Development Of System Dynamic Model To Diagnose The Logistic Chain Performance Of Shipbuilding Industry In Indonesia

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Abstract

This paper proposes a system dynamic model to facilitate assessment of logistic operating performance of shipbuilding industry in Indonesia. The model is intended to capture more accurate mechanism of logistic operation that allow the company to systematically prognosticate logistic performance, to locate points of bottleneck, to analyze potential factors creating the bottleneck, and to select logistic scenario which will yield better logistic performance. Since the financial difficulty, either due to scarcity of fund resources or poor financial management, has been creating the unfavorable condition currently faced by many shipbuilding industries in Indonesia, the model developed is mainly concern with the integration of money flow together with material and information flow. In this paper, product quality, cost, and delivery time are considered as the indicators of logistic performance.

Key Words: Shipbuilding industry, integrated logistic, system dynamics model.

1. INTRODUCTION

Logistic refers to operating processes directed to maintaining flow of materials, in process inventory, finished goods, services, and related information from point of origin to point of consumption for the purpose of conforming customer requirements. Traditionally, much attention has been given to controlling physical and information flow to meet customer requirements for delivery of product quality in appropriate quantity, cost, time, and place [see Attwood and Attwood, 1992; Mooler, 1994; Bowersox and Closs, 1996; Johnson and Wood, 1996]. This stances, however, assumes that there is no financial problem encountered by the company in its logistic operations. As a matter of fact, the assumption is not always fulfilled. Financial difficulty may critically disrupt flow of goods and information through its influence on the capability of the company in procuring required materials, parts and components, manufacturing process, and ultimately delivering finished product to the customer [Diawati and Cakravastia, 1998].

Further, Diawati and Cakravastia [1998] explain that many shipbuilding companies in Indonesia, not mention during the economic crisis, currently face this unfavorable condition. Source of many logistical problems in Indonesia companies in concerned with disruption of money flow, either due to scarcity of fund or due to poor financial management. Disruption of money flow critically hinders flow of goods and service resulting in inferior conformance to performance requirements.

This paper proposes a system dynamics model of logistic activities in shipbuilding industries in Indonesia that comprises money flow together with material and information flow. The model is intended to capture mode accurate mechanism of logistic operation that allows the company to systematically prognosticate logistic performance and behavior, to locate points of bottleneck. to analyze potential factors creating the bottlenecks, and to select logistic scenario which will yield better logistic performance. Three aspects are considered to represent the logistic performance: quality, cost, and delivery time of the final product produced by the company. The three aspects of performance are recognized as the key factors determining competitive position of the company in gaining customer order. The flows of goods, information, and money integrate the shipbuilding company and the related parties, either at the upper stream side, i.e. suppliers or manufacture of materials, Parts, and components, or, at the lower stream side, i.e. customers or intermediaries between shipyard and its final customers. In addition, the model regards the determination of logistic infrastructure in setting logistic parameters that influence the system performance.

2. INTEGRATED LOGISTIC

Logistic is a terminology representing a continuously evolving concept along with the development of business environment condition s. In the 1950s, the Council of Logistical Management (CLM) defined logistic as: "*the broad range of activities concerned with efficient movement of finished products from the end of the production line to the customer, and in some cases include the movement of raw materials from the source of supply to the beginning of the production line. These activities include the freight transportation, warehousing, material; handling, protective packaging, inventory control, plant and warehouse site location, order processing, marketing forecasting, and customer service"* [Moller, 1994].

In beginning of the 1960s a new concept of business logistic was defined to accommodate the increased service and more diversified products which were the 60's trends in the market. Business logistic was defined as: *"the management of all activities that facilitate movement and the coordination of supply and demand in the creation of time and place of utility in goods"* [Moller, 1994].

The prior CLM definition defined the core activities in logistic, but the latter definition has been broadened to emphasize the creation of time and place utility as logistic aims. Coordination of supply and demand is also seen as the umbrella for the logistic activities which is an important improvement to the concept [Diawati and Cakravastia, 1998].

