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Demand Fluctuation and Supply Chain Integration: Case Studies of Japanese Firms

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Abstract

Current Japanese OEMs utilize both Make-to-stock (MTS) and Make-to-order (MTO) to cope with demand fluctuation. In this paper, we study how leading manufacturing firms utilize MTS and MTO by observing two case studies, Toyota and Omron's operations in China. We showed both companies strategies to mix MTS and MTO along with integrating internal and external parties.

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1. Introduction

In today's turbulent business environment, it is quite important for organizations to be responsive to customers' demands, and an important tool in doing this is an effective demand and supply chain. Significant challenges in managing supply chain stem from demand fluctuation, longer lead time and higher uncertainty in the extended supply chains by globalization. As a result, the globalization has weighed more on the demand-to-supply side of the economies than on the supply-to-demand side. However, factors that lead to demand fluctuation include not only global business range but also seasonality, taxation, product availability and pricing. Hence, the organizational interest for a product that shows variations over time focuses on supply chain management activities to increase supply stability and decrease demand fluctuation. Most of international companies have employed Supply Chain Management (SCM) based on demand forecast in recent years. In the global SCM, however, it is not easy to manage supply chain effectively, due to the various processes and procedures in coordination of supply chain. Demand fluctuations in the supply chain lead to uncertainty in inventory policy and hence the inventory costs increase. Variability in order sizes grows as demand signals propagate upstream in the supply chain. For example, the bullwhip effect is a major cause of higher costs and inefficiencies in supply chains. It describes how small fluctuations in demand at the customer level are amplified as orders pass up the supply chain through distributors, manufacturers and a variety of suppliers. In this paper, we discuss how the focal companies control the fluctuation by utilizing MTS and MTO. For this, we observe their internal and external integration activities of supply chains in China.

2. Literature Review

2.1. Demand Fluctuation and Supply Chain Integration

Now more than ever, firms try to improve the efficiency of their supply chains in order to maintain a competitive advantage (Ambe, 2011). In recent, as market environment is more fiercely competitive than ever before, the very nature of competition has changed. Increasing global competition, advances in technology and increasing customer expectations promise to eradicate traces of mediocrity. As business contexts had become globalized, a variety of supply chain risks have been raised. Significant challenges in managing supply chain stem from demand fluctuation, longer lead time and higher uncertainty in the extended supply chains by globalization. In particular, one of the most significant problems lies in the demand management area in the supply chain (Naude and Badenhorst-Weiss, 2011). Demand fluctuation and forecast inaccuracy risk result from a mismatch between a company's business plan projections and actual demand. If forecast are too low, products might not be available to sell. However, forecasts that are too high result in excess inventories and, inevitably, price mark-downs. Forecast inaccuracies can also result from information distortion within the supply chains (Chopra and Sodhi, 2004; Trkman and McCormack, 2009).

The bullwhip effect is the uncertainty caused from this information distortion flowing up and down the supply chain. In other words, information distortion by higher demand fluctuation is apt to cause the bullwhip effect in long supply chain. When the demand order fluctuations in the supply chain are amplified as they moved up the supply chain, the bullwhip effect occurs (Lee at al., 1997; Chopra and Sodhi, 2004). Distorted information from one end of a supply chain to the other can lead to tremendous inefficiencies in managing total supply chains. We think demand fluctuation cannot be controlled but can be effectively managed if supply chain management has included responsive and collaborative relationships between a focal company and related players. Today, to solve these fluctuation problems, most of companies in same supply chains are trying to cooperate. By these collaborations it is also possible to fulfill multiple customer requirements including cost, quality, delivery speed, delivery dependability, innovativeness and flexibility (Boyer and Lewis, 2002; Flynn and Flynn, 2004; Zhao et al., 2008). Hence, SCM needs to satisfy both the current and future customers, and integrate customer needs into supply chains efficiently (Park et al., 2009; Park et al., 2012).

However, configuration, collaboration, and coordination complexities of supply chain have been important variables (Tomino et al., 2009; Abdelkafi et al., 2011). In particular, Supply chain Integration (SCI) is one of the most important competitive strategies used by modern enterprises (Narasimhan and Kim, 2002). The major partners of the supply chain are the focal organization and the customers, the suppliers, and any other partners involved in the business transactions. For this reasons, supply chain integration is exceedingly difficult. It requires hard work and focus on both internal processes of firms and integration endeavor with external players. Thus, we think that the main aim of supply chain management is to integrate various external players as well as internal and external supply chain processes to satisfy market demand. In this sense, inter-organizational capabilities to integrate internal processes of supply chains are the essence of supply chain integration (Comes-Casseres, 1996; Hagedoorn and Duysters, 2002; Chiang and Trappey, 2007). Furthermore, in terms of external suppliers management, supplier selection and evaluation plays an important role in establishing an effective supply chain (Lee and Kimz, 2008; Lin, et al., 2009; Chen, 2011). A stream of literature concerning integration with suppliers in Japanese and USA contexts focuses on (1) information and physical flow coordination; (2) coordinative mechanisms for individual suppliers in a supply chain; (3) coordination incentives within supply chain for performance improvement; (4) supplier selection and evaluation, (5) inter-organizational collaboration through contracts, information, and mutual trust (Sahin and Robinson, 2002; Narayanan and Raman, 2004; Araz and Ozkarahan, 2007; Li and Wang, 2007; Tomino et al., 2009). Diverse forms of coordination with suppliers and their collaborative endeavors impact on supply chain performance. In view of supply chain integration in mobile industry, Park et al. (2009) show how the key players in the mobile phone industry utilize their strategic alliances and collaboration arrangements. Through case study, they examined NOKIA (as mobile phone manufacturer) and Texas Instruments (as component supplier) have maintained collaborative strategic alliances for their mutual competitive advantages.

