

To Design a Supply Chain Based on Product Type Ship

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ABSTRACT

A shipbuilding project is classified as an EPC project that characterized by low margins and intense competition in the market. These products comply with both lean and agile supply chains. This paper defines the concept of supply chain in shipbuilding projects and implementation of this concept in shipbuilding is stated. The Combined Supply Chain using advantages of both Lean and Agile supply chains is proposed and adopted to overcome of delay times and achieve a reduction in final product ship.

KEYWORDS: Shipbuilding, EPC Projects, Combined Supply Chain.

1. INTRODUCTION

One of the main concerns of managers and project stakeholders of shipbuilding projects is to be able to complete the project in a predetermined schedule and budget. According to complicated design of ships and requires extensive use of technology in ship building projects, it has been more important. The major operational problem of these projects is becoming larger the estimated completion date compared by real date. The rise time causes an inflation in final cost of the project and on the other hand the project will be uneconomic. In fact, cases such as changes in requirements, technology failure, delay of suppliers and manufacturers, out of time approval, changing priorities, the slower than anticipated activities and ... impose delays to the project [1].

Projects to build ships and marine structures are categorized in heavy industries and are the kind of Engineering – Procurement – Construction projects that are characterized by low profit margins and intensive competitive market. Such projects lead shipbuilding companies to take policies which make them able comply with future changes.

The biggest challenge of failure of such projects is due to the multiplicity of organizations involved in them. Owner, design firms, construction companies, materials and equipment suppliers, regulators, investors, government agencies, the final consumer and maintenance teams are just some groups that are involved in the life cycle of a ship. At all times, project teams are involved in the exchange of information and materials together.

Obtaining approvals for some activities, particularly the supply of materials and equipments is inestimable. Main equipments should be supplied internationally have a longer delivery time and therefore have more uncertainty in the time they are delivered. On the other hand need for exchange of information, plans and drawings between suppliers may also lead to increase the delay time [2].

Cargo transportation market and customer needs are constantly changing and developing so the ship's life cycle has been became shorter.

Customer needs are oriented in a variety of use and functions of ship, lower costs, better quality and more rapid access so the supply chain must be able to respond to the market. In these days business world, supply chain management is known as a tool to achieve economic benefits in short term and long-term competitive advantages. Supply chain management contains a set of approaches and efforts of producers, suppliers and distributors and to coordinate the value chain in such a way that appropriate amounts of products, produced and distributed to the appropriate time and place and as a result, customer satisfaction is achieved [3].

Supply chain management approach is founded on the fact that there is a competition between supply chains instead of companies and Supply chain management is an approach to design, organize and implement of activities. Suppliers, manufacturers, distributors and customers are merged together by supply chain management, to meet the requirements of customers more efficiently and more effectively

As a result, company will be able to respond to customers' various demands rapidly and with high quality. As companies' competition has risen to supply chains level, the supply chain management is taken as one of the important strategies for success among the competitors.

Despite the importance of major equipment procurement in Shipbuilding projects is easily understandable, but relatively little research in this field have been published that is scrutinizing this issue. There are also few frameworks those forthcoming improvements to be carried out on them.

The major problem is to achieve the appropriate design of supply chain and to manage effectively according to the type of the product ship and its life cycle. The research is following such a design and supply chain management be able to have a continuing dynamism in the competitive environment of supply chains and is compatible with the product type of ship, hence can adapt itself with changes along time and provide the needs of diverse customers and their market share of ship will be increased.

In general to design a supply chain is having a network configuration Including market profile, selection and allocation of supplier and distribution methods and finally assigning different type of products to different markets. According to Fine, designing a supply chain is to prioritize of capabilities that allow it to provide a network through the

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development and strengthening of relations between the members and using dynamic process to relate capabilities as a chain [4]. On the other hand, as soon as it reaches out to design a supply chain, supply chain management is started. It is related to the coordination of material flows and inventories, information and financial flows.

According to Beamon there are several criteria for classification methods of supply chain and hence several supply chain models can be categorized [5]. Aitken and colleagues examined the impact of product life cycle on supply chain strategy and resulted that a single supply chain strategy will not be used for all types of products [6].