In the 1980s, the revolution in information technology has a significant influence on logistic. The extensive uses of computer have changed the characteristics of logistical activities, from focus on tools and technique interest toward purposive structure and effective management. Organizational change toward logistical orientation and implementation of information system were of particular interest. In 1986 logistic was defined by CLM as: "*the process of planning, implementing, and controlling the efficient, cost effective flow and storage of raw materials, in-process inventory, finished goods, and related information from point of origin to point of consumption for the purpose of conforming to customer requirement"*.

Further advancements in information technology have continuously increased the important role of the technology in the logistical activities. It brought the emergence of the concept of advanced logistic, which underlines the implementation of information technology in logistic. Advanced logistic is based on synchronization of the activities of multiple organizations in the logistic chain and sharing information between supply-chain actors on a real time basis [OECD, 1996]. The integration of all function and works involved in logistic chain becomes fundamentals importance to the achievement of performance goal [Bowersox and Closs, 1996].

From the perspectives of integrated logistic concept, three areas of logistic operation are defined, namely procurement or inbound logistic, manufacturing chain, and physical distribution or outbound logistic. Each of the areas refers to different focus and direction of the flow involved in logistic. Procurement focuses on acquiring and arranging movement of materials, parts, and/or finished goods from suppliers to manufacturing or assembly plant, manufacturing chain concentrates on managing work-on-process inventory as it flows between stages of manufacturing, and the area of physical distribution is concerned with movement of finished product to customer.

Embodied in the three areas mentioned above, three kinds of flows are considered. First, inventory flow represent movement of goods, starts with the initial shipment of a material or component part from a supplier and are finalized when a manufactured or processed product is delivered to a customer. Second, information flow identifies specific location within a logistical system that has requirements. The primary objectives of developing and specifying requirements are to plan and execute integrated logistical operation. Within individual logistic areas, different movement requirement exists with respect to size of order, availability of inventory, and urgency of movement. The primary objective of information sharing is to reconcile these differentials. Third, flow of money is one way flow direction from point of destination to point of origin of supply. It represents the payment made by customer to intermediaries, intermediaries to manufacturer, manufacturer to subassembly manufacturer, or subassembly manufacturer to raw materials suppliers [Diawati and Cakravastia, 1998].

3. GENERAL STRUCTURE OF SHIPBUILDING INDUSTRIES

The structure of shipbuilding industries (Figure 1.) comprise stakeholder involved in shipbuilding process, including customer, shipbuilding company, shipyard, domestic and overseas suppliers of materials, parts and components, domestic and international forwarders, port authority, other government authorities, and financial institutions. Arrow sign represent inventory flow move between logistic stakeholders. In the opposite direction of inventory flow is money flow transferred from point if destination to point of origin in the logistic system through financial institutions. Information flow represented by rectangular pipeline facilitating information exchange between logistic stakeholders with various paths.