Collaborative network capabilities in supply chains satisfy complex customer requirements that either manufacturer or suppliers alone may not satisfy (Bowersox et al., 1999; Squire et al., 2005). As a result, an important strategic priority for many firms is to enhance supply chain integration and achieve competitive advantages through supply chain integration (Ahmad and Schroeder, 2001; Stank et al., 2001; Peppard and Rylander, 2006; Di-Domenico et al., 2007; Zhao et al., 2008; Rajagopal and Rajagopal, 2008).

Most of supply chain integration studies have mainly centered on manufacturer-suppliers relationships. Besides, many of these studies have focused on the success of Japanese manufacturing including Toyota (Miyazaki, 1996; Lincoln et al., 1998; Manabe, 2002; Amasaka, 2002; Liker and Choi, 2004; Tomino et al., 2009). There has been a lack of studies which consider integration of internal and external supply chain players alike. In particular, recent studies have little done studies of supply chain integration practices of various industries together. This paper contributes to the body of the literature by conducting case studies of supply chain integration of automotive and medical companies. Furthermore, this paper mainly focuses on supply chain management corresponding to demand fluctuation and analyzes the integrative processes between assemblers, their suppliers, and external dealers (marketing agencies).

2.2. Research Focus

Generally, production system as research object is classified as make-to-stock (MTS), assemble-to-stock (ATS), make-to-order (MTO), configure-to-order (CTO) and engineer-to-order (ETO) in the manufacturing continuum. In this study, we regard BTO and MTO as same concepts. However, we consider different cost structures by production methods of MTS and MTO (Bowersox et al., 2002, Chinen, 2006; Tomino et al., 2009). For make-to-stock (MTS) method, as production increases, manufacturing and transportation cost decreases in proportion to economies of scale but the cost of keeping stock increases. In contrast, make-to-order (MTO) method takes the cost of keeping small stock but yet takes high cost for production and transportation costs.

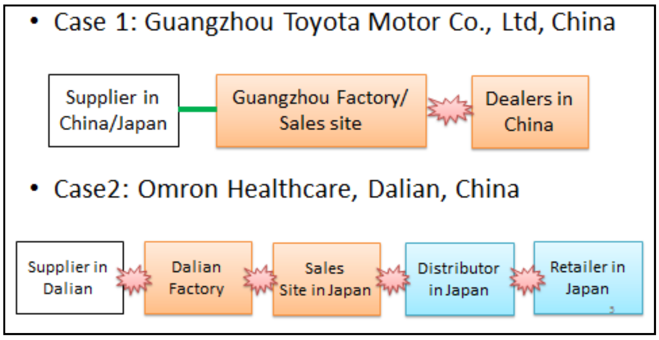
In case of Japanese automotive industry, it is known that Make-to-order (MTO) makes production lead time longer because it has to accommodate additional customer order specifications. One alternative is to use Make-to-stock (MTS) by anticipating the level of customer demand while assuming additional inventory risks for the various components of finished cars. A challenge of today’s operations management is to resolve the conflicts between lead time and inventory risks by using MTS and MTO. Consequently, current Japanese OEMs utilize both MTS and MTO (Tomino, 2003, 2004, 2006; Tomino et al., 2009). Production and delivery of component suppliers are based on the advance notification from their manufacturers. Thus, the accuracy of production forecasting is critical in controlling inventory risk. In the month of actual production, their production system runs much like MTO. Furthermore, most of automotive firms integrate marketing channels internally.

However, unlike automotive firms, most of electronic and healthcare firms do not integrate marketing channels internally. Consequently, it is difficult to forecast and control demand accurately like automotive firms. Therefore, for electronic and healthcare firms, it is a tremendous challenge to respond to demand fluctuation through integration with external marketing agencies.

In this paper we discover how case study firms utilize MTS and MTO while observing their supply chain integration. In next section, we will analyze comparative case studies of Toyota and Omron in China.

