12

Logistics Strategies to Facilitate Long-Distance Just-in-Time Supply Chain System

Liang-Chieh (Victor) Cheng
University of Houston
United States of America

1. Introduction

Just-In-Time (JIT) has become a paradigm in supply chain management since its introduction to the U.S. manufacturing industries in the 1970's (Chopra & Meindl, 2007). Aiming at total logistics cost reduction and customer service enhancement, JIT generates significant impact on the all logistics aspects for the JIT system participants (Daugherty & Spencer, 1990; Gomes & Mentzer, 1991). As international and domestic competitive pressure increases, an increasing number of companies are adopting JIT principles with the anticipation of productivity advancement, waste reduction, and quality breakthroughs. Experts have agreed that JIT strategy has constituted a potent force in improving the U.S. manufacturing competitiveness (Modarress et al., 2000; Wood & Murphy Jr., 2004).

In the present chapter, a long-distance JIT supply chain in a global context is defined as an inter-organizational logistics system which processes physical flows and deliver goods cross across country boundaries at the right time, to the right locations, of the right quantities, and with the right quality (Kreng & Wang, 2005; Wong & Johansen, 2006; Wong et al., 2005). A JIT supply chain entails a highly efficient logistics system as the operational foundation (Bagchi, 1988; Bagchi et al., 1987; Giunipero et al., 2005). Specifically, transportation assumes a much more important role in a JIT system than a conventional multi-echelon supply chain (Schwarz & Weng, 1999). Furthermore, the demand for efficient and integrative distribution centers is drastically higher than the traditional approaches in that shipments entirely rely on distribution centers at each echelon to coordinate and process inbound and outbound flows in a timely manner (Lieb & Millen, 1988). Failure in any particular logistics process could potentially lead to a bottleneck, hindering expected efficiency of JIT systems (Chopra & Meindl, 2007).

Initially established in Japan, the JIT production and purchasing concepts are recognized as a cornerstone of the Japanese manufacturing sector success. The original JIT design is embedded in close and tightly connected distribution networks. The networks are supported by innovative logistics arrangements, such as load-switching and freight consolidation to facilitate inbound and outbound flows (Giunipero et al., 2005). In the last decades, supply chain system has evolved from its original local scale to a multi-national, or even global scope; in the meantime, the demand for JIT operations from global marketplace does not diminish. As a result, manufacturers that attempt to implement extended, long-distance JIT systems will need a substantial modification for the original form of the JIT system (Kreng & Wang, 2005; Wong & Johansen, 2006; Wong et al., 2005).

The thrift development of international logistics and regional economic integration, has led to successes for international operations. U.S. manufacturers establish the well-known Maquiladora between U.S. and Mexico to leverage cost advantages (Wood and Murphy 2004). Dell Computer and HP are lead computer brands utilizing global JIT operations by integrating supply chain partners (Dean & Tam, 2005). In these instances, information technology (IT) utilization and efficient long-distance haulage connecting manufacturing and distribution are key determinants for JIT successes (Bookbinder & Dilts, 1989). Designing an integrated long-distance value chain enabled by synchronized inter-firm information system is thus critical for successful JIT systems (Schniederjans & Cao, 2001).

The foregoing discussion leads to several interesting questions with regard to the emerging global, long-distance JIT system. How can firms configure a global, long-distance supply chain network? How should supply chain partners establish strategies for logistics functions to support a wide-spread value system? In the logistics literature, there is a lesser amount of published work addressing necessary transformation required by global JIT coordination. The present study attempts to develop a systematic approach to establish a global, long-distance JIT system.

This chapter conducts an extensive literature relative to JIT studies and supply chain strategies supporting this strategy. The research integrates multiple research streams and presents a framework utilizing inter-firm IT and consolidation to establish a long-distance JIT system. State-of-the-art communication technologies (e.g. RFID) and logistics strategies (cross-docking) beyond conventional JIT "pillars" are incorporated into the proposed framework. Finally, the main contribution is a roadmap that accounts for long-distance JIT planning and the synthesis of logistics strategies that facilitate the long-distance JIT strategy.

2. Logistics strategies in a JIT supply chain

2.1 Conventional JIT transportation strategies

JIT system requires consistent transportation service and special handling equipment. Participants of this system should be equipped with higher level of flexibility and adaptability to account for tight coordination in the transportation and distribution network (Harper & Goodner, 1990). The JIT strategy entails a complex and complete rethinking on sourcing decisions and plant and warehouse locations. Broad scale implementation JIT logic of transportation systems result in the following changes (Chapman, 1992; Gomes & Mentzer, 1991): 1. Decreased lead-time requirements necessitating quick transportation; 2. Smaller shipment sizes necessitating more frequent dispatches to contain total transportation costs.

The goal of JIT is a significant reduction of work-in-process inventory by frequent feeding of production inputs. The demand of more frequent, small-size, and premium shipments seem to cause higher transportation cost, and trading off reduced inventory against higher transportation costs become the critical factor for total cost minimization. The systemic JIT approach allows small margin for transportation cycle variation to avoid production disruption. Either delay or early arrival could disrupt production processes. In addition, external factors, e.g. weather, congestion and unexpected accidents, could cause serious delay in JIT and have negative impact on supply chain as a whole.

Highway traffic congestion and JIT manufacturing/inventory management are two rapidly growing, parallel phenomena in today's business scene. Deteriorating traffic congestion has the potential to curtail the gains that supply chain partners pursue through implementation of JIT (Rao & Grenoble, 1991b). In addition, the smaller and more frequent orders, shortened lead-times, and precise scheduling called for by JIT can in turn severely impair the already clogged streets and highways. The smaller size, more frequent delivery transportation has nontrivial negative impacts on the overall transportation infrastructure (Rao & Grenoble, 1991a, 1991b). Both traffic congestion (a social problem) and JIT (a management opportunity) are growing rapidly and are probably on a collision course.

