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Abstract

This study is an attempt to elucidate the spatial structure of "Just-in-Time" (JIT)-based logistics for the distribution of automotive parts in Japan. A diverse range of opinions on spatial structure have been presented in economic geography in the West: namely the ways in which implementing JIT causes the locations of parts suppliers to become concentrated or dispersed; and the things which can be considered as contributing factors in such concentrations or dispersals. In response to this, the authors of this paper decided to carefully clarify the reality of such logistics in Japan by considering case examples of certain automotive parts suppliers which have implemented JIT from early on despite being located far from their respective car-assembly plants. The authors will also shed light on the fact that, in order to accommodate distribution from remote locations, cross docks operated by third-party logistics providers (3PL) are located near car-assembly plants, and will seek to further clarify the functions of these cross docks. This analysis has also enabled new insights to be gained: the fact that concentrations of suppliers such as in Toyota City are exceptions to the norm, and that instead suppliers tend to be dispersed over a wide area in Japan; the fact that, even in JIT-based logistics, economies of scale are being pursued and inventories are being stored; and the fact that in deliveries to car assembly plants 3PL cross docks are performing an important function in making small-lot, high-frequency deliveries.

Keywords: Just-in-Time; Automotive parts supplier; Distant location from car assemblers; Punctual and frequent delivery; Third-party logistics providers; Cross dock; Japan

1. Introduction

This study is an attempt to elucidate the spatial structure of "Just-in-Time" (JIT)-based logistics for the distribution of automotive parts in Japan.

In economic geography in the West, ever since the 1980s, studies have been promoted on the restructuring of industries and the shift toward flexible production systems. Amongst them, there were many studies conducted from the late 1980s to the early 1990s which alluded to JIT. These studies were accumulated as developments in research on the demise of Fordism.

Some of the studies also presented a diverse range of opinions on spatial structure: namely the ways in which implementing JIT causes the locations of parts suppliers to

become concentrated or dispersed; and the things which can be considered as contributing factors in such concentrations or dispersals.

However, much of this research has consisted of been case studies on the Japanese automobile industry's expansion into Europe and America. Even though it is believed that JIT first emerged in Japan and that this is where it has been most developed, there has been little investigation of the actual conditions of JIT in Japan. Furthermore, in Japanese geographers' studies of the domestic automobile industry assumed the implementation of JIT was supposed to be self-evident, and so there has not been any detailed clarification particularly of JIT-based linkages and the actual state of logistics. For this reason it is believed that, in response to the great interest in JIT shown by overseas geographers, Japanese geographers need to acquaint people overseas with the actual state of JIT in Japan.

Thereupon, in this paper, the authors decided to clarify the reality of such logistics in Japan by considering case examples of certain automotive-parts suppliers in Japan which had implemented JIT from early on despite being located remotely from their respective car-assembly plants. The authors will also shed light on the fact that, in order to accommodate this kind of distribution from remote locations, cross docks operated by third-party logistics providers (3PL) have been located near the car assembly plants, and we will further clarify the functions of these kinds of distribution facilities.

This analysis has also enabled new insights to be gained, including the fact that concentrations of suppliers, such as in Toyota City, are exceptions to the norm, and that instead, suppliers tend to be dispersed over a wide area in Japan; the fact that, for this reason, even in JIT-based logistics, long-haul transportation is being consolidated, economies of scale are being pursued, and inventories are being stored; and the fact that, in deliveries to car-assembly plants, 3PL distribution centers are performing an important function in making small-lot, high-frequency deliveries.

During this study, the authors conducted numerous interviews with executives and logistics personnel at relevant companies, and were able to obtain much useful information. However, since actual volumes of traded and transported parts, transportation costs, ratios of distribution costs to production costs and other such quantitative data are confidential, the authors were unable to access such information. For this reason, unfortunately, the authors were unable to include any quantitative analysis in this study.

Following is a summary of the organization of this paper. In Chapter 2, the authors briefly review the thinking behind the research methodologies in geography related to JIT-based logistics, as well as the results obtained. In Chapter 3, the authors review how

JIT is being implemented by parts suppliers in Japan from both a historical perspective as well as a production/distribution systems perspective. In Chapter 4, the authors examine the role played by 3PL distribution centers in making frequent punctual deliveries to nearby car-assembly plants. In Chapter 5, as well as bringing these findings together, the authors examine how the distribution of automotive parts in Japan is likely to change as the automobile production becomes increasingly globalizing.

2. The perspectives of JIT research in geography

2.1. *The definition of JIT*

JIT is a production/management system that was originally created by Japan's Toyota Motor Corporation. In most geographic research, the Toyota Production System is referred to as JIT. Taiichi Ohno (1988), a former executive vice president at Toyota Motor Corporation, gives the following points as the definition of JIT. a) The operational structure of a production site is managed by teams comprised of multi-skilled workers who have been trained on the job. A multi-skilled worker refers to a worker being in charge of several consecutive steps in an operation. This enables the type and volume of manufactured products to be regulated according to fluctuations in demand, and it enables adjustments to be made to the allocation of workers required for a job. b) Total Quality Control (TQC) is implemented on the principle of full participation by all personnel. c) Process control is performed based on a principle of JIT. In response to demand generated by customers, JIT seeks to shorten production process times, and contributes to the company's return on sales and capital turnover ratio. At the same time as eliminating excess inventories of parts, JIT also seeks the efficient utilization of equipment and labor. d) Comprehensive cost controls are implemented to eliminate unnecessary expenses.