We thought briefly two reasons to analyze firms' operation in overseas. First, it is not easy to establish the same operation in foreign countries, even though the operation in Japan is stable (Abo, et. al, 1991). In Toyota case, we focus on the effort between production site and marketing site in China. In Omron Healthcare case, we shed light on the efforts among its factory in China, sales site in Japan and external parties in Japan. Second, it is necessary to regard different natures of marketing channels in different industries as mentioned above. In Toyota, the dealers in China are under its control, however, not every firm has the marketing channel as same as Toyota. Therefore, we choose a firm, such as Omron Healthcare, with external distributor and retailer. For these two reasons, these case studies are appropriate for the analysis (Fig. 1).

Figure. 1 Observation focus of two case studies



3. Case Studies

3.1. Methodology

We have adopted a multiple case study method to explore our research question (Yin, 1981, 2003; Voss et al., 2002; Krajewski et al., 2005). We interviewed several executives from Toyota and Omron and several executives from their suppliers and dealers (or sales agencies). The interviews were conducted from 2003 to 2012. The information was gathered from managers that possesses expert knowledge about the subject of inquiry through interviews.

As shown in Appendix 1, we have conducted interviews for Toyota (5 interviews), Omron (3 interviews) 1 dealer, and 1 supplier (first tier) interviews. In view of our prior extensive knowledge base on Toyota and Omron in Japan, our interviews focused on Toyota and Omron in China this time. With their permission we have carefully documented the details of each interview. All interviews were tape-recorded and detailed documentations were made. For consistency we have used formal semi-structured interview questions. As needed we also asked additional proving questions. Post-interview analyses included comparison of our multiple interview results with previous literature findings.

3.2. Japanese vehicle company: Toyota

3.2.1. GTMC (GAC Toyota Motor Co., Ltd.)

We interviewed Toyota Japan (Toyota Motor Corporation), GTMC (GAC Toyota Motor Co., Ltd.), Japanese and Chinese car dealers, and part suppliers. The interviews were conducted from 2001 to 2008.

Firstly, we analyze a case of GTMC which is one of the Chinese local corporations of Toyota. It is a good example which started production and sales function at the same time in 2004 (establishment in 2006) and reflected the manufacturing philosophy of Toyota into the system.

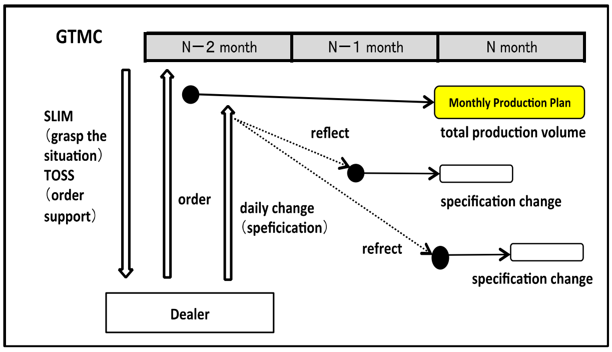
First of all, we show the process of production planning at GTMC. The production planning of the vehicle production for the Nth month begins in the N-2th month, two months before which receives order (allocation of cars demand) from dealers of GTMC control. How to sell cars in China is basically a stock sale at the dealer store and a customer watches a display vehicle and purchases one.

Each dealer performs the forecast order of the vehicle at the final specifications level considering the situation of the stock vehicles and future sales. At this point, GTMC finalizes the total complete volume requirements for the Nth month production plans of each model (Camry, Highlander, Yaris, Camry hybrid) and fixes the allocation of cars of Nth month to each dealer, namely monthly production planning. In principle, GTMC does not hold inventory cars.

After that, a dealer can demand a change about the specifications (a model and color) of the vehicle which it ordered every day as needed. This is close to the system of the daily change in Japan.

GTMC collects and reflects the order change information that received from a dealer into production planning two times a month. Change of specifications depends on the procurement situation (in particular, transportation parts that has a long procurement lead time from Japan). Most of changes are about the color. Specifically, GTMC establishes production planning for previous two weeks of Nth month in N-1th month and for later two weeks of Nth month at the beginning of Nth month (Fig.2).

Figure 2. GTMC production planning



3.2.2 Coordination mechanism between production and marketing of Toyota

As the establishment of GTMC may be relatively new among the production bases of Toyota of the world in 2004 (the start of production in 2006), GTMC makes coordination process of production and marketing of Toyota explicit knowledge while using IT effectively. Here, we clarify the contents of coordination process of production and marketing of the Toyota style by two examples of the IT system called SLIM (Sales Logistics Integrated Management) and TOSS (Total Order Support System).

3.2.2.1. SLIM

SLIM is a system to always grasp the situations such as sales plans, production progress, logistics, and the finished vehicle stock of the dealer possession. One of the most distinctive features in a series of systems constituting SLIM is a liquid crystal display (LCD) located in the wall surface of one head office of GTMC. Various kinds of information are updated and displayed for every 45 minutes in a huge liquid crystal display. Specifically, sales branches (272 sales branches as of March, 2011) of GTMC in the whole land of China are displayed in a vertical axis and the latest situations of each process of the supply chain are also displayed in a horizontal axis such as the sales plan (the sale accomplishment situation) of each dealer, the fund preparations situation of the dealer, production progress of GTMC, the number of car volumes in the factory yard, the situation of the out-bound logistics, the situation of the store inventory car, and the delivery of waiting situation to customers.