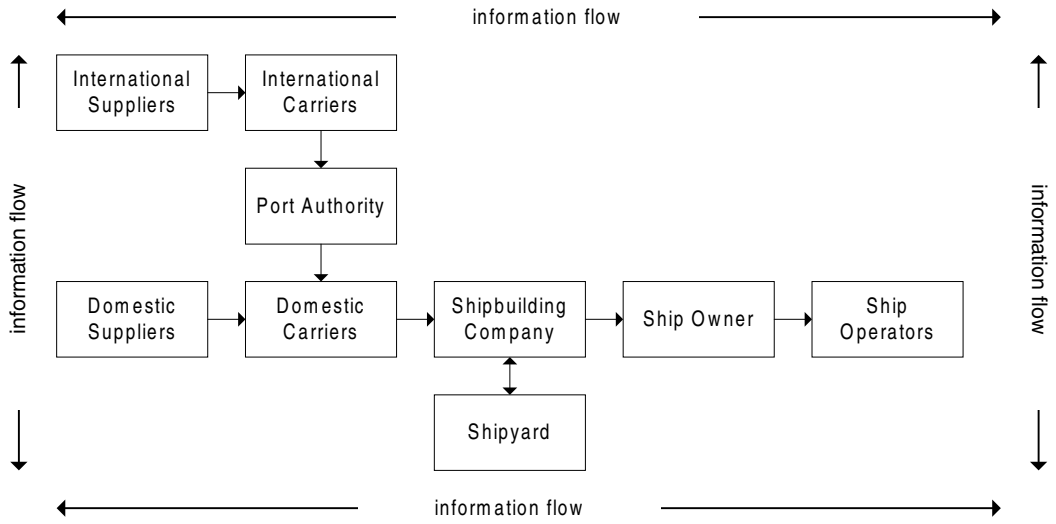

Figure 1. General structure of shipbuilding industries [Diawati and Cakravastia, 1998]

The flow of production process in shipbuilding industries is illustrated in Figure 2. The basic components of ship, most of all made from steel or metal sheet, are constructed in the hull prefabrication shop. The main processes conducted in this shop are marking, cutting, and forming. Later, in the element assembly shop, the basic components are joined together to build construction element. Type and quantity of the construction elements produced depend on the sequence and size of the sections that going to be produced in the block assembly shop. In this shop elements are joined to form a basic section, sidewall, and deck. Thus, group basic sections and outfitting components are assembled to construct a block. Subsequently, each block is erected in the building birth to construct the complete ship and launched to the sea for testing and finishing process.

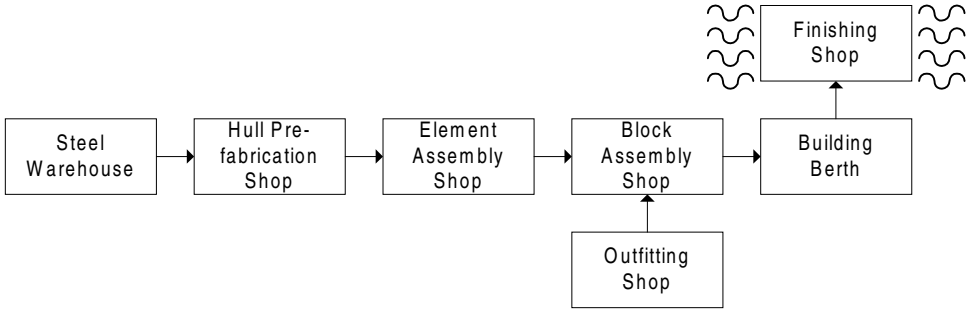

Figure 2. The flow of production process in shipbuilding industries [Wiwi, 1996]

4. MODEL

Traditionally money flow is excluded from the discussion of logistic flow. Indeed, field study in several shipbuilding industries in Indonesia discovered that late payment of inventory orders potentially disrupted the entire flow of inventory resulted in long delivery delay, higher production costs due to manufacturing delay, possibly additional works to deal with deteriorated materials or component parts, and sub standard quality of finished product [Diawati and Cakravastia, 1998]. Moreover, the payment scheme in current practices of shipbuilding contracts contributes a significant role to create the worse financial problem during the economic crisis.

The causal diagram of money flow in shipbuilding industries, given in Figure 3, consists of one positive and one negative loop. In the developed model, the shipbuilding process divided into three stages. The first is ship design, at this stage the ship building company translates the customer requirement into technical drawing and specification. The second stage is ship construction which consist of all process begin from keellaying until ship testing in the construction process. The final stage is delivering the finished ship to the customer. The first loop describes the role of working capital availability and progress payment from the customer to ensure the development of each stage in shipbuilding process. Here, the operation at each stage not only constrained by the availability of resources and materials, but also the customer delay to fulfill the payment scheme. The second loop illustrates the alternatives to fulfill the fund requirement generated by each stages. The payment decision taken will be based on the financial position of the company. The structure of company financial position model is modified from Lyneis [1980].