2.2 Buyer-supplier proximity paradigm

Common wisdom of JIT implementation suggests that inbound suppliers should be readily located as close as possible to the production centers, as known as the "supplier-buyer plant proximity" paradigm in JIT practices. Schonberger and Gilbert (1983) indicate that JIT purchasing is facilitated by buying from a small number of nearby suppliers – the ideal being single-source purchasing strategy. Nearby suppliers have several advantages. First, JIT material supply with short delivery might reduce total waste of inventory and transport cost. Second, emergency condition such as unexpected material stockout could be rescued by premium delivery. Consequently, configuration of close locations of suppliers and manufacturers with JIT supply chain system reduce the uncertainties. Fig. 1 shows short-distance inbound transportation between suppliers and one manufacturer.

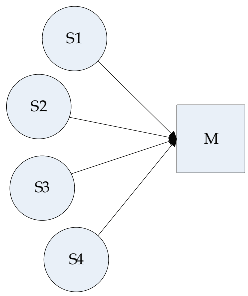


Fig. 1. Short-distance JIT

This proximity paradigm, however, has potential risks. Fast changing market conditions or geographical restrictions may prevent this rigid proximity arrangement from sustaining or even achieving production economies of suppliers and/or buyers. In addition, suppliers follow the proximity paradigm are more likely to incur high site specificity and asset specificity and make the suppliers captive to their manufacturer (Williamson, 1985). Additionally, abrupt termination of the supplier-buyer relationship or potential substitute suppliers brought by industrial incidents, such as technology advancement, could make relation-specific investment obsolescent.

2.3 Necessary modifications for long-distance JIT system and deviation from conventional JIT paradigms

Interestingly, JIT researchers have presented contrasting insights into the location arguments between buyers and suppliers. While the prior research stream suggests that JIT partners should locate close to each other for tight coordination, another group of experts suggest otherwise. Anderson and Quinn (1986) indicated that deregulation made longer distance transportation feasible in JIT systems in that the transportation costs can be better controlled than before. Ansari (1986) observed that, in his field study, a majority of U.S. firms (eleven of twenty-one) consider location of suppliers of little or no importance in JIT; in contrast, only two out of twenty-one U.S. companies deem supplier proximity an important factor. Bartholomew (1984) also found that United States auto suppliers are not necessarily close to the assembly plants and that adoption of JIT does not lead suppliers to move plants closer to customers. Finally, Harpter and Goodner (1990) point out that JIT can be implemented in a number of industrial supply chains which overcome geographical challenges by creative design of transportation system.

Accordingly, despite of the wide acceptance of JIT from the U.S. firms (Wood and Murphy, 2004), conventional JIT experiences cannot directly translate into US firms' achievement without any modification. Issues regarding quality, on-time delivery, and fair pricing were more important in the selection of supply chain partners (Ansari, 1986). The global end-to-end supply chain networks of US firms are geographically spread-out, a substantial difference from the original JIT philosophy. In addition, the long-distance supply chain system posts challenges for inter-firm coordination which seemingly contradict to the JIT's original frequent shipping approaches.

Hence, large-scale JIT partner will need to confront the following disadvantages. Firstly, frequent long-distance transportation will certainly cause high transport cost, so efficient and integrative transportation and distribution processes must be arranged to minimize the total costs. Secondly, long-distance transportation results in longer lead-time, and high lead-time variation in turn can cause higher inventory costs. Consistent long-haul modes, therefore, should be utilized to maintain service level. Lastly, JIT participants should be prepared for emergency shortage of material with long-distance supply and distribution line. These disadvantages incur substantially higher logistics costs in the forms of premium delivery or higher level of safety stock. In the next section, multiple approaches are proposed to account for the prior issues. Whereas, the strategies may deviates from the conventional small, frequent shipping activities, the main objective of these strategies is aimed at the consistency of transportation function, inventory minimization, and in the meantime reduces traffic congestion.

3. Strategies to overcome long-distance supply chain

In order to overcome the challenges caused by the long-distance supply chain, three "pillars", i.e. B2B IT, consolidation, and inventory classification have been documented in the logistics literature. Whereas these pillars are necessary for global JIT, additional strategies utilizing cutting-edge technologies and logistical arrangements will be required to enable the JIT system. This section first summarizes the three pillars and then proceeds with applications of the latest JIT-enabling communication and logistics innovations that serve as JIT facilitators.

3.1 B2B IT for JIT supply chain coordination

Inter-organizational, or B2B, communication technology serves as the foundation for coherent operations (Bookbinder & Dilts, 1989; Lee et al., 1999). In a complex, cross-functional and, possibly, -cultural supply chain, B2B e-commerce could enhance the information sharing between supply chain partners (Malone et al., 1987). As an example, the prevalent EDI system as well as the Internet has been proved to make it possible to track information and trace physical flow among supply chain partners – suppliers, carriers, and buyers are able to obtain accurate data on inventory in transit and in turn better estimate lead-time (Lee et al., 1999).

Extended JIT system can take advantage of integration across the entire value system and reduce the total lead-time by a nontrivial magnitude. Without a IT-enabled network, the bullwhip effects, exasperated by the long-distance transportation and communication, supply chain participants may not substantiate the JIT benefits (Lee et al., 1997). Ultimately, higher level of information sharing among the coordinated processes will translate into timely deliveries and shorter replenishment cycle in JIT system, thus realizing lower inventory levels and better bottom-line performances (Claycomb & Germain, 1999).