An icon separated by color is displayed in the screen, and one icon expresses a vehicle.

Each vehicle is managed by an IC chip, and the information is sent to the server and updated whenever it passes each process. It can display various kinds of detailed information (specifications such as a color or the model) of each vehicle icon when an operator operates a terminal connected to the management board. Furthermore, the color of the icon of the vehicle changes automatically whenever store standard inventory is exceeded and a vehicle beyond the planned production lead time appears. For example, as GTMC, by this system, can grasp the information of the dealer on a screen for which target of the sales plan went unachieved, it can cope with confirmation and the measures to the dealer. The president, a production manager, and members of each sales district charge gather before SLIM board once a week, share information, and perform detailed cross-functional adjustment of production and marketing. This artificial adjustment becomes the key.

3.2.2.2. TOSS

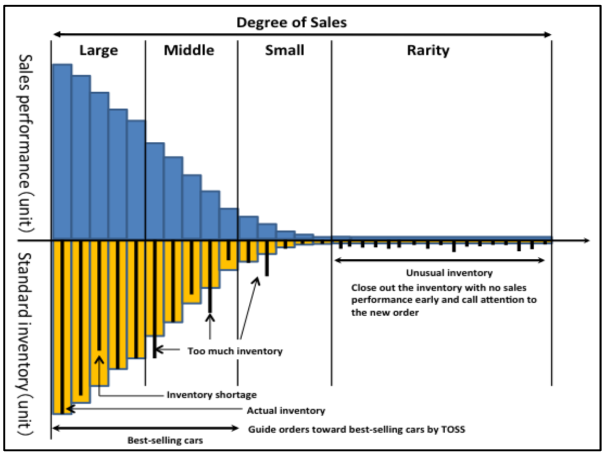
GTMC has TOSS which is an ordering support system introduced from 2009. This system is important in planning supply-demand balance of production and marketing.

GTMC, utilizing SLIM, comprehends inventory of the whole supply chain and the situation concerning lead time information, and the sales trend of the vehicles as just mentioned. TOSS is the system to request appropriate vehicle ordering to dealers based on gathered information through SLIM. When a dealer places an order for the vehicle to GTMC, TOSS is the system to help a judgment of the dealer about what kind of specifications and which car model should be ordered to maintain appropriate standard stock.

When we see an example of Camry produced at GTMC, seven specifications occupy approximately 80-90% of all unit sales, even though the number of the main specifications is about 80. Therefore GTMC classifies the “hot (best-selling)” products according to specifications by 4 ranks of A (large amount of products), B (middle amount of products), C (small amount of products), D (rarity) depending on the past sales results and sets each standard inventory quantity for every store. GTMC does not put the store inventory as a general rule for the minor specifications of the D rank that just over 10 cars per dealer are sold in a month and maintains the system which is close to make-to-order production. GTMC shows recommended order, increases accuracy of order and keeps the appropriate inventory, while adding the stock situation of each dealer, the order situation, and the sales results to these “hot(best-selling)” products analysis data (Fig.3).

Before 2009 when TOSS was introduced, the order from the dealer was often based on perception and the experience of the person in charge, and massive fluctuation occurred between the sales results and the stock quantities at the last specifications level about the sales of the car in inexperienced China. To promote an appropriate order, TOSS was introduced.

Figure 3. TOSS (Total Order Support System)



For example, it incorporated the system to call attention to the dealer and confirm it, when the specifications that hardly had orders in the past are ordered. But TOSS is not the system to force order to dealers, but to show recommended order. The dealer finally places an order by an original judgment in reference to information shown in TOSS. This point is important. In this way, Toyota’s case illustrates that the positive functions of marketing dealers are not merely to pass onto customer order to the manufacturers but to actively achieve the advanced production planning (Asanuma, 1997). Marketing supports the stabilization function of the expected production plans of Toyota. GTMC introduced TOSS to support Chinese dealers with very little sales experience, but TOSS has just a supporting role to recommend order and the dealers have an authority to determine orders and the responsibility for taking a inventory. This operation at GTMC is similar to that of Japan. In turn, this role definition motivates dealers to enhance their demand prediction accuracy and at the same time aggressively engage in their marketing efforts. As a result, sales increase. In addition, 3-4 days before the actual production dealers may request changes in color and model types at Toyota Japan and 2 weeks before the actual production dealers may request at GTMC so that the production side helps inventory stock risk reduction of the marketing side.

Furthermore, needless to say, it is not IT tools themselves such as SLIM or TOSS that are important here. Rather, we should pay attention to coordination mechanisms between production and marketing and production planning capabilities of the Toyota style, simultaneously achieving both production and marketing efficiencies while securing the maximum of customer satisfaction.