To implement JIT even more efficiently, it is necessary for both car assembler and parts suppliers to be linked by an electronic information network, and to collaborate in a JIT-based production system. In JIT especially, long-term business relationships are maintained and information is exchanged closely with a small number of suppliers who have selected according to such criteria as high quality, low costs and punctual delivery. This provides benefits that can be enjoyed by both suppliers and assemblers in the way of profits generated through more moderate transaction costs and through a learning effect brought about by the accumulation of production experience (Monden, 1998).

From this perspective, many studies in economic geography in Europe and America, have perceived the concept of JIT as a composite phenomenon that includes: (1) changes to a company's internal production system and labor relations; (2) the reorganization of relationships with suppliers and subcontractors; (3) the introduction of a Japanese-style production/management system; and (4) the efficient distribution of parts. In this paper, since it is not possible to cover the entire spectrum of contributing factors, our argument will be limited to the spatial aspects associated with the distribution of automotive parts.

2.2. The spatial implications of JIT

In economic geography in the West, many arguments have been developed concerning the spatial implications of JIT. They indicate the following four factors as the main causes for why the introduction of JIT encourages the build-up of suppliers in areas around car assembly plants. (1) Not only are transportation costs reduced, but by making quality control and inspections easier, transactions costs are also cut (Sheard, 1983; Estall, 1985; Morris, 1988, 1992; Hill, 1989). (2) The exchange of information is made easier. This includes technical cooperation at the initial design stage (Williams et al., 1992; Linge, 1991; Mair, 1992). (3) Relationships of trust are formed between customers and suppliers, and it becomes easier to maintain high quality, to make punctual deliveries, and to respond promptly to unexpected situations (Mair, 1993). (4) Specialized labor markets and business-to-business networks are formed (Swyngedouw, 1987).

On the other hand, views have been expressed that implementing JIT is still possible even in networks with suppliers who are geographically dispersed over long distances. Various factors are given as reasons for this: (1) technological innovations in transport and the development of telecommunication (Wells and Rawlinson, 1992; Gertler, 1988; Rainnie, 1993; Morgan, 1999); (2) the intensive production of mass-produced and standardized parts (Reid, 1995; Glasmeier and McCluskey, 1987; Phelps, 1993); (3) the orientation toward sophisticated technology (Ansari, 1986; Schamp, 1991); (4) the orientation toward an cheap/obedient workforce (Reid, 1990); and (5) the small-scale nature of business customers and the diversification of risk avoidance (Morris, 1989).

Among these arguments, there are many economic geographers who also believe that the implementation of JIT is embedded in the circumstances of each individual region, and that it is a model which is learned and which has evolved in a variety of ways. Their research suggests that the spatial implications of JIT would be diverse (Mair, 1992; Lung et Mair,

1993; Lung et al., 1999; Kirat and Lung 1999; Linge, 1991; Hudson, 1994; Sadler, 1994; Schoenburger, 1987; Lee, 2002; Boyer et al., 1998; Freyssenet et al., 1998).

On the topic of the diversity of the spatial implications of JIT from a distribution-centered perspective, van Egeraat and Jacobson (2005) mention the following. Through the introduction of JIT, if shipments are made more frequently, then transportation costs and the costs for ordering and assembling parts will also increase. One measure to counter this is to attune and rationalize individual orders to match assembly schedules, thereby averting any increases in ordering/assembly costs. Another countermeasure is to reduce the distance needed for procurement. However, the following reasons can be given for doing business with a supplier who is located a long distance away; differences in labor costs in the area where the supplier is located; parts being produced in an intensive manner, and economies of scale to be pursued. The accumulation of technical capabilities in the region, or historical circumstances; continued Inertia of location; parts mass produced with cheap labor costs may be supplied from a distance; intensive production of high value-added parts also being performed at the distant place. It has also observed that, when suppliers have expanded in scale and begin to deliver to a number of assemblers, they tend to locate away from their customers.

Based on these trends in research on JIT, Dicken (1998) summarizes as follows. In his research in economic geography, he compares the features of craft production, Fordist mass production and Japanese-style of flexible production. He also compares the Just-in-Time system with the Just-in-Case system, asserting that it is premature to believe that JIT is a clearly defined production paradigm that will replace Fordism.. Then, as a result of technological innovations in transport and communications leading to lower transportation costs and improved ability to manage long-distance subcontractors, there has been an increase in the number of international subcontractors utilizing the cheaper workforces of developing countries. However there is a range of arguments as to the kind of spatial implications that would emerge if JIT was introduced. The reality is that there can be a diverse combinations of long-distance linkages and short-distance linkages. JIT varies according to the conditions in which each industry or company finds itself. Dicken argued that what is certain, though, is that the global economy is comprised of clusters of regional activity which are intricately interconnected, and that JIT is embedded in a variety of ways in diverse business-to-business networks.