The mechanism of materials availability constraint in the production process is shown in the second loop in the causal diagram of material flow given in Figure 4. Three kinds of delay that are identified possibly restrain the materials procurement process in ship building company: (1) delay by the international forwarder, (2) delay at the national port due to the custom process, and (3) delay by the national forwarder. The field study encountered that delay in the custom process often becomes the main problem due to its unpredictability. Demands for shipbuilding will be determine by customer satisfaction. In the developed model customer satisfaction is measured by the delivery delay and ship quality. Delivery delay is indicated by the ratio of unfilled orders and production rate. Workers skill and materials inventory time in the model defines the quality of the ships produced by the company. Longer inventory time will deteriorate the quality of materials and components, thus the quality of ships constructed. Besides ship quality and delivery delay, the performance of logistic chain activities in the developed model also evaluated by the production cost. Since ship price is determined in the contract prior to the construction stage, production cost will be indicated by the net profit. Figure 5. give the model outputs that could be used to evaluate the logistic performances.

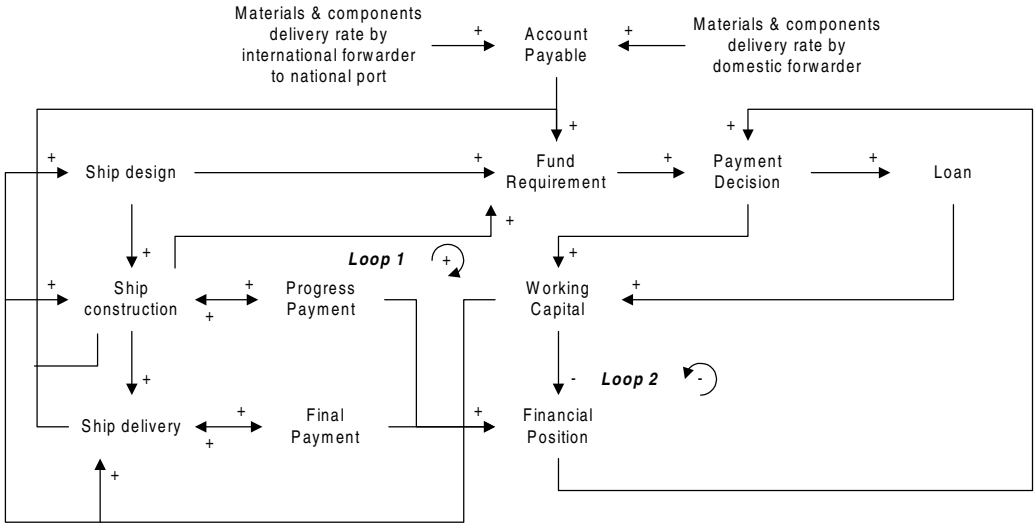

Figure 3. Causal diagram of money flow

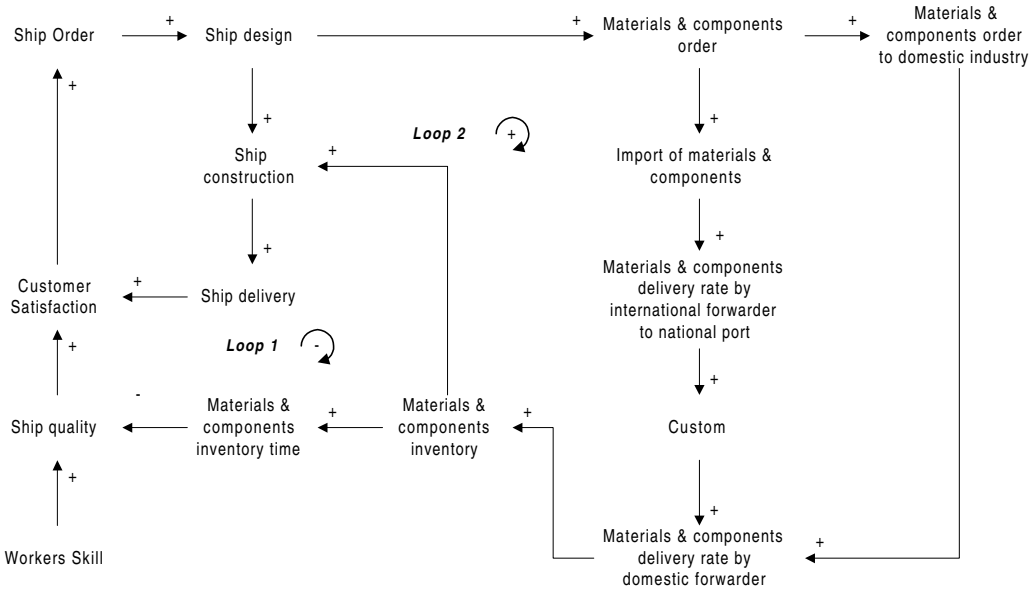

Figure 4. Causal diagram of material flow

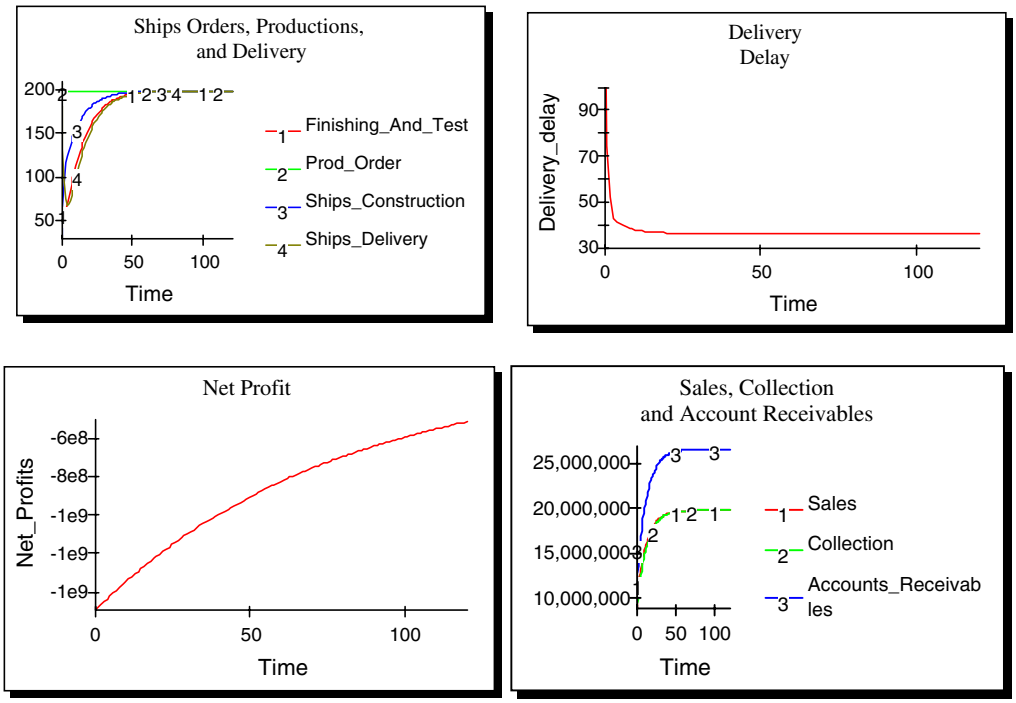

Figure 5. Model output

5. CONCLUDING REMARKS

The model developed comprises the integration of three important flow in logistic chain activities, flow of materials, flow of money, and flow of information. The integration is intended to capture more accurate mechanism and behavior of logistic operation in shipbuilding industries in Indonesia. Through the examination of model behaviors, the model is intended to facilitate the assessment of logistic operating performance indicated by the ship quality, delivery delay, and financial indicators,

and the design of the logistic policy to improve the conformance of the company performance requirement.

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