2. METHODOLOGY

2.1 Shipbuilding; an Engineering – Procurement – Construction Project

Shipbuilding is the industry that produces products such as ships, offshore structures and floating equipments for its customers. The importance of this industry can be summarized as a large source of employment and driver of related industries. Other items that are given more importance to the field are maritime transport, providing the decline in foreign exchange payments, defense and military reasons, and reduce dependence on foreign vessels [7].

To form the final product the preliminary design has to be done according to the customer needs (Engineering) then the raw materials, parts and equipments must be provided (Procurement). Finally the construction and fabrication begins (Construction). Production processes in shipbuilding industry can be shown in Figure 1.

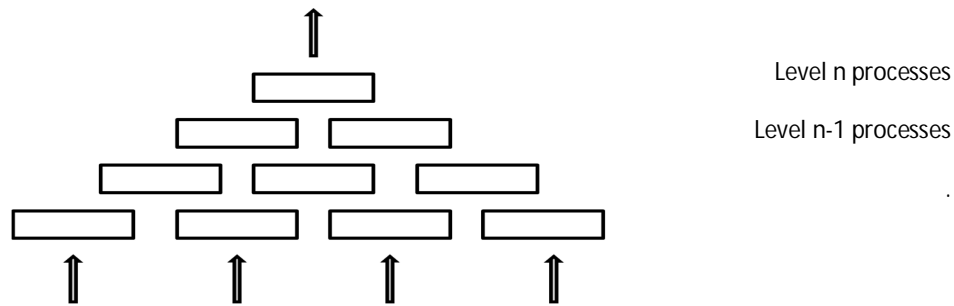


Figure 1 Product processes in a shipbuilding project

Each rectangular symbolizes a process of the project. Arrows at the low level indicate ingoing raw materials, equipment and parts and the arrow icon on the top level is the final product ship. As the figure 1 shows, one of the main characteristics of the shipbuilding project is a large variety of raw materials needed. Another feature that is also shown is many processes including engineering, procurement and construction in the early stages of production. These points confirm that the investment needed in early stages of shipbuilding project is more that needed at the final levels of production.

Aggregation of needs to diverse sources at primary levels of project and hence need to large investment set the critical point of a shipbuilding project at procurement stage that is already supplying raw materials, equipments and etc. Studies show that a major part of delays imposed on a building project is due to delay in supply and logistics of raw materials and main equipments. So shipbuilding companies are to form a network with suppliers and customers for the proper management and supervision in the procurement stage and removal of uncertainty. Therefore, the concept of supply chain, supply chain management, how to communicate with suppliers, determination of boundaries in network and such subjects are stating below this title.

2.2 Supplying Material

In general, the supply chain is composed of two or more organizations that are officially separated and are related to each other by the flow of materials, information and financial affairs. These organizations may be firms that supply raw materials, components, finished products or services like the distribution, storage, wholesale and retail produce. Even the final consumer can be considered one of the organizations. Financial flows, materials and information on a company's supply chain are shown in Figure 2.

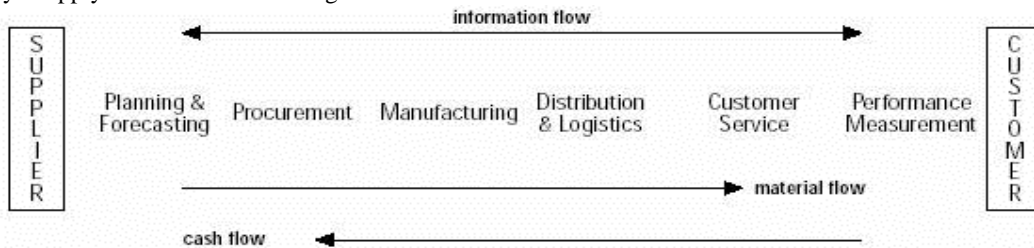


Figure 2 Flows of material and information along the supply chain

Thus, a supply chain is configured of the company and its customers and suppliers. At the beginning of a supply chain, supplier of supplier can be added. Finally the whole set of companies that are giving service to each other are involved in the chain. These companies provide services such as logistics affairs, finance, marketing and information technology.