In the economic geography advocated by Dicken (1998), as these business-to-business networks expand globally and reorganize, industrial locations develop disproportionately in response to political and economic factors. Dicken uses the concept of global production

networks to explain the economic geography of a complex world; that is, the continuum of economic flow from raw materials through processing, distribution and finally to services. How the structure of business-to-business networks comprised of global production networks is shaped corresponds to the concept of governance. Furthermore, the concept of governance is embedded within social circumstances. Although businesses are the main pillar of such a structure, it is also influenced by research and development, by technological aspects of transport and communications, and by national policies and social systems. In other words, production networks shape business-to-business networks, and while the location and behavior of such businesses are embedded deeply in society, they are also incorporated in systems of governance based on institutions, rules and conventions. Dicken then sheds light on the type of structure developed by the three powers of business, state and technology in the interactions between national, global and local economic spaces.

On the topic of global production networks in the automobile industry, Dicken (2003. 6-34) summarizes: in response to the maturation, diversification and fractionalization of the automotive market, production systems have developed from Fordist mass-production systems to JIT, and thence to modularization. The role of the state, in other words protectionism, policies to entice overseas companies, and policies to create regional integrated markets, also influence the globalization of the automobile industry. Consequently, the relationship between car assemblers and parts suppliers has changed. With the introduction of JIT, car assemblers now strive for close communication and long-term business relations by selecting a small number of suppliers based on price, quality and accurate deliveries. Meanwhile, as car assemblers have relocated overseas, there has been a demand by suppliers for international-type adjacent locations. Rather than just the cross-border procurement and distribution of parts, supplier networks are now framed globally, in conjunction with the exchange of technological, financial and human resources.

Next, on the topic of the spatial development of JIT, Dicken (1987) refers to the following issue. In JIT, long-term stable relationships are built with a small number of suppliers who possess superior flexibility. For this reason, a geographically close relationship is needed between customers and suppliers. On the other hand, parts produced in labor-intensive processes are dispersed globally, and are procured over a wide area from NIEs in Latin America and Asia. This leads us to the question: how should we view the differences in this kind of spatial development of JIT?

In answer to this question, Dicken (1992. 26-28) summarizes as follows on the procurement of parts based on the expansion of Japanese automobile companies into

Europe. The JIT-based procurement of parts leads to cross-border rationalization and reorganization of management across a wide area, and reciprocal joint strategy ventures develop between car assemblers and parts manufacturers both in Europe and elsewhere. Japanese companies, while being influenced by the regulations on local contents, then choose whether to import parts from Japan or from European companies, or whether to purchase them from Japanese companies that have expanded into Europe. In other words, various spatial developments of JIT are formed. In the economic geography of the automobile industry, regionalization is proceeding concurrently with globalization.

In economic geography, as an example of the introduction of JIT, research has also been conducted on the effects of overseas expansion by the Japanese automobile industry on the location of parts suppliers in Europe. Since Japanese companies mainly utilized the existing network of suppliers, there was no locational integration of parts suppliers in Europe (Rawlinson and Wells, 1993; Jones and North, 1991). In the U.S.A. especially, it was reported that, although there was locational integration at the state level, suppliers were dispersed broadly at the county and city levels (Bingham and Sunmonu, 1992; Head, Ries and Swensen, 1995; Reid, 1995).

Furthermore, Japanese geographers highlighted the fact that Japan's automobile companies, which have expanded overseas, and car assembly plants, which have relocated to peripheral areas in Japan such as Kyushu in far southwest, ensure the delivery of parts by using warehouses and by utilizing the "milk-run" method in which circuits are made to collect parts from suppliers dispersed across a wide area (Fujikawa, 2001; Ogawa, 1994, 1995; Saito, 2001; Nagao, 2000; Tomozawa, 2004).

In this way, it has been shown that the distribution of parts procurement by Japanese automobile companies that have expanded overseas has been conducted over long distances and wide areas and with inventories on hand. This seems to contradict the original objective of JIT in Japan, of "not having any inventories of excess parts" (Ohno, 1988). Is this overseas distribution of automotive parts just a reflection of the domestic expansion of JIT in Japan?

In the following chapters, the authors will explain in more detail the spatial reality of the distribution of parts by suppliers in the Japanese automobile industry which continues to reorganize amidst ongoing globalization.

2.3. The effects of modularization

In recent years, module production has been introduced to the production of automobiles and electric appliances. A module refers to a highly systemized part that has been pre-assembled up to the stage immediately prior to being fitted to the finished product.

According to Sturgeon (2002), a typical example of a module production network is the U.S.-model industrial organization in the electronics industry. Leading companies are “deverticalized,” and they outsource production of their end products to globally-operated “turn-key suppliers.” This has the following benefits to the major leading companies. They can concentrate on market competition and on associated marketing and service activities. They can focus their capital investment on technological innovations in production. They are able to avoid the financial, administrative and technical issues raised by fixed capital. And, by being guaranteed massive orders, suppliers are able to acquire new abilities, such as improvements in quality and delivery costs, and the concurrent economies of scale and scope.