3.2 Freight consolidation

The efficiencies benefited from better supply chain B2B coordination can also help arrange consolidation (Daugherty et al., 1994; White, 2005). Lately, the regional economic integration, e.g. EU and NAFTA, have removed cross-nation boundaries and help international trading partners to develop large scale consolidation. As such, less-than truckload (LTL) carriers can operate multi-national haulage and move goods to the assigned consolidation center in a JIT fashion. Consolidation of inbound freight involves grouping two or more small shipments from one or more suppliers to form a single large shipment (Bagchi, 1988). Items in temporary storage awaiting consolidation can be combined with outbound shipments for faster, more reliable truckload (TL) transportation (Buffa, 1987).

Fig. 2 shows a manufacturer having long-distance lines without freight consolidation and receiving shipments separately. In contrast, Fig. 3 shows a long-distance inbound transportation system with consolidation, which displayed a relatively simplified freight network. A regional distribution center of this system could assemble loads for multiple suppliers for consolidated shipments to a plant. Inbound small shipments can still operate on a JIT basis, yet the outbound transportation utilizes the more efficient and quicker TL mode.

Consolidating inventory items has been a critical strategy for managing the transportation-inventory trade-off which is targeted at the total logistics cost minimization (White, 2005). Order quantity and order cycle in a consolidation setting are substantially different from those individual, separate orders (Schniederjans & Cao, 2001). Consolidation of items into a single order changes each item's inventory costs regarding ordering, carrying, and expected stockout. Initially, large-scale consolidation may temporarily increase each shipping unit's processing cost and/or inventory carrying cost in the consolidation center. However, consolidation programs combine multi-items into a single order and hence help firms negotiate freight rates (Daugherty & Spencer, 1990).

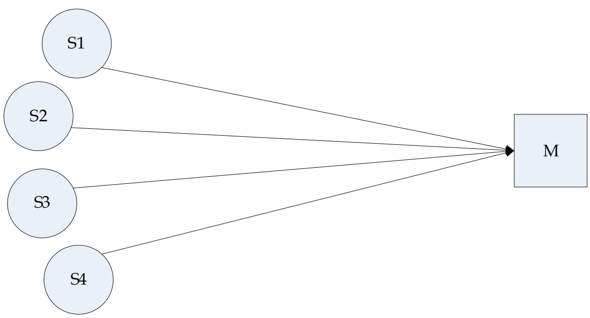


Fig. 2. Long-distance JIT

Fig. 3. Long-distance JIT with freight consolidation

By consolidating items for shipping purposes, buyers and shippers can reach increased shipping weight and lower freight rates without substantial increase of the order quantity of content items (Gupta & Bagchi, 1987). Inversely proportional freight rate structure works against the consolidated shipping weight and makes consolidation realize cost minimization. Moreover, decreasing freight rates may eventually offset the cost increase in consolidation and hence serve as the motivation of long-distance JIT due to the existence of strong economies of scale in transportation costs (White, 2005).

3.3 Supplier clustering

Supplier clustering and deciding the number and location of consolidation centers are important decisions to long-distance JIT transportation system planning (Wafa & Yasin, 1996). Firms acquire material from not only nearby suppliers but also long-distance suppliers. Consolidation hence may not be justified as a stand-alone system for an individual firm without adequate vendor and/or load concentration in the region serviced by the consolidation center. Shippers' ability to profitably consolidate freight depends on several factors, such as supplier concentration in the region under consideration, line-haul distance between the consolidation center and the destination, and the amount of freight generated in the region (Kelle et al., 2003). As a result, clustering vendors complement consolidation and may help achieve transportation scale economies. Fig. 4 shows consolidating without clustering the shippers.

At higher vendor concentrations, the mean cost per unit freight weight is likely to exhibit a downward trend, implying economies of scale from freight consolidation. These scale economies indicate that consolidation may perhaps be justified in a JIT inventory system with high vendor and/or load concentrations in the area serviced by the consolidation center (Banerjee et al., 2007; Wafa & Yasin, 1996). With an additional consolidation center, percentage of shipments through consolidation could increase and cost per unit could decrease. In cases of insufficient load it may be prudent to locate a consolidator who could arrange consolidation of freight in the same region and thus meet JIT procurement requirements. Fig. 5 shows the clustering and consolidating of the inbound JIT transportation system.

To cite most contrasting examples, compare neighboring origin-destination (OD) pairs versus long-distance OD pairs in supply chains. Consolidation would probably prove uneconomical for small shipments emanating from numerous points scattered over, for instance, Massachusetts and destined for points located in Connecticut. However, it would likely be a superior alternative for shipments from New Jersey to California, with supplier grouping and freight consolidation performed in the northeast area of the U.S.