In most shipbuilding projects, procurement of major equipments has been less attention and this has caused many delays. The main equipments are capital equipment installed for forming the integrated part of ship. Figure 3 proposes a general network for procurement of major equipment in a shipbuilding project [8].

Phase of supplying materials and equipment in shipbuilding projects (procurement) is included of two sets of materials. Supplying bulk materials such as sheets, welding consumables, colors, etc purchasing of basic equipment such as engines, generators, propellers, pumps, boilers, gearbox and The second set has its own characteristics and requirements vary greatly with the purchase of bulk materials. Some of these differences include long lead time, higher prices of equipment and complex technology. Manufacturing and delivery time of original equipment usually vary between several months to a year for long-distance equipment. There are many internal and external factors affect the timing and delivery of major equipment.

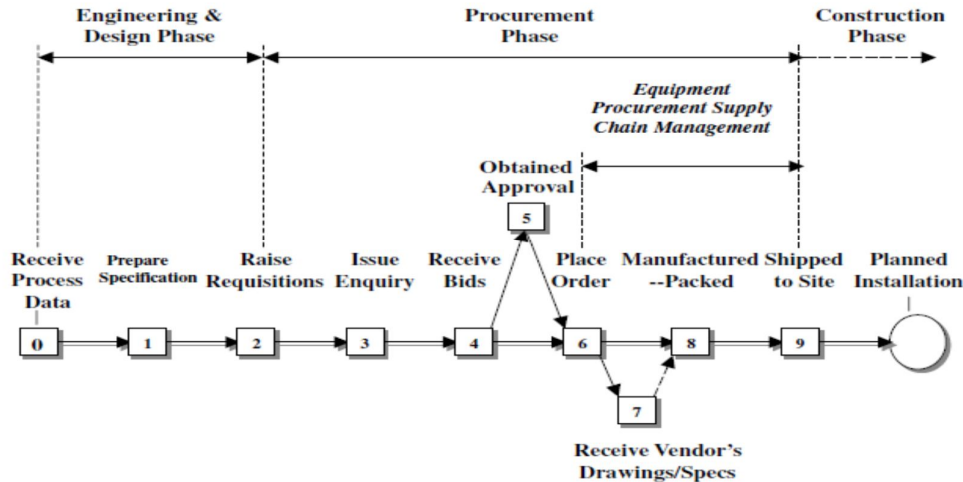


Figure 3 General network of supplying material and equipment

2.2 Subheading

Supply chain management is coordinating all activities of the company with the activities of its suppliers and customers. There are many definitions of supply chain management, which almost all of them include the concept of coordination of production, inventory, logistics, information flow and knowledge between members of a supply chain to obtain the best combination of responsiveness and efficiency for customer [9].

Suppliers and customers should have the same goals and they have to obtain mutual trust in this regard. Customers must have an acceptable level of confidence with quality of products and services to their suppliers and the suppliers must have the same of financial flows to their customers. Following five performances are considered to achieve an efficient and effective supply chain management.

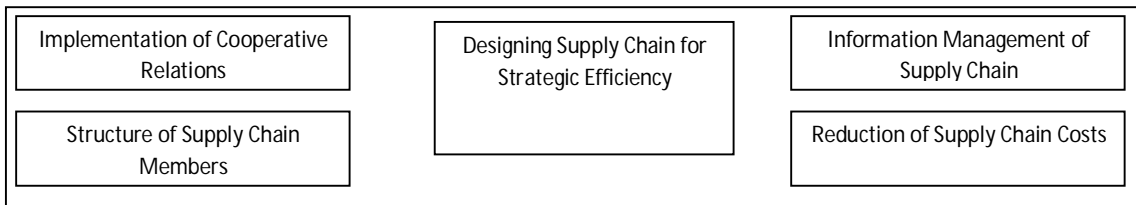


Figure 4 Five performances of supply chain management

The main root of most problems supply chain management is involved, is the mismatch between product type and the type of its supply chain. Such inconsistency can be resolved through design an agile supply chain for innovative products and designs a lean supply chain for standard products. Uncertainty and variability in product demand are the distinction between lean and agile supply chain.