In this kind of module production network, the sharing of codified knowledge becomes more important than implicit knowledge. Massive volumes of codified knowledge, including prices, flow between a leading company and its suppliers. In this way, a module production network has a relatively open character, and since basic technical processes are widely accepted and have become standardized, it becomes possible to transfer systemized technology between companies. For this reason, there are minimal barriers to entering and leaving the network, allowing organizational flexibility. As a result, these networks do not become tied down to any particular location, product or customer.

In other words, geographical flexibility allows companies to expand or withdraw networks to/from certain locations. This in turn permits even greater access to regionally-specific factors and markets. Furthermore, systems can easily be transferred to lower-cost regions when available. By having organizational flexibility, suppliers can more easily respond to the diversity of leading companies and products. Suppliers shared by networks have a greater ability to adapt to demand. The end result is that capital can be used more intensively.

Concerning the effects of modularization in the automobile industry, Sturgeon and Florida (2004) write that globalization, deverticalization and modularization are three factors which can be described as being characteristics of the automobile industry in recent years. Underlying them are changes in technology and markets, and in particular, reductions in transportation and communications costs and the intensification of price competition. As a result of globalization, while the automotive industry tends to disperse to locations in regions with lower costs, at the same time, economic activity in the areas of knowledge-creation and

technology development tends to accumulate spatially. In this way, trade between transplants flourishes, and a value chain is formed in which production and procurement are conducted globally.

In the globalization of production, companies make investments to search for markets. As part of that process, they expand into and locate to developing countries. However, any reductions in costs resulting from cheaper labor costs tend to be offset by low productivity, deficiencies in raw materials and parts, poor infrastructure, customs duties and added transportation costs. As a result, the pursuit of economic efficiency is pursued through the assembly of completely knocked down (CKD) kits. Using CKD also works to eliminate excess production capacity at factories back in mother country.

Furthermore, in the globalization of production, companies also make investments to cut costs. With the progress of regional economic integration, companies locate and relocate to low-cost areas on a continental scale. Low-cost production locations, such as Mexico, Canada, Spain and Eastern Europe are integrated into global networks.

In global supply chains that have been formed in this way, suppliers co-locate close to new module factories. One reason for this is because the module suppliers need to be involved from the initial stages of automobile development. Another reason is that, according to regulations on local contents, automakers must control their procurement of low-cost parts from developing countries. A supplier that is located close to an automaker's design center acts as an intermediary between global sourcing and local sourcing. Module suppliers globalize rapidly by uniting with automakers. At the same time as centralizing at the core locations of automakers, they conduct production activities dispersed all over the globe.

On the topic of supplier parks or industrial condominiums, which are factory configurations where module suppliers are located close to a car assembly plant, Frigant and Lung (2002) make observations based on examples in Brazil and France.

Takeo (2001) suggests that, as globalization and modularization proceed, the future locations of automotive parts suppliers will change as follows. (1) Small and lightweight standardized parts will be sourced globally from a wide area according to cost and quality. (2) Large parts such as the car body, which have standardized processing and assembly technology, will be supplied at the location of the market by suppliers located close to the car assembly center. (3) Parts such as engines and transmissions, which require precision technology and massive capital expenditure, will be consolidated to technology-intensive centers in advanced countries.

In the West, modularization involves splitting up the assembly line and removing labor-intensive and unprofitable segments to external companies. In the U.S.A., this has resulted in the creation of huge parts suppliers. Modularization is especially suitable in the case of new plants in the West, where labor costs are high. In developing countries, there are also assembly-production systems which can flexibly satisfy small-scale local demand immediately without waiting for parts suppliers to emerge.

In Japan's domestic automobile production, more so than modularization, there is more widespread use of unitization and shifts to electronic systems. Rather than producing large modules, the preference is to make parts smaller and lighter, and to improve functionality and multifunctionality. As a result of these kinds of parts becoming systemized, parts suppliers are progressively consolidating through integration, elimination and amalgamation, and their corporate groups are restructuring (Takeno, 2001).

It would be difficult to say that large-scale modularization is actively undertaken in Japan's domestic automobile industry. The following are possible reasons for this. (1) In Japan, the birthrate is declining and her population is aging. Therefore, the prevalence of cars, including used car market, is widespread, and we cannot expect any significant increase in demand in the future. For this reason, the automobile industry cannot afford to make new capital investments to support modularization. (2) Japan's automotive market is mature, and so what is desired in new vehicles is that individual customer orders are satisfied as high-class luxury commodities. For this reason, rather than modularization which is oriented to standardization, what is preferred by consumers and what is consistent with market trends is differentiation by equipping cars with parts, which is oriented to a shift to electronic systems and unitization by which advanced functions and added value are raised. (3) Since Japan has many suppliers who have historical traditions and who have built up sophisticated technology that supports individual specialized processes, it would not be easy to consolidate and integrate these into module suppliers. (4) Japan has poor road conditions, making the transport of large module parts extremely difficult. Another reason is that, since existing car assembly plants tend to be located in urban areas, there is no room to locate module suppliers adjacent to the assemblers. Nevertheless, even in Japan's automobile industry, it is likely that modularization will proceed to some extent, and that there will be further integration and consolidation of parts suppliers.