3.2.3. Coordination between make-to-stock (MTS) and make-to-order (MTO)

Japanese vehicle-manufacturers involve information flows from customer order placement to final order fulfillment including production and purchasing plans. Production plans (annual and daily production details) require timely and reliable information of customer demand through nation-wide dealership network (Tomino et al., 2009). In general, Japanese production schedule and plan (annual, monthly, weekly, and daily) and part purchasing plans are important components of supply chain processes. Supply network is consisted of multiple tiers of suppliers and demand network is connected through national sales offices, retail distributors and final customers. For our research purpose, we did not involve 2nd or 3rd tier suppliers because in Japanese context first tier suppliers are responsible of the performance outcomes of 2nd and 3rd tier suppliers as well. This study focused on examining the comprehensive relationships between suppliers, manufacturers and dealers in the Chinese context.

In terms of production planning processes total production volumes by each product line is based on previous month’s records and therefore each month’s production plans change very little. In this way, Toyota operates in monthly cycle which is fairly long planning time span. As Toyota fixes its production plans in the monthly intervals, it controls the fluctuations of production plans. But since such production plans are based on long production cycles, the adjustability to demand change falls. Therefore, for specifications, Toyota also uses short production cycles (which are usually fewer than three days at Toyota Japan and two weeks at GTMC) to enhance market responsiveness. At the same time, Toyota utilizes both short and long production cycles for the modified cycle of specifications. Although the final production volume of product specifications may be up to tens of thousands, in general there are “hot (best-selling)” products that customer prefers so that mostly the items for major production adjustments by dealers are except “hot (best-selling)” products. Since such production plans are based on long production cycles, dealers adopt their marketing efforts in ways not to damage customer satisfaction but to stabilize their overall order patterns.

Through utilizing TOSS depending on “hot (best-selling)” products, GTMC maintains stabilization of the production. At the same time, Toyota maintains short time cycles (daily change system) as much as possible, for other small special order cars and specifications (items) which may require some changes in their order plans. The customers who insist particular feature orders tend to tolerate longer adjustment periods. Therefore, with the uses of short and long production cycles Toyota effectively fulfills both production and marketing goals.

In this way, Toyota’s monozukuri (product manufacturing) combines short and long term change cycles in different levels and achieve both production and marketing efficiencies and realizes coordination between MTS and MTO.

As we analyzed Toyota, Japanese OEMs generally utilize both MTS and MTO. This is due to particular aspects of their component suppliers (Tomino et al., 2009). A car has in general 20,000 to 30,000 component parts. Japanese OEMs receive nearly 70% of components from their suppliers. Thus, any changes in production schedule affect component purchase plans which in turn impact production schedules of component suppliers. Many suppliers produce component parts according to advance notification from manufacturers and start making these components prior to receiving final change specifications. Unusual levels of inventory may arise with slight discrepancies between advance notification and actual orders. In the long run, this is what both OEMs and their suppliers should avoid. As OEMs use MTO, it is challenging for supplier to procure all the components in timely manner. This situation demands OEMs to devise structures that provide flexible production plans while stabilizing component procurement schedules. OEMs’ production schedule determines the heart of the inventory risk and delivery time issues involving large numbers of suppliers.

3.3 Medical equipment Company : Omron Healthcare[1]

3.3.1. Omron Healthcare Dalian, China

Omron Healthcare Co., Ltd is one of the major healthcare equipment and machine firms in the world, that customers are familiar with its blood pressure monitors, digital thermometers and other products. Here we focus on Omron Healthcare Dalian in China (Kobayashi et al., forthcoming). As production activities in Dalian factory (China) were increasingly important

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[1] The case of Omron Healthcare is based on the description from Kobayashi et al. (forthcoming)

to Omron Healthcare, it brought the production systems in home country which called ONPS[2] to Dalian and renamed the system DNPS (Dalian New Production System) in 2005. In 2010, the inventory level temporarily fell down, but it went up soon without noticed. Some products were even short of inventory although the factory worked very hard on manufacturing them. One of the main causes of the problem was that the irregular bulk orders disturbed regular production plan. DNPS actually performed remarkably on inventory reduction and productivity improvement. But regardless of how precisely DNPS could shorten the frequency of demand forecast from monthly demand forecasting to the weekly, production site had no idea or means of access to the actual market situation, and what it did is just "manufacturing products". The production site also knew nothing about sales site's policy and plans, except basic order information such as product numbers and purpose of use. Besides, production site and sales site did not dare to try to share detailed information together. It means production site's effort only contributed the local optimization (good impact only inside of production site), but the firm needed all parties involved to work together in order to solve the inventory problem.

To solve the problem, Omron Healthcare started working on organizing order types and initiated a new system called Make to Availability (MTA) in 2010 for the regular order supply. MTA is based on Theory of Constraints (TOC), which is to focus on removing the bottleneck and improving the companywide product information flow in order to link the activities to profit. On this occasion, each department/party shall not focus on optimizing its own department/party but instead shall consider how to generate a smooth flow of information for the entire firm. In briefly, the production history can be described into two phases. In the first of two phases for production, Omron Healthcare paid much attention to the production capability building and the cooperation with the supplier, and DNPS was a key system. In the second phase, Omron Healthcare made much work on a wider range of cooperation, which involved more departments and parties to make information flow traveling through them, and both DNPS and MTA played a big role.