3. RESULT AND DISCUSSION

3.1 Equations and Mathematical Expression

Ship or an offshore structure is a complex product that combines innovative products and standard products and called mixed product. Although in many cases, the ship to meet the needs of customers encompasses many reforms, but

the whole process of shipbuilding project in all the vessels are relatively common. Life cycle of mixed products such as ships is long. Innovation in mixed product is mostly done in some of their constituent parts, for example, a ship may be equipped by a modern radio or navigation systems replaced the previous models or it may be replaced old propulsion systems by new FPP propellers and modern engines to reduce the fuel consumption. As mentioned before there are many components that are generally included in product assembly work and it leads to a large number of suppliers involved building a ship. The mixed products generally and specifically about the ship, the company's relationship with the final customer is based on the concept of agility.

Of newly stated supply chain concept and its use in shipbuilding projects has led to be faced with some difficulties and resistance of individuals and organizations in early stages of implementation. Table 1, shows the points of weakness in relationship between shipbuilding companies and suppliers in three effective levels.

Table 1 Weakness points of supply chain in shipbuilding companies

Weakness Points	Level 1 (Supplier)	Level 2 (Shipbuilding Company)	Level 3 (Environment)
	1. Off-time delivery 2. Debility in achieve the required quality 3. Debility in continuing the long time relationship 4. Debility in remaining the fixed final price 5. Debility in transparent flow of information	1. Debility in finding and proper evaluation of supplier 2. Debility in planning of purchase and delivery 3. Debility in proper explanation of requirements 4. Debility in keeping the stable financial flow 5. Debility in transparent flow of information 6. Variety of decision making units for production 7. Unstable level of demand for ship	1. Lack of existence of a third party organization between suppliers and the company 2. Lack of clearly defined processes to form supply networks

According to ship's specification as a mixed product, one of the key decisions to be made by the company is what products will be produced indoor and what products will be purchased, which activity will be outsourced. Mixed products comply with both lean and agile supply chains.

An extensive research has been done on the advantages of Lean and Agile supply chains and it is found that there can be defined another type of supply chain between these two types, called "Combined Supply Chain". This approach is generally related to the "Made to Order" products that are manufactured according to the customer's order. Ships and marine structures are categorized by "Made to Order" products that are in the mature stage of product life cycle and the fluctuating of demand is very low and forecast has a relatively high accuracy. Critical factor in the maturity period of a ship product life cycle is cost. In addition quality and on-time delivery has to be noticed as other effective elements. In a supply chain of ship production due to high volume of diverse materials needed for final product, there is a combination use of both Lean and Agile supply chains. For instance, paint and welding consumables are produced in a lean supply chain, while pumps and engines are produced in an agile supply chain. Table 2 shows the specifications of combined supply chain for the product ship.

Table 2 Characteristics of combined supply chain for product ship

Title	Combined supply chain
Goal	Well understanding of customer requirements and obtain product diversity. Innovation is done in middle products and sub-systems.
Production planning	Made to Order. Limited ability to produce diverse products.
Market	Using innovation in mid products and equipments response to customer needs to achieve an extensive share of innovative products market.
Demand Patterns	Accurate estimation of demand. Deviation occurs in mid products and components.
Inventory	Long time inventory for diverse material and components. Keeping inventory at least for one product.
Delay time	It can be found in mid products and main equipments and must be resolved to obtain on-time delivery according customer due date.
Product Design Strategy	Using modular design to develop different products

As mentioned earlier, procurement in a shipbuilding project includes two categories of raw materials and main equipment. A set of raw materials consumed in large scale (bulk), such as color, metallic materials, welding consumables, pipes and fittings and ... which are classified among standard products. To supply this set of project needs the lean supply chain is proposed and the pulling approach is proper. Long-term relationship with suppliers of these materials is proposed to make use of advantages such as reduce the delay time on lean supply chain, increase efficiency, increase production flexibility and reduce the cost. Lean supply chain approach prepares a schedule to supply. Changes in products are very low and in details so the production cost of standard materials (raw materials) is mostly minimized. This leads to a reduction in overall cost of the final product ship. Predictable patterns of demand for these types of items needed for the shipbuilding project will lead to reduce the uncertainty in forecast orders and delivery time in the supply chain.