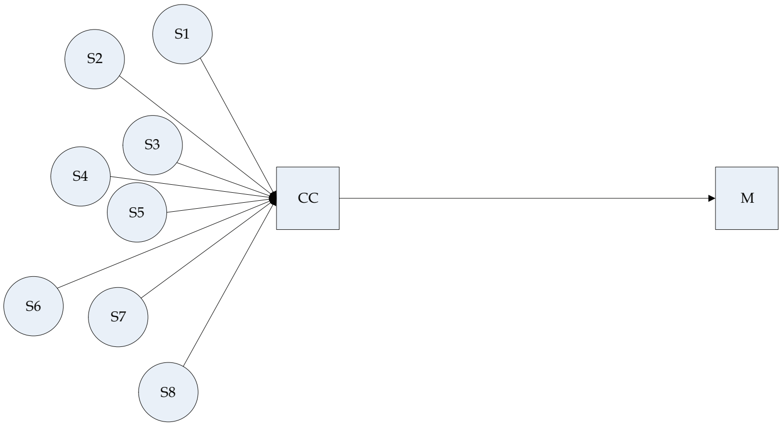


Fig. 4. Long-distance JIT with consolidation but without supplier clustering

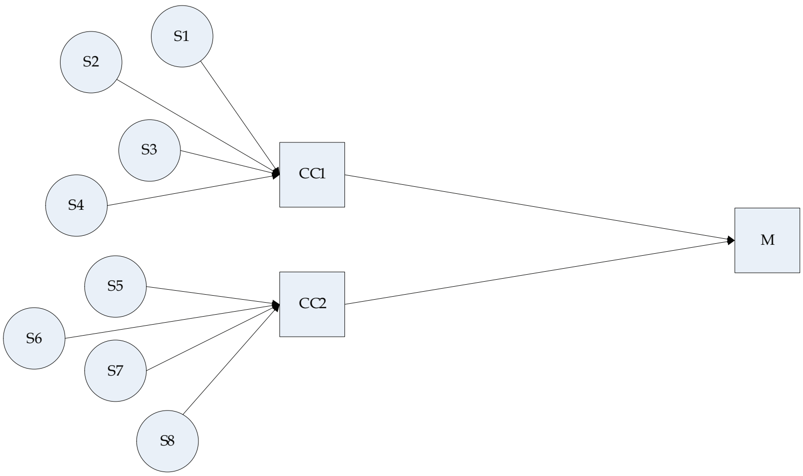


Fig. 5. Long-distance JIT with freight consolidation and supplier clustering

3.4 Cost-minimizing transportation mode selection

Because of the potentially high costs resulted from frequent deliveries, carrier selection is crucial for JIT system, especially for long-distance supply chain (Evers, 1999; Schwarz & Weng, 1999). The trend toward deregulation in the transportation industry has created a highly competitive environment in which both freight rates and services are adaptive to innovative shipping strategies. Most certainly, freight consolidation and supplier clustering affect the transportation modal selection. Service levels, i.e. delivery consistency, must thus be thoroughly examined to ensure the minimal transportation-inventory cost trade-off in JIT system.

Trucking is the prominent option for JIT management. Transportation scholars have employed trucking to establish a long-haul JIT model connecting assembly and distribution (Anderson & Quinn, 1986; Gupta & Bagchi, 1987). The long-haul transportation mode in the literature displays features resembling TL, i.e. fast, high-level service line haul from supply sources to the marketplace. The end-to-end TL operations have advantages over LTL operations in long-distance transportation (Lieb & Millen, 1988). TL removes stops in supply chain echelons and thus shortens transportation cycles. In contrast, the multiple terminal connections for LTL increase the likelihood of delays, thus hindering JIT operations. Consequently, if combined with freight consolidation, the distribution of transportation tasks can be as follows: TL should serve the main portion of long-haul transportation, while LTL will be mainly accounted for the feeding operation for cross-docking or the consolidation to take advantage of frequent but small shipments (Gupta & Bagchi, 1987; Lieb & Millen, 1990).

Researchers also propose that rail transportation serves as an alternative for long-haul transportation in the JIT system. While a stream of literature indicates that trucking will replace railroads' role in the JIT setting (Anderson & Quinn, 1986; Hoeffer, 1982; Lieb & Millen, 1988), Higginson and Bookbinder (1990) suggest that railroad industry might outperform competing modes beyond the cost advantages for long-haul. Potential strategies qualified for a rail JIT system include, but are not limited to 1) guaranteed delivery dates, 2) prearranged pickup and delivery, 3) short-term storage, 4) tardiness penalties, 5) regularly scheduled priority trains, 6) bypassing of time-consuming yard functions, 7) close communication with shippers and consignees, and 8) efficient freight consolidation. In short, long-distance JIT system users should incorporate railroads into their transportation choice set in addition to trucking.

Growing air forwarder/consolidator industry now gives firms an additional alternative to move their freight. Air freight integrators, such as Eagle Logistics, provides services by utilizing excess capacities from airlines. Schwarz and Weng (1999) explicitly suggest that, considering the total cost trade-off, firms may offset the high air freight costs through the saving in inventory carrying costs. This trend could mean a higher air freight volume which could drive air transport cost down. Shippers, carriers, and buyers thus should keep an eye on the changing air cargo alternatives and use total cost analysis to estimate the likelihood to use air transport into JIT systems, especially for emergency or express shipments (Gooley, 2000).

3.5 Emergence of 3PL partnerships as a global JIT requirements

Extensive 3PL engagement in the global JIT system might be the most distinct feature from the original JIT form. The prominent examples of 3PL integration, perhaps, are displayed in the U.S. computer industry. Dell Computer has followed a strict JIT rule – requiring its suppliers or consolidators (3PL) within 1 hour driving distance to fulfill JIT manufacturing (Magretta, 1998). Furthermore, HP also partners with global 3PL specialists, e.g. FedEx and UPS, to integrate the China-U.S. laptop supply chain (Dean & Tam, 2005). In the era of global supply chain, companies buy parts and components from abroad. Then, those imported parts and components are oftentimes consolidated by 3PLs that are within the driving distance from a manufacturer (Kreng & Wang, 2005). In a foreign manufacturing environment, a cluster is often formed through physical proximity for JIT manufacturing (Wood and Murphy, 2004). Accordingly, the proximity paradigm has never been totally abandoned by successful firms. Rather, they utilize the extended transport networks of global 3PL's in various regions. This partnering with 3PL's streamlines the JIT operations and contributes to lean and agile supply chain (Kreng & Wang, 2005).