3.3.2. Coordination mechanism between production and marketing of Omron

3.3.2.1. Supply chain integration

Omron Healthcare recognized the importance of involving all departments and external

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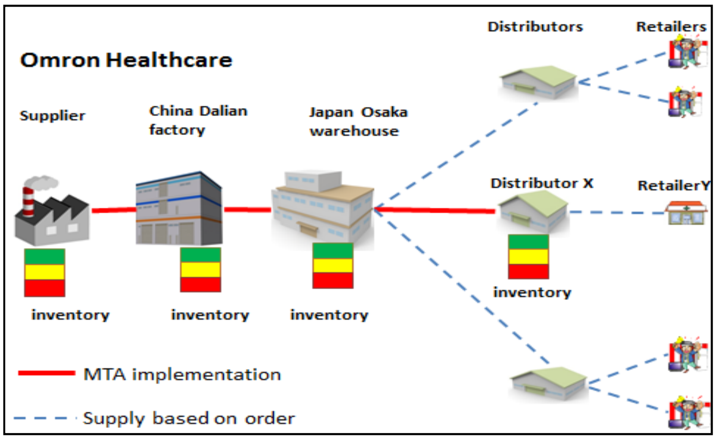
[2] Omron New Production System(ONPS) utilizes Kanban based on TPS, in which parts and products supply comes from customer demand.

players in order to make the new system (MTA) work. First of all, it started internal department integration. In March, 2010, six-day workshop was held for sharing the common goal by all members. All managers from production, logistics, product development and sales departments were gathered. They were required full commitment to the workshop during the six days. Before this workshop, DNPS was perceived as the system not for total inventory control but for the inventory control at production site. Sales department did not utilize DNPS for the control of their distribution inventory. Other than learning the new system, managers also did in-depth discussion on what would be the problems after system implementation. Additionally, managers shared their own situation and subjects, and truly deepened mutual understanding for the first time. At the workshop, increasing the sales team's comprehension was especially important because all customer information and order information came from the sales person. If sales manager could not fully understand the whole concept, the way the members of the firm pass information would not be any different from the past. Sales site tended to pass the orders to production side with more amount than the one of actual demand because it did not want to have inventory shortage and fail to response to its customer (i.e. distributor). Moreover their fluctuation of production volume was amplified since sales site has passed the order information that mixed up with regular order and bulk order for special campaign. That fluctuation brought the inventory shortage problem at production side. Therefore, sales site could not completely trust production site and kept to order more than the actual demand to prevent opportunity loss until this workshop. At the end of the workshop, Omron Healthcare decided to give MTA a shot and started the implementation around August, 2010, a trial on five kinds of products and aimed to integrate management between production department and sales department. Now it implements the MTA with 170 items.

According to Omron Healthcare, MTA is a production system that links finished goods inventory and market demand. It replenishes stock according to downstream demand information (source from the market or distributor or sales site). MTA means that they manufacture in order to guarantee availability of their products for distributors. Basement for production planning was changed from the order from sales department to the sales shipping inventory. Sales persons basically do not need to order to production department based on their sales forecast. Here DBM is the main methods to support MTA. Dynamic Buffer Management (DBM) is an important inventory management method to support MTA. It visualizes which item should be given the priority of production and how volume should be manufactured. First, it calculates the maximum amount of inventory for each item as a buffer to cope with demand fluctuation. The initial maximum amount of inventory is defined as the maximum demand during supply lead time. Supply lead time is the sum of order lead time, production lead time and delivery lead time. The maximum demand is basically the past maximum sales at the time when the product was the best seller in the item. Then, item's inventory is divided to three zones: green, yellow and red. The supply priority is dynamically adjusted by an easy rule. Red zone means the inventory is ready to short. Those products in red zone should be manufactured as first priority. Yellow zone is the ideal level of inventory and those products should be manufactures as second priority. Green zone means quite sufficient inventory, and the supply is not in a hurry at that time. Present inventory is the sum of the inventory amount in shipping warehouse in Japan, the amount on transportation, the amount in warehouse in Dalian and the amount in manufacturing process in Dalian factory. The amount of supply to be manufactured is subtraction of the present inventory from the maximum inventory.

For the regular order, sales person do not need to make an order, and people on production side do not need to work hard on controlling the inventory level anymore. Information system help two departments share information of inventory amount, products/parts location and factories' circumstances at any time. All actual information is visualized on the information system and shared between production and sales departments.