Faced with a decline in domestic demand and an excessive production capacity, the circumstances of the Japanese automobile industry have been worsening since the 1990s. For this reason, some Japanese companies have formed alliances with Western companies promoting the standardization of chassis and exporting engines and other CKD parts from

Japan. If anything, Japanese companies are now becoming heavily involved in module production overseas.

3. The practice of JIT in Japan by remotely located suppliers

3.1. Selecting target regions and companies

In doing research on JIT, we must keep in mind the fact that JIT systems are highly integrated and organized systems that bring together the various internal and external relationships of a business. In implementing JIT, car assemblers, suppliers, and distribution personnel are interconnected online and share an information network; ordering, delivery, production planning, production processes, and distribution are controlled and highly centralized. The distribution of automotive parts is more than simply an issue of truck delivery. As shown in Figure 1 shows, in examining the distribution of automotive parts, this paper also examines the corporate group relationships involved in effecting parts-related transactions, the technological background, and also the characteristics of the production systems that interface with distribution. For example, in forging a trading relationship between a car assembler and supplier, is there a contribution of capital? Are executive officers dispatched? What other affiliations or ties exist? What kinds of technological features are there supporting the placement of orders to remotely located domestic suppliers? When and in what fashion was JIT-based production and distribution introduced? Was it based on the guidance of the car assembler? This kind of background needs to be clarified.

As the globalization of automobile production evolves, the production processes for important parts, especially those located domestically within Japan, involve the creation of electronic programs, and are characterized by being capital and technology-intensive, requiring massive investment. In order to recover this capital investment, businesses must simultaneously pursue high-mix production and economies of scale. Furthermore, in adopting and implementing JIT, businesses can overcome the risk of increasing labor costs attributable to the increased responsibility of workers, as well as the risk of unfavorable conditions resulting from increases in distribution costs. The suppliers must therefore either maintain a large share of a specialized market, or find a location oriented toward a cheap workforce, or save on labor costs by employing new technology. Accordingly, in implementing JIT, it should be possible to disperse the locations of suppliers to a region from which parts can be transported within the delivery lead time.

The introduction of JIT involves a shift to an information-based system, and there is a risk that it could lead to business relations becoming entrenched within that network. If investment is needed in production facilities which are for the exclusive use for certain customers, or on the other hand, if the suppliers enjoy an oligopoly, then there is a risk that costs will increase. Consequently, in forming these kinds of business relations, rather than simply a problem of cost, emphasis should also be placed on the trust between businesses.

Parts suppliers, which are able to locate remotely from car assemblers, do not produce large or heavy goods which are difficult to transport or store. Their goods are also different to those, such as interior or exterior decorating, which strongly reflect the choices and desires of preferences and designs by individual customers at the time of ordering. Rather, these parts suppliers tend to produce goods which are easy to standardize, allowing production to be planned ahead.

In view of these prerequisites, the target region and businesses examined in this chapter were selected according to the following conditions. First, a region was selected, which is located a medium or long distance from the location of car assemblers; where there is a collection of leading suppliers; and where the majority of those suppliers have devised distribution schemes to overcome their remoteness. In the case of the concentration of the automotive parts industry around Toyota City, it is self-evident that it has been formed mostly from the dealings with Toyota. The businesses selected for this study were parts suppliers which are situated in more remote locations, which have large capital bases, and which conduct a diverse range of distribution with a number of car assemblers.

Second, it was decided to make the target region in which the parts suppliers had been located there from before or during World War II in other words, not having just recently located there. In the case of businesses locating to remote areas in recent years, one contributing factor for their expansion would have been the availability of newly-built expressways. It is already evident that JIT would have been adopted by these businesses from their outset. Instead, by targeting examples of businesses and regions which have been remotely located since long ago, the authors can clarify the way in which JIT-based production and distribution systems have been introduced prior to improvements to the transport and communications infrastructures.

Accordingly, the authors will examine the formation and subsequent development of the parts industry in the area around the Ueda Basin in Nagano Prefecture. An automotive parts industry was located in this area in the early stages of World War II, despite its remoteness from car assembly plants, and over the years, the industry has nurtured the formation of business relations and relationships of trust with car assemblers. The industry

also adopted JIT under the direct guidance of Toyota. The authors will focus examination on two examples of Art Metal (AM) and Nissin Kogyo (NK), which are typical parts suppliers in this region.

3.2. Reasons for locating in remote areas

The area around Ueda City in Nagano Prefecture in the central region of Japan is an inland basin surrounded by mountainous terrains, about 200km northwest Tokyo. The terrain is a high plateau, with a cool climate and snowfall in winter. Numerous automotive parts suppliers located to the area around the Ueda Basin in the years before and after the World War II. Together with the electronics industry, the automotive parts industry plays an important role in the regional economy. However, the area is located some 300-400km from Toyota City and other places where car assembly plants are located (see Figure 2). Below, the authors will shed light on the reasons why suppliers have located in such a remote areas.

