaling performance of each indicator using scale consisting of five scale, 5 scale for excellent, 4 scale for good, 3 scale for average, 2 scale for bad, and 1 scale for bad. The results of the measurement of the performance of the supply chain to suppliers reinforcement steel construction is 4 that good categorie. While the value of supplier of ready mix concrete performance is 4,23 that very good categorie.

This study was conducted a survey of three project managers at the same contractor and two suppliers consisting of ready mix concrete and reinforcing steel suppliers. More respondents either the number of contractors and suppliers still needed for further research. The research is focused only on the road project as well as the steel material and ready mix concrete. So that further research could be conducted in different projects such as building, bridge, dam with the specific materials in each project.

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