3.6 Inventory classification to facilitate transportation

An additional fine-tuning strategy to enhance long-distance JIT is the inventory classification. Higginson and Bookbinder (1990) indicate that the well-known ABC classification can be utilized to match distinct transportation modes. For instance, type A, or fast-moving items, should be transported by truck to satisfy time constrains. Type B items can utilize a combination of railroads and short-term storage so firms can reduce freight rates and capitalize on short-term postponement leverage. Type C, slow-moving items, could use modes to meet cost or service considerations. In sum, JIT participants will need to evaluate the trade-off inventory cost against the cost of shipping to determine the best mix of transportation arrangements and, ultimately, the total JIT optimization.

3.7 Cross-docking arrangement for seamless physical flow

Utilizing cross-docking to reinforce JIT systems, interestingly, remains unexplored by logistics experts. Cross-docking mechanisms implemented in a consolidation center can allocate and assort large sporadic incoming items into bundles of shipments, which can be specified by the B2B IT system (Gümüş & Bookbinder, 2004; Waller et al., 2006). If combined with freight consolidation, the distribution of transportation tasks can be performed as follows: TL serves as the main portion of long-haul transportation, while LTL will account for the feeding operation for cross-docking or the consolidation to take advantage of frequent but small shipments (Lee et al., 2006). As an example, highly efficient cross-docking operations equipped with Auto ID technologies, e.g. the Wal-Mart automated bar code system, help specify the attributes of shipments and handling directions, and then guide the shipments to loading docks, awaiting outbound transportation. Cross-docking thus helps JIT participants overcome the bottlenecks resulted from complex allocation and assortment processes. Finally, equipped with cross-docking expertise, supply chain partners can have greater agility which substantiates the timely delivery in JIT strategy (Sung & Song, 2003).

3.8 Advanced communication JIT enablers

The latest communication technologies have made superior supply chain coordination possible, a determinant for an effective JIT system (Bookbinder & Dilts, 1989). Satellite communication, e.g. global positioning system (GPS), together with the latest radio frequency communication has been proposed to facilitate communication throughout the entire global supply chain system (Giermanksi, 2005). Auto identification (auto-ID) systems, e.g., automated bar code or radio frequency identification (RFID) technologies, can enhance the allocation and assortment functions and control physical flows real-time in distribution centers or terminals (Rutner et al., 2004). In an auto-ID enabled terminal system, multiple shipping entities, e.g. cases, pallets, containers, and shipment contents can be processed

automatically and communicated simultaneously across the entire supply chain (Keskilammi et al., 2003; Penttilä et al., 2006).
The prior technologies can strongly improve the performance at all coordination interfaces. At individual terminals, prolonged, manual operations for freight allocation and assortment are usually considered less productive for multi-echelon logistics systems. Auto ID system can, contrastingly, read attributes on shipment ID tags or bar codes, automatically assigning the shipments to cross-docking for outbound transportation or storage for later processing (Lee & Özer, 2007). Equipped with the latest auto-ID technologies, carriers will be capable of achieving real-time JIT coordination even in a multiple-terminal network.
Finally, advanced IT can assist regulatory institutions businesses to reduce traffic congestion - the major external obstacle for JIT transportation (Rao & Grenoble, 1991b). In the private sector, a number of software packages, such as transportation management system, are now available for improving scheduling and routing of material and goods movements. Such packages can be utilized to explore less congested routings (Rao & Grenoble, 1991a). For transportation administration, long-term policies include investments in 1) logistics facility relocation; 2) satellite operation; 3) changing channel structure and public-private cooperation. In short, endeavor from businesses and transportation regulators in investing supply chain communication and coordination technologies should help alleviate congestion and eventually facilitate the JIT practice.

4. A roadmap to simulate and manage long-distance JIT system

From a manufacturer's perspective, transportation in a JIT supply chain can be split into two directions: outbound distribution and inbound supply. Both outbound distribution and inbound supply transport systems need to solve not only short-distance but also long-distance delivery problems. This chapter presents a roadmap as an illustration of managing inbound long-distance JIT system (Fig. 6). While only the inbound section is presented here, the same principle can be applied to outbound section.
With reference to Fig.6, the first step for long-distance JIT operations is to seek the support from top management and to establish consistency with overall business strategy. Operations of the logistical chain are not independent from a firm's and its trading partners' strategies; changes in one business unit (e.g., JIT implementation) need to be assessed in light with strategic impacts along the chain. For a long-distance transportation system, firms participating in JIT systems need to conduct thorough evaluation into how inventory and transportation costs are correlated. The cost trade-off results will direct the subsequent implementation processes.
Supply chain partners should then establish an inter-firm IT system which facilitates terminal processing and freight tracking. The multi-layer terminal network should also be equipped with advanced supply chain technologies and solutions to support cross-docking and consolidation processes. Supply chain optimization programs can be utilized to categorize supply geographical locations and classify inventory items. Equipped with technology and cross-docking expertise, supply chain partners can have greater flexibility to determine transportation modes. Logistics managers should carry out total cost examinations and study alternatives, or various combinations of them: freight consolidation, supplier clustering, and optimal transportation arrangements. Finally, implementation needs continuous managerial effort to monitor the performances.