(1) Historical conditions

Prior to the Great Depression of 1929, raising silkworms was popular with local farmers in the region. As a result, the sericulture industry developed, producing raw silk. Since raw silk was a major export for Japan at the time, the farmers and residents in the region became sensitive to trends in international markets, and so a prescient and progressive industrial atmosphere was born. However, with the Great Depression of 1929, the sericulture industry lost its export market and was dealt a devastating blow. Then, based on the newfound surplus workforce and factory equipment and on the accumulation of capital, the region set about enticing the munitions industry, which was the growth industry of the time, to relocate there.

Subsequently, during World War II, factories producing aircraft engine parts and radio communication equipment relocated to the region in order to escape the air raids which were striking the metropolitan areas of Tokyo and Osaka. In 1942, AM moved from Tokyo to Ueda, where it began producing pistons for aircraft engines. This move created the basis for the automotive parts industry's location to the region.

After the war, manufacture of aircraft parts for the munitions industry was switched to the manufacture of automotive parts. As the demand for automobiles increased, more and more companies have ventured into the production of automotive parts. Amid these circumstances, AM expanded its production to pistons for cars and motorcycles. Then in

1953, AM split off its brake pistons manufacturing business, and NK was founded. NK subsequently developed as an independent manufacturer of brakes for cars and motorcycles. AM and NK established a number of sub-factories in the region, and continued to form networks comprised of large numbers of subcontractors. In this way, numerous parts suppliers began to locate in the area around the Ueda Basin – not only suppliers of pistons and brakes, but also suppliers of door locks, horns, gearboxes and suspension equipment (see Figure 3).

(2) The development of sophisticated technological capabilities

Ever since aircraft parts were produced during the war, the characteristics of the automotive parts industry in the area around the Ueda Basin have been high-precision aluminum-alloy casting and the associated accumulation of processing technology.

In addition, manufacturers of numerically controlled machine tools have also located to this area. For this reason, numerically controlled machine tools have permeated throughout the entire region, from part-time farmers to small subcontracted factories. The accumulation of sophisticated technology extends throughout the network of subcontractors (Friedman, 1988, Chapter 5).

(3) Abundant workforce

Although labor shortages have been a problem by the development of electronics industries in this region in recent years, previously, surplus workforces in rural areas meant a skilful and obedient labor, and that was also cheaper and more abundant than in metropolitan areas.

(4) Inertia of location

As suppliers with advanced technological capabilities and unique design skills, AM and NK have established within their own plants, design and trial manufacture units as well as other units that produce molds and machine tools for internal use. As such, it would not be easy to separate the production processes from these units. In particular, the precise and sophisticated processes related to brake controls and electronic integrated circuits could not be easily transferred overseas, even if the Japanese yen appreciated.

(5) The pursuit of economies of scale in the production of parts

Rather than dispersing production locations by locating close to individual car assembly plants, by ensuring the concentrated location of flexible production lines that can support high-mix production in the Ueda area, economies of scale can be pursued and the disadvantages of long-haul transportation costs can be compensated for. Consequently,

by making deliveries to individual car assemblers in this way, both AM and NK have gained large shares of Japan's domestic market.

(6) Overcoming locational disadvantages: business group alliances (*keiretsu*) and technological development

AM is a Toyota corporate group company. Both, AM and NK are members of the *Kyoryokukai* (Kanto Kyohou Kai), which is an organization of Toyota-affiliated parts suppliers. Furthermore, as a result of equity participation by Honda Motors, since 1971 NK has also been a member of that corporate group.

Honda Motors began business later than Toyota and Nissan, and it traded with distant parts suppliers belonging to other corporate groups, based on price levels and technical standards. As competition in the market has become fiercer, Honda Motors has chosen large-scale parts suppliers with superior technical capabilities from both within Japan and overseas, and has made them part of its corporate group. As a result, Honda Motors ended up forming business relations with suppliers who were located even further away (Mair, 1994).

NK, being a member of Honda Motors corporate group (*keiretsu*), has many engineers and executives on temporary transfer from the headquarters of Honda. Furthermore, in collaboration with Honda Motors, NK has also established a research and development facility and test course in a location which is completely different from where their plants are located. The facility is located in Tochigi Prefecture, about 200km northeast of Tokyo, and its research includes the development of brake systems which do not slip on snowy or icy road surfaces. Establishing a joint research and development facility this way in a different location compensates for disadvantages related to the plant's location.

In addition, as Honda Motors has expanded its Production overseas, NK has also made inroads in the U.S.A., Brazil, Vietnam, Indonesia, China, Thailand and Britain. However, production of electronic integrated circuits for anti-locking brake systems, which require advanced technology, has been concentrated at the Ueda Factory where its headquarters is located.