Figure 4. Supply Chain Integration of Omron



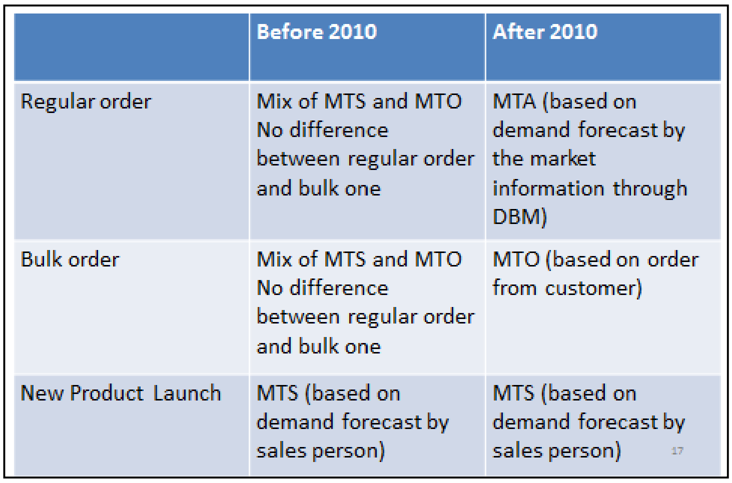
Source: Kobayashi et al. (forthcoming)

Second of all, Omron Healthcare also worked on integration with external parties, such as the suppliers and dealers. It held a meeting with people from the suppliers, explained the MTA system, and implemented DBM to the supplier who agreed with. With dealers, as a trial, Omron Healthcare implemented MTA to one of its distributors with a few kinds of products (Fig.4). Its ideal thought is to place the MTA to more downstream players (more distributors and retail stores), then the demand of the end customer will be more visible than ever before.

3.3.3. Coordination between make-to-stock (MTS) and make-to-order (MTO)

Production site treats the bulk order from sales site as a special order, and makes another production plans (MTO and MTS) separately from the MTA which deals with the regular order (Fig. 5). People in charge of production attend the formal meeting in sales department and information sharing becomes denser than before. Production site adopts MTO to respond to the bulk order. The bulk orders can be operated in MTA if the amount of orders is allowed by the MTA standard. Additionally, production site adopts MTS as for the new products. It is necessary to prepare enough inventories before the introduction of new product to the market. The amounts of those advance inventories are set according to the sales and promotion plans by sales department. Production people understand actual sales are often below those plans or forecasts since no one knows whether it is going to be a blockbuster or not.

Figure. 5 Coordination of MTA, MTO and MTS



	Before 2010	After 2010
Regular order	Mix of MTS and MTO No difference between regular order and bulk one	MTA (based on demand forecast by the market information through DBM)
Bulk order	Mix of MTS and MTO No difference between regular order and bulk one	MTO (based on order from customer)
New Product Launch	MTS (based on demand forecast by sales person)	MTS (based on demand forecast by sales person)

In 2012 summer, the inventory in the warehouse located in Osaka is reduced about 30% to 40% compared to it before the implementation of MTA. The inventory in Dalian factory is reduced about 40%. The inventory problem has not completely disappeared after MTA implementation, yet monthly meetings and other communications between two departments enable actual demand information of regular order and sales policy (bulk order for campaign and the new product debut) to be visible for each department.

3.4. Comparison of cases

A challenge of today's operations management is to resolve the conflicts between lead time and inventory risks by using MTS and MTO. Current Japanese OEMs utilize both MTS and MTO (Tomino et al., 2009).

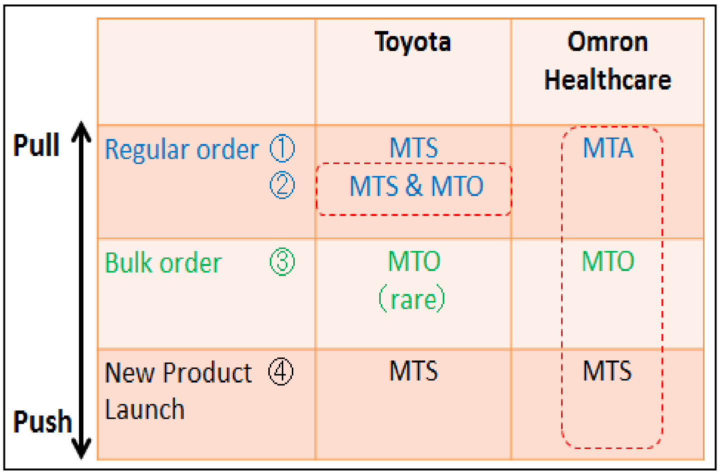
Toyota operates in monthly cycle which is fairly long planning time span. As Toyota fixes its production plans in the monthly intervals it controls the fluctuations of production plans. But since such production plans are based on long production cycles, the adjustability to demand change falls. Therefore, for specifications, Toyota also uses short production cycles (which are usually fewer than three days at Toyota Japan and two weeks at GTMC) to enhance market responsiveness. At the same time, Toyota utilizes both short and long production cycles for the modified cycle of specifications. Although the final production volume of product specifications may be up to tens of thousands, in general there are "hot (best-selling)" products that customer prefers so that mostly the items for major production adjustments by dealers are except "hot (best-selling)" products. Since such production plans are based on long production cycles, dealers adopt their marketing efforts in ways not to damage customer satisfaction but to stabilize their overall order patterns.