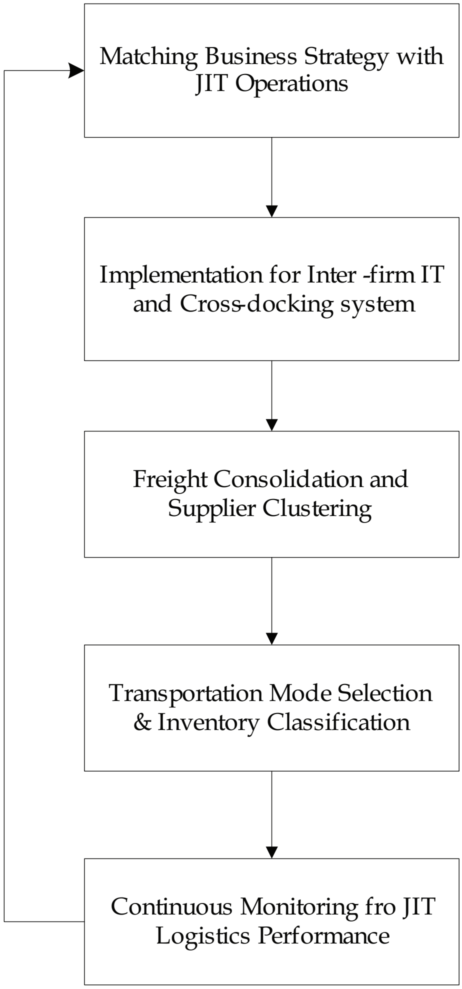


Fig. 6. Roadmap for implementing long-distance JIT system

5. Concluding remarks

5.1 Discussion and managerial implications

The emerging global supply chain network and increasing outsourcing has drastically extended the geographical span of logistics systems. Furthermore, fierce competition from local and international markets has forced firms to utilize cross-nation, oftentimes global, long-distance JIT for superior customer service level. Equipped with advanced technology and consolidation capabilities supporting conventional JIT operations, supply chain partners may be able to optimize the inventory and transportation cost trade-off in JIT. This chapter thus proposes that by integrating the latest communication technologies (e.g. RFID) and advanced logistics arrangements (e.g. cross-docking), firms could enhance long-distance JIT without sacrificing supply chain profitability and service levels. Finally, this study presents a roadmap to guide decisions of long-distance inbound JIT. The framework is aimed at solving obstacles hindering long-distance JIT, i.e. high transportation costs, long lead-time, traffic congestion, and emergency risks.

Given the complexity of an extended supply chain network, management could utilize the framework to evaluate financial impacts of individual logistics strategies in long JIT systems and the combinations of them. Specifically, supply chain partners will need to jointly monitor rate schedules and service policies incurred by modified freight transportation. They also need to review inventory costs caused by a consolidation strategy. As well, the logistics managers shall carefully evaluate alternatives concerning the supplier clustering, inventory classification, delivery frequency, transport mode of different materials, and risk management for emergencies & response and recovery plans.

Additional accommodations may further facilitate the long haul JIT. The main thrusts of a JIT strategy in production and warehousing should not restrict the method of delivery, as long as that mode can meet JIT service level and overall cost requirement. Rao and Grenoble (1991a, 1991b) suggest short term tactics and long term strategies to deal with traffic congestion problem of JIT system. Off peak deliveries and computer routing support could be the most effective without drastic change in logistics operations. Delivery during non-rush hours can result in more predictable deliveries and less disruption to operations. The cost involved in accommodating off-peak deliveries could be minor if the space and labor is available and the facility already operates around the clock. Other short terms for more efficient transportation infrastructure include improved shipping/receiving facilities, speedy delivery administration, vendor incentives to improve operations, delivery truck design, and unitization/palletization.

5.2 Limitations and future research

This chapter is positioned as being a guideline for fine-tuning the original form of JIT. IT utilization, shipment consolidation, and transportation mode selection are the three major components to change the conventional “buyer-seller proximity” paradigm. While the three “pillars” of modified JIT is not new and all these elements are a must regardless of distance in JIT system, these elements only have been separately examined in the literature. Empirical studies as to how these elements individually and collectively contribute to a JIT design success are limited in amount. Currently, there is no empirical research studying the weights and trade-offs of the three JIT pillars, let alone the extended JIT applications in the global contexts. As a result, the following questions remained not fully addressed: among those companies that are practicing successful JIT, how many firms do or do not utilize IT, consolidation (and cross-docking), and/or fast transportation?

Furthermore, the similarities and divergences for domestic and global JIT supply chains in practices are largely unexplored in the empirical research. In-depth field works and extensive empirical studies are therefore in order. Along this line, it is not a secret that U.S. automakers modified Japanese JIT system in seeking competitiveness in the market. Given the highly complex processes and multiple variables in global JIT operations, what would be the system-wide remedial and emergency alternative for JIT failure? As well, extant global

JIT supply chains only focus on particular buyer-supplier pair in the system. Extensive dyadic and triadic method investigating the entire JIT system is thus necessary.
Combinations of the aforementioned solutions and the proposed roadmap paved an avenue for firms to conduct pilot JIT exercise and/or simulation analysis. The high complexity and implementation costs may prevent extensive implementations or experiments for long-distance JIT. Hence, firms or researchers can utilize the prior logistics strategies to simulate scenarios of long-haul JIT on both inbound and outbound sides of a supply chain. Simulation scenarios should reflect long-distance JIT design before and after supporting strategies, e.g. freight consolidation, are implemented. By doing so, supply chain partners may capitalize on low cost simulation exercise to better estimate impacts of the actual decisions pertaining to JIT operations.