3.3. The introduction of JIT in production systems

At AM and NK, the introduction of JIT was tried out at an early date. Proposals for improvement (*kaizen*) were advanced from the production floor, and in the 1960s, delivery

schedules for parts were being rigidly adhered to through the introduction of the *gaichu kanban* (the process where production is only executed on receipt of an order). “*Gaichu*” means “order”, and “*kanban*” refers to the written instructions for parts which are sent from a post-process to a pre-process or a parts supplier, when a part is required. In JIT, it is impermissible to produce reserve parts in advance before a *kanban* has arrived. Written on the *kanban* are: the type and name of the parts, the reference number, the required quantity, the deadlines for delivery (appointed times), the frequency of delivery, and the delivery destination within the factory. Historically, *kanban* would be inserted into a plastic case, attached to the order and delivery, and would have traveled back and forth between plants. Nowadays, the process has been computerized, and delivery slips, printed with the details of the electronic *kanban*, are attached to the parts being distributed. Furthermore, improvements in productivity and efficiency have been sought by manufacturing general-purpose machines at each company’s machinery plant to accommodate high-mix production, by improving the self-manufacture of molds and jigs, by introducing the U-shaped production line, and by making workers multi-skilled so that an individual worker can manage several machines. A “U-shaped production line” differs from a straight-line production line in that when a part currently being processed is sent on “one-piece-at-a-time”, each part enters through an outlet near the entrance to the production line. This makes it easier for a single worker to be engaged in multiple processes.

However, fully-fledged JIT-based production systems were not perfected until 1976-77, following to the first oil shock. The factors that made it possible were electronic *kanban* allowing the linking and unification of information networks between individual car assemblers and parts suppliers; the ordering, production, distribution and delivery functions had become highly planned; and the production of parts and finished cars had become interconnected under a consistent information system.

Following the oil shock, by utilizing the electronic *kanban* with parts suppliers, Toyota was able to bring order and production information online, and to create an even more efficient JIT system. It first adopted a policy of spreading JIT to local suppliers around Toyota City, and then, from 1976, it expanded JIT to all the distant suppliers that were members of the Kanto Kyohou Kai. Taiichi Ohno, then the Executive Vice President of Toyota, was the founder of JIT, and was effectively responsible for its introduction. With regard to AM and NK in particular, he spent two weeks in Ueda and directly supervised improvements to the production system, including distribution. In other words, it would appear that Toyota considered AM and NK in the Ueda district as model cases in which to implement long-distance JIT-based production and distribution.

Then, following the full implementation of JIT by Toyota, AM and NK proceeded to bring online their order information with other car assemblers, and promoted JIT-based production and distribution. In this way, by means of across-the-board implementation of JIT, AM and NK shifted to a more flexible production system, including the programming of production using electronic information, the introduction of robots and numerically controlled machines, technological improvements and shorter times for the replacement and rearrangement of molds and jigs, and a production line which accommodating high-mix small-lot production.

Car assemblers do design medium-term and long-term production plans, but based on the information received from the purchasing customer, those plans may be revised, ultimately, production decisions are made five days prior to the car being assembled. By programming production in conjunction with car assemblers' information systems, parts suppliers can commence production at the same time as orders are confirmed. In implementing production and distribution well in advance of this approximately five-day delivery and lead time, parts suppliers located in Japan are able to overcome the disadvantages of being located remotely from their customers.

3.4. JIT-based distribution

In 1962, during the period of rapid economic growth, there was a surge in the demand for automotive parts. In response to this increase, AM and NK made capital investments, and the transport unit within AM was reorganized, resulting in the establishment of Art Kompo Unyu (AKU) in Ueda City.

In addition to AM and NK, AKU has also been in charge of distribution for other individual suppliers around Ueda. As well as pistons and brakes, it is also engaged in the transport of such parts as horns, door locks and piston rings. Automotive parts account for approximately 70 percent of its transport volume.

In 1976, at around the same period as for AM and NK as described in the previous section, a JIT-based transportation system was also established at AKU under the direct guidance of the then Executive Vice President of Toyota, Taiichi Ohno. This was a system that centered on overnight road transport, whereby parts that were produced by evening would be delivered to a distribution depot (cross dock) near the car assembly plant in time for production to commence the following morning. Furthermore, drivers at AKU are also responsible for operating forklifts during loading and unloading, which contributes to savings in handling and to reductions in overall distribution costs.

Parts are collected from the factories of each of the suppliers around Ueda and brought to the depot at AKU headquarters. The farthest collections are made from NK's Naoetsu Factory, almost 150km northwest from Ueda City. It specializes in motorcycle brakes, and was located here in 1973, due to the ready supply of raw materials from a nearby large-scale aluminum refining plant. The reason it does not ship directly to motorcycle plants in each region is that its brakes are combined at the depot at AKU headquarters with other motorcycle parts from other companies and factories.

The depot at AKU headquarters performs a vendor consolidation function. Scales and merits of transport are pursued. Parts are collected from individual suppliers around Ueda and are brought here to be sorted according to the car assembly plant they are destined for, and consolidated and loaded onto large trucks for overnight transportation.

Figure 4 shows AKU's routes for middle-distance and long-distance mainline transport as of September 2004 when the surveys were conducted. Looking this closely, the authors can observe the following three patterns.

(1) Parts are transported to the AKU depot near the car assembly plant, from where small-lot high-frequency deliveries are made to the car assembly plant. Deliveries to Toyota's factories around Toyota City and to Honda Motors' Sayama and Hamamatsu factories fit this pattern.