Other categories of equipment and materials needed in a shipbuilding project are which they called "Main Equipment", and have long lead time and farther supplier. These type of components are mostly products which in turn are manufactured "Made by Order". Main engines, generators, propellers, propulsion systems, pumps, communication

and navigation equipment, air conditioning systems, raw materials and special grades of steel with some specific sections of metal, are examples of these items. In shipbuilding project in order to provide these items at the early stages of the project the advantages of an agile supply chain is taken. Production in any volume of product, shipped to different markets and also supply custom made products with minimum delay, rapid transportation is obtained by using an agile supply chain. Hence for procurement of main equipments in a shipbuilding project, the use of agile supply chain and long-term relationships are proposed. This approach is widely using information systems and technologies and also by using electronic data interchange, data can be transferred quickly to the chain members to make proper decisions. Particular issues of this type of supply chain are concerned to employee and organizations. Items such as knowledge systems and support of staff are classified in. Generally, the innovations and changes in order to meet diverse customer needs are met through this type of supply chain.

For the ship as a mixed product, making innovation in systems, subsystems and equipment and design, is always exist. So the use of combined supply chain provides the possibility of avoiding delays due to changes in the final product ship. Approach to select of suppliers in a shipbuilding project using a combined supply chain, is to select the ones with low cost, high quality, speed and flexibility.

4. CONCLUSION

Shipbuilding project as an Engineering – Procurement – Construction (EPC) project has features like the high diversity of production processes and raw materials needed by the project. Consequently of many production processes, large amount and varied raw materials, machinery, manpower and space required for storage of materials is needed. These issues confirmed the high volume of investment required in early stages of ship production. Aggregation of needs to diverse resources at primary levels of project and hence need to large investment set the critical point of a shipbuilding project at procurement stage that is already supplying raw materials, equipments and etc.

To design and manage a supply chain for shipbuilding projects should be noted that this project includes the provision of two categories of bulk materials and main equipments. The first consists of simple and standardized products and the latter contains products that are made to order with long delivery time. Thus, the study proposes a supply chain that combines advantages of Lean and Agile supply chains for shipbuilding project. Lean and long-term relations in supply chain are suitable for supply of bulk raw materials and agile supply chain to supply the main equipment with farther supplier and long delivery times.

The general characteristics of a combined supply chain for shipbuilding projects could also outlined the following.

- To meet the diverse needs of final customers;
- To use information technology tools in order to establish a transparent flow of information in the supply chain;
- To make flexibility by using the advantages of agile supply chain;
- Reducing the delay times across the supply chain;

Despite adopting a combined supply chain in shipbuilding projects, the project results indicate the existence of some delays in the supply of main equipment and in the supply of metal raw material in detailed. Further research is suggested on the use of the concept of "Theory of Constraints" and integrating of critical chain in supply chain in procurement stages of EPC projects.

REFERENCES

- [1]. Yeo K.T. et al.2002. Integrating supply chain and critical chain concepts in engineer-procure-construct (EPC) projects. *International Journal of Project Management*, 20: 253–262.
- [2]. Steyn H.2002. Project Management applications of the theory of constraints beyond critical scheduling. *International Journal of Project Management*, 20: 75–80.
- [3]. Ansari.A. et al.1990. *Just- in-Time Purchasing*. Free Press, New York,
- [4]. Fine C.H. 2000. Clockspeed-based strategies for supply chain design. *Production and Operations Management*. 9(3), 213-221.
- [5]. Benita M. Beamon.1998. Supply chain design and analysis: Models and methods *International Journal of Production Economics*. 55: 281-294.
- [6]. Aitken J.2003. The impact of product life cycle on supply chain strategy. *International Journal of Production Economics*, 85: 127–140.
- [7]. Storch, R. L., Hammon, C. P., Bunch, H. M., Moore, R. C.1995. *Ship Production*. The Society of Naval Architects and Marine Engineers.
- [8]. K.T. Yeo.2006. Managing uncertainty in major equipment procurement in engineering projects. *European Journal of Operational Research*: 171: 123–134.
- [9]. Kim So Wook.2006. Organizational structures and the performance of supply chain management. *International Journal of Production economy*, 22: 323-341.
- [10]. Sanderson J. et al.2008. The challenges of supply strategy selection in a project environment: evidence from UK naval shipbuilding. *Supply Chain Management: An International Journal*, 13: 16–25.