Through utilizing TOSS depending on "hot (best-selling)" products, GTMC maintains stabilization of the production. At the same time, Toyota maintains short time cycles (daily change system) as much as possible, for other small special order cars and specifications (items) which may require some changes in their order plans. The customers who insist particular feature orders tend to tolerate longer adjustment periods. Therefore, with the uses of short and long production cycles, Toyota effectively fulfills both production and marketing goals. In this way, Toyota combines short and long term change cycles in different levels and achieves both production and marketing efficiencies and realizes coordination between MTS and MTO (Fig. 6).

On the other hand, Omron had problems to cope with tremendous demand fluctuation. For this, production site of Omron treats the bulk order from sales site as a special order, and makes another production plans (MTO and MTS) separately from the MTA which deals with the regular order. People in charge of production attend the formal meeting in sales department and gradually incorporated their statements and thoughts into sales plan. With such effort, production site is able to know information about big changes in production volume in early time, which never happened before. With sales site's cooperation, production site adopts MTO to respond to the bulk order (National Day or New Year campaign).

The number in Fig.6 represents easiness and difficulty of demand forecast. The smaller the number is, the more pull-like by the market demand, the bigger the number is, the more push-like by the demand forecast.

Figure 6. Case analysis results



		Toyota	Omron Healthcare
Regular order	①	MTS	MTA
	②	MTS & MTO	
Bulk order	③	MTO (rare)	MTO
New Product Launch	④	MTS	MTS

In this study, we mainly focus on both companies' general operation as red dotted circled. For Toyota, we observed how it copes with regular order when specifications changes are needed. For Omron Healthcare, we studied how it copes with three types of orders.

4. Conclusion

Japanese vehicle manufacturers in terms of production and purchasing plans, inventory risk management, use MTS and MTO. It is noted that in two ways Toyota has made extra efforts to improve the stability of the manufacturing plan as general operation(Tomino, 2003, 2004; Tomino et al., 2009). First, Toyota's dealers take responsibility of inventory risks for all the sales order of cars. Second, Toyota carefully considers challenges of component suppliers. Daily specification change system sets the acceptable range. Toyota limits the rate of specification change of each component within ±10% of production plan. This policy aims at reducing big discrepancy between components and actual orders in its Kanban system. Toyota considers the impact of schedule change on the production plan of its component suppliers.

Toyota emphasizes precise advance notifications and consciously attempts to enhance them. It establishes monthly production planning carefully after having examined the capabilities of Toyota marketing and the sales dealers and a demand trend. Therefore all the sale dealers are responsible for the decided amount of production as a general rule. As a result, the inventory risk occurs to the dealers, but it helps improvement of the demand prediction of the dealers, the order accuracy and aggressive sales effort, and finally strengthens Toyota.

Different from automotive companies, however, healthcare companies internally have no distributors. Thus, it is difficult to integrate external supply chain such as sales agencies and distributors. As a result, healthcare company like Omron suffered from demand fluctuation such as bulk orders. To respond to these problems, these companies more try to integrate external supply chain players as well as internal supply chain department.

When we consider the adaptation to a demand fluctuation, previous studies' attention is apt to go only on the side of the adaptability of production to demand, but it is more important how to keep stability of the production side. In other words, it is also important how to control demand according to production. Also, we should notice that mixture of MTS and MTO sounds a smart solution to control demand fluctuation, instead of choosing either one. Unintentional flattery to demand may force the production side to increase cost more than required and, as a result, may reduce profitability. Firms should competitively position as the winners of global supply chain that integrate both dynamic and rapidly changing demand requirements (market-in) with stable and efficient supply responses (product-out).

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Appendix 1: Interview Details

Date	**Company**	**Department**	**Position**	**Hour**
9/15/2003	Toyota Japan	Production Engineering Planning Division	General Project Manager	4.0
2/6/2008	Toyota Japan	Production Control Division	General Manager	3.0
5/29/2010	GAC Toyota Dealer A	First Dealer Shop	General Manager	2.0
2/3/2011	GAC Toyota	 e-CRB Promotion Division e-CRB Promotion Division Vehicle Sales Department Production Management Division Administration Division	Vice President General Manager General Manager Senior Coordinator Deputy General Manager	4.0
2/3/2011	GAC Toyota Motor China Investment	Corporate Planning Department	Specialist Business Planning&Research	1.0
2/3/2011	GAC Toyota Dealer A	First Dealer Shop	General Manager	3.0
8/21/2012	Omron Healthcare Dalian	Production Control Division	Chairman of the board, Vice President	4.5
9/21/2012	Omron Healthcare HQ Japan	Production Strategy Department: R&D Management Department Production Information System Department	General Manager Senior Engineer Senior Staff	2.0
9/28/2012	Omron Healthcare Tokyo Office	Sales Department	General Manager	2.0
9-11/2012	Consulting company B	HQ Office	Chief Executive Offier Project Director Project Director	5.0
8/21/2012	Omron Healthcare Supplier A	 Production Department Production Department Production Department Quality Management Department	President General Manager Deputy Manager Manager Manager	1.0