(2) Parts are delivered to 3PL cross docks near the car assembly plant, from where small-lot high-frequency deliveries are made to the car assembly plant. Deliveries to Honda Motors' Suzuka Factory and to each of Daihatsu's factories fit this pattern.

(3) From the AKU depot, parts are transferred onto another company's trucks and transported long distances. Deliveries to Honda Motors' Kumamoto Factory fit this pattern. The Kumamoto Factory manufactures motorcycles, and was established in 1976 in Kyushu district in the far southwest of Japan. Parts are relayed from NK's Naoetsu Factory to the depot at AKU's Ueda headquarters and then onto AKU's Kasugai Depot. From the Kasugai Depot, parts are transported to the Kumamoto Factory by a separate trucking company. Three days out of the five-days lead time is spent transferring the parts twice, and transporting them almost 1,000km. This is an example of long-haul transport that arose because the assembly plant was relocated in a distant area.

AKU's Shiga Depot is also not located close to any car assembly plants. Parts destined for Mitsubishi Motors are transferred at there to a transport firm designated by Mitsubishi Motors. The parts are collected using the "milk-run" method, in which the designated transport firm comes to the depot, and combines the parts with deliveries from other

suppliers in Shiga Prefecture. The Shiga Depot could be described as an intermediate location midway along the transport route.

Let us examine the reasons why depots are used in this way along the various routes, and why mainline transport is consolidated onto trucks. As mentioned previously, firms can try to reduce manufacturing costs by introducing JIT to the production process. However, reducing the distribution costs caused by the introduction of JIT is not an easy task. At this point, firms introduce information technology; they consolidate the scattered warehouses (distribution depots) in order to reduce the warehouse costs and land costs; and they consolidate and share transport in order to reduce transportation costs. In other words, what happens is they try to improve load efficiency, and pursue economies of scale in distribution (Hamilton, 1995, 27).

However, establishing these relay points has the disadvantage of attracting increases in *en route* handling costs and lead times. For this reason, mainline transport is consolidated onto large trucks, load efficiencies are improved, and overall distribution costs can be reduced by making frequent punctual deliveries at final destination.

From these perspectives, the authors can see that an important role is performed by 3PL cross docks and distribution depots run by transport firms, which are established close to car assembly plants. In the next chapter, the authors will take a closer look at the actual conditions required for these approaches.

4. Punctual and frequent deliveries to car assembly plants

4.1. The system of punctual and frequent delivery

As discussed in the preceding chapter, deliveries by AKU are not always made directly to the car assembly plants. In this section, the authors will consider the reasons for this.

Suppose that each parts supplier was to deliver finished parts one after the other. The arrival and departure of trucks at the car assembly plants would be irregular, resulting in either a surplus or a shortage of space for trucks to stop and for the cargo to be handled; ultimately, the car assembly plants would need vast areas of land for trucks to park and for cargo to be handled. At the car assemblers too, there would be surpluses and deficiencies in hardware and in labor for processing the loading, unloading and delivery of goods, leading to superfluous costs. In order to reduce these costs it becomes necessary to

standardize and equalize the arrival of trucks and deliveries to the car assembly plants (Sugita, 1998, 1999).

Consequently, in implementing JIT, costs can be significantly reduced by having distribution depots or 3PL cross docks of appointed suppliers set up in the vicinity of the car assembly plants; having them collect, sort and consolidate the various parts; and then having them deliver the parts at the time specified by the car assembler, in the specified quantity, to the work area for the specified process. This system is called the “system of punctual and frequent delivery.” At the distribution depot, based on information from car assemblers, the required parts are sorted according to each specified time, delivery point, and quantity, and are transferred onto the delivery trucks. By consolidating delivery from suppliers in this way, car assemblers are able to manage their distribution costs better, and to collectively manage the costs involved in the procurement of parts, such as by promoting further computerization.

Next, the authors will take a close look at the system of punctual and frequent delivery to car assembly plants that transferred from AKU's transportation discussed in the previous chapter.

In making deliveries to Honda Motors' Suzuka Factory, AKU utilizes the Honda-designated 3PL cross dock adjacent to the factory. From late night until early morning, AKU's trucks arrive here from the Ueda area in Nagano Prefecture. AKU's drivers operate the forklifts and complete the unloading themselves. Then, from early morning, the 3PL workers sort the parts. In the case of NK's brakes, in order to accommodate Honda Motors' daily two-shift 16-hour production system, some parts are delivered once every two hours eight times a day, and others are delivered once every four hours four times a day. Depending on the target vehicle model and the part types, they are delivered at different times and to different locations along the production line. Before deliveries can be made in this way, parts brought in by a large truck need to be divided up small lots at the cross dock. This 3PL cross dock is engaged in punctual and frequent delivery, daily sorting approximately 20,000 different parts delivered from about 250 parts suppliers.

In 1971, AKU also established a distribution depot near the Kasugai Interchange along the Tomei Expressway in Kasugai City, Aichi Prefecture. From here, it delivers parts to Toyota's various plants located around Toyota City. