

Chapter 16

Dynamic Supply Chain Management for Lean Manufacturing

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ABSTRACT

Lean is a management philosophy to eliminate waste both in the inside and from the outside of factories. A supply chain strategy is a key issue for the improvement of the outside. Recent information technologies provide even small- and medium-sized supplier companies with a chance for entering into contracts with major supplier companies and large manufacturing companies in different Keiretsu groups, but will give the trouble for surviving in the dynamic supply chain environment at the same time. This chapter proposes a strategy for MTO (Make To Order) companies to find suitable business partners in the dynamic supply chain environment and to enter into proper contracts with the partners as well as to obtain appropriate profits. A supply chain model proposed in the chapter provides a negotiation protocol to determine suitable prices and delivery times for ordered products through the iteration of the negotiation process between the organizations, as well as through the modification processes of production schedules. A two-layered supply chain model is firstly proposed as a basic model for dynamic supply chain management of MTO companies. The model is extended to a three-layered supply chain model for representing the negotiation protocol among multi-layered organizations. A prototype of a supply chain simulation system is developed and computational experiments are carried out to evaluate the effectiveness of changing business partners and negotiating among the partners cooperatively.

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INTRODUCTION

The book 'The machine that changed the World' introduced the term 'Lean' in 1990 (Womack et al., 1990). Essentially, lean is centered on preserving value with less work (Holweg, 2007). Lean production is an integrated system that accomplishes production of goods/services with minimal buffering costs (Hopp and Spearman, 2004). Lean production uses half the human effort in the factory, half the manufacturing space, half the investment in tools, half the engineering hours to develop a new product in half the time. It requires keeping half the needed inventory, results in many fewer defects, and produces a greater and ever growing variety of products (Womack et al., 1990).

Lean manufacturing, lean production, or lean enterprise, often simply called 'Lean', is a management philosophy derived mostly from and is frequently used as a proxy for Toyota's production system (Shah and Ward, 2007). The basis of Toyota Production System (TPS) is the absolute elimination of waste. Ohno (1988) points out that the two pillars needed to support the TPS are 'autonomation' and just-in-time (JIT). Autonomation, called 'Jidoka' in Japanese, means "to make the equipment or operation stop whenever an abnormal or defective condition arises" (Sugimori et al., 1977). JIT philosophy is known as "producing only the necessary products at the necessary time in the necessary quantity" (Sugimori et al., 1977). To maintain JIT production in Toyota plants, Ohno (1988) devised Kanban system as a means to pull material from an upstream station and manage product flow (Shah and Ward, 2007). To produce the kind of units needed, at the time needed, and in the quantities needed, firms use Kanban and pull production systems, which require that suppliers deliver sufficient quantities of the right quality product at the right time. This JIT delivery by suppliers is predicated on providing suppliers with regular feedback on quality and delivery performance, and providing training and development for further improvement. Because no

firm has infinite resources to expend, the supplier base needs to be limited to a few key suppliers with whom firms can have long term relationships rather than short term contracts (Shah and Ward, 2007). The firms have constructed closer relationships with the key suppliers. The relationships are known as 'Keiretsu'. One or more companies in Keiretsu are divided into some levels which are called tiers. The second tier consists of major supplier companies. The following third or fourth tiers include a lot of small and medium-sized supplier companies. Toyota is considered the biggest of the vertically-integrated Keiretsu groups.

Shah and Ward (2007) proposed the following definition to capture the many facets of lean production as "Lean production is an integrated socio-technical system whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability". To establish lean philosophy, we consider the elimination of waste both in the inside and from the outside of factories. Continuous improvement, called 'Kaizen' in Japanese, is usually applied to a workstation or local area for improving their work environment and productivity for the inside of factories. On the other hand, a supply chain strategy is a key issue to establish mechanisms that enable and ease the continuous flow of products for the outside of factories. When a supplier company belongs to a Keiretsu group, it expects to receive orders of products continuously. Instead, the supplier is stringently required for the strict observance of delivery time in order to keep up JIT philosophy. When a supplier company belongs to the lower layer of tiers in a keiretsu group, profit margins of the supplier may decrease and the risk of economic disruption may increase in general.

Information technologies have been making great progress from the 1990s. The Internet environment has rapidly spread all over the world. By using information processing system, even small and medium-sized supplier companies (SMEs) can also easily make communication with other major supplier companies and large manufactur-

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