6. References

Anderson, D.L. and Quinn, R.J. (1986), The Role of Transportation in Long Supply Line Just-in-Time Logistics Channels. *Journal of Business Logistics*, Vol.7, No. 1, pp. 68-88

Ansari, A. (1986), Strategies for the Implementation of JIT Purchasing. *International Journal of Physical Distribution & Materials Management*, Vol.16, No. 7, pp. 5-12

Bagchi, P.K. (1988), Management of Materials under Just-in-Time Inventory System: A New Look. *Journal of Business Logistics*, Vol.9, No. 2, pp. 89-102

Bagchi, P.K., Raghunathan, T.S., and Bardi, E.J. (1987), The Implications of Just-in-Time Inventory Policies on Carr. *Logistics and Transportation Review*, Vol.23, No. 4, pp. 373-384

Banerjee, A., Kim, S.-L., and Burton, J. (2007), Supply Chain Coordination through Effective Multi-Stage Inventory Linkages in a JIT Environment. *International Journal of Production Economics*, Vol.108, No. 1/2, pp. 271-280

Bartholomew, D. (1984), The Vendor-Customer Relationship Today. *Production & Inventory Management*, Vol.25, No. 2, pp. 106-121

Bookbinder, J.H. and Dilts, D.M. (1989), Logistics Information Systems in a Just-in-Time Environment. *Journal of Business Logistics*, Vol.10, No. 1, pp. 50-67

Buffa, F.P. (1987), Transit Time and Cost Factors: Their Effects on Inbound Consolidation. *Transportation Journal*, Vol.27, No. 1, pp. 50-63

Chapman, S.N. (1992), Using Risk-Averse Inventory for JIT Process Improvements. *Production & Inventory Management Journal*, Vol.33, No. 4, pp. 69-74

Chopra, S. and Meindl, P. (2007), *Supply Chain Management : Strategy, Planning, and Operation*, 3rd Ed. Prentice Hall, Upper Saddle River, NJ, USA

Claycomb, C. and Germain, R. (1999), Total System JIT Outcomes: Inventory, Organization and Financial Effects. *International Journal of Physical Distribution & Logistics Management*, Vol.29, No. 9/10, pp. 612-630

Daugherty, P.J., Rogers, D.S., and Spencer, M.S. (1994), Just-in-Time Functional Model. *International Journal of Physical Distribution & Logistics Management*, Vol.24, No. 6, pp. 20

Daugherty, P.J. and Spencer, M.S. (1990), Just-in-Time Concepts: Applicability to Logistics/Transportation. *International Journal of Physical Distribution & Logistics Management*, Vol.20, No. 7, pp. 12-18

Dean, J. and Tam, P.-W. 2005. The Laptop Trail, *Wall Street Journal*: B.1
Evers, P. (1999), The Effect of Lead Times on Safety Stocks. *Production and Inventory Management*, Vol.40, No. 2, pp. 6-10
Giermanksi, J.R. (2005), *The Smart Container: Its Technology, Its Function, and Its Benefit in Securing the Global Supply Chain*, Council of Supply Chain Management Professionals, Oak Brook
Giunipero, L.C., Pillai, K.G., Chapman, S.N., and Clark, R.A. (2005), A Longitudinal Examination of JIT Purchasing Practices. *International Journal of Logistics Management*, Vol.16, No. 1, pp. 51-70
Gomes, R. and Mentzer, J.T. (1991), The Influence of Just-in-Time Systems on Distribution Channel Performance in the Presence of Environmental Uncertainty. *Transportation Journal*, Vol.30, No. 4, pp. 36-48
Gooley, T.B. (2000), Domestic Air Freight Makes a Comeback. *Logistics Management & Distribution Report*, Vol.39, No. 4, pp. 65-69
Gümüş, M. and Bookbinder, J.H. (2004), Cross-Docking and Its Implications in Location-Distribution Systems. *Journal of Business Logistics*, Vol.25, No. 2, pp. 199-228
Gupta, Y.P. and Bagchi, P.K. (1987), Inbound Freight Consolidation under Just-in-Time Procurement: Application of Clearing Models. *Journal of Business Logistics*, Vol.8, No. 2, pp. 74-94
Harper, D.V. and Goodner, K.S. (1990), Just-in-Time and Inbound Transportation. *Transportation Journal*, Vol.30, No. 2, pp. 22-31
Higginson, J.K. and Bookbinder, J.H. (1990), Implications of Just-in-Time Production on Rail Freight Systems. *Transportation Journal*, Vol.29, No. 3, pp. 29-35
Hoeffer, E. (1982), Gm Tries Just-in-Time American Style. *Purchasing*, Vol.19, No.?, pp. 69-?
Kelle, P., Al-Khateeb, F., and Anders-Miller, P. (2003), Partnership and Negotiation Support by Joint Optimal Ordering/Setup Policies for Jit. *International Journal of Production Economics*, Vol.81/82, No. 431-441
Keskilammi, M., Sydänheimo, L., and Kivikoski, M. (2003), Radio Frequency Technology for Automated Manufacturing and Logistics Control. Part 1: Passive RFID Systems and the Effects of Antenna Parameters on Operational Distance. *International Journal of Advanced Manufacturing Technology*, Vol.21, No. 10/11, pp. 769-774
Kreng, V.B. and Wang, I.C. (2005), Economical Delivery Strategies of Products in a JIT System under a Global Supply Chain. *The International Journal of Advanced Manufacturing Technology*, Vol.26, No. 11-12, pp. 1421-1428
Lee, H.G., Clark, T., and Tam, K.Y. (1999), Research Report. Can EDI Benefit Adopters? *Information Systems Research*, Vol.10, No. 2, pp. 186-195
Lee, H.L. and Özer, Ö. (2007), Unlocking the Value of Rfid. *Production & Operations Management*, Vol.16, No. 1, pp. 40-64
Lee, H.L., Padmanabhan, V., and Whang, S. (1997), Information Distortion in a Supply Chain: The Bullwhip Effect. *Management Science*, Vol.43, No. 4, pp. 546-558
Lee, Y.H., Jung, J.W., and Lee, K.M. (2006), Vehicle Routing Scheduling for Cross-Docking in the Supply Chain. *Computers & Industrial Engineering*, Vol.51, No. 2, pp. 247-256
Lieb, R.C. and Millen, R.A. (1988), JIT and Corporate Transportation Requirements. *Transportation Journal*, Vol.27, No. 3, pp. 5-10

Lieb, R.C. and Millen, R.A. (1990), The Responses of General Commodity Motor Carriers to Just-in-Time Manufacturing Programs. *Transportation Journal*, Vol.30, No. 1, pp. 5-11

Magretta, J. (1998), The Power of Virtual Integration: An Interview with Dell Computer's Michael Dell. *Harvard Business Review*, Vol.76, No. 2, pp. 72-84

Malone, T.W., Yates, J., and Benjamin, R.I. (1987), Electronic Markets and Electronic Hierarchies *Communications of the ACM*, Vol.30, No. 6, pp. 484-497

Modarress, B., Ansari, A., and Willis, G. (2000), Controlled Production Planning for Just-in-Time Short-Run Suppliers. *International Journal of Production Research*, Vol.38, No. 5, pp. 1163-1182

Penttilä, K., Keskilammi, M., Sydänheimo, L., and Kivikoski, M. (2006), Radio Frequency Technology for Automated Manufacturing and Logistics Control. Part 2: RFID Antenna Utilisation in Industrial Applications. *International Journal of Advanced Manufacturing Technology*, Vol.31, No. 1/2, pp. 116-124

Rao, K. and Grenoble, W.L. (1991a), Modelling the Effects of Traffic Congestion on Jit. *International Journal of Physical Distribution & Logistics Management*, Vol.21, No. 2, pp. 3-9

Rao, K. and Grenoble, W.L. (1991b), Traffic Congestion and Jit. *Journal of Business Logistics*, Vol.12, No. 1, pp. 105-121

Rutner, S., Waller, M.A., and Mentzer, J.T. (2004), A Practical Look at Rfid. *Supply Chain Management Review*, Vol.8, No. 1, pp. 36-41

Schniederjans, M.J. and Cao, Q. (2001), An Alternative Analysis of Inventory Costs of JIT and EOQ Purchasing. *International Journal of Physical Distribution & Logistics Management*, Vol.31, No. 2, pp. 109-123

Schonberger, R.J. and Gilbert, J.P. (1983), Just-in-Time Purchasing: A Challenge for U.S. Industry. *California Management Review*, Vol.26, No. 1, pp. 54-68

Schwarz, L.B. and Weng, Z.K. (1999), The Design of a JIT Supply Chain: The Effect of Leadtime Uncertainty of Safety Stock. *Journal of Business Logistics*, Vol.20, No. 1, pp. 141-163

Sung, C.S. and Song, S.S. (2003), Integrated Service Network Design for a Cross-Docking Supply Chain Network. *Journal of the Operational Research Society*, Vol.54, No. 12, pp. 1283-1295

Wafa, M.A. and Yasin, M.M. (1996), The Impact of Supplier Proximity on JIT Success: An Informational Perspective. *International Journal of Physical Distribution & Logistics Management*, Vol.26, No. 4, pp. 23-34

Waller, M.A., Cassady, C.R., and Ozment, J. (2006), Impact of Cross-Docking on Inventory in a Decentralized Retail Supply Chain. *Transportation Research: Part E*, Vol.42, No. 5, pp. 359-382

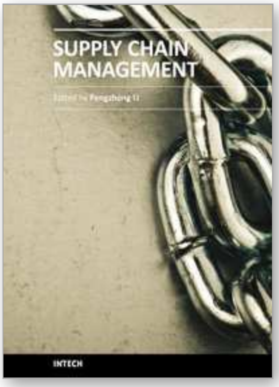
White, S.C. 2005. Special Report: Freight Consolidation. Council of Supply Chain Management Professionals

Williamson, O.E. (1985), *The Economic Institutions of Capitalism*, Free Press, New York

Wong, C.Y. and Johansen, J. (2006), Making JIT Retail a Success: The Coordination Journey. *International Journal of Physical Distribution & Logistics Management*, Vol.36, No. 2, pp. 112-126

Wong, C.Y., Stentoft-Arlbjørn, J., and Johansen, J. (2005), Supply Chain Management Practices in Toy Supply Chains. *Supply Chain Management*, Vol.10, No. 5, pp. 367-378

Wood, D.F. and Murphy Jr., P.R. (2004), *Contemporary Logistics*, 8th Ed. Prentice Hall, NJ. U.S.A.



Supply Chain Management
Edited by Dr. pengzhong Li

ISBN 978-953-307-184-8
Hard cover, 590 pages
Publisher InTech
Published online 26, April, 2011
Published in print edition April, 2011

The purpose of supply chain management is to make production system manage production process, improve customer satisfaction and reduce total work cost. With indubitable significance, supply chain management attracts extensive attention from businesses and academic scholars. Many important research findings and results had been achieved. Research work of supply chain management involves all activities and processes including planning, coordination, operation, control and optimization of the whole supply chain system. This book presents a collection of recent contributions of new methods and innovative ideas from the worldwide researchers. It is aimed at providing a helpful reference of new ideas, original results and practical experiences regarding this highly up-to-date field for researchers, scientists, engineers and students interested in supply chain management.

How to reference
In order to correctly reference this scholarly work, feel free to copy and paste the following:

Liang-Chieh (Victor) Cheng (2011). Logistics Strategies to Facilitate Long-Distance Just-in-Time Supply Chain System, Supply Chain Management, Dr. pengzhong Li (Ed.), ISBN: 978-953-307-184-8, InTech, Available from: http://www.intechopen.com/books/supply-chain-management/logistics-strategies-to-facilitate-long-distance-just-in-time-supply-chain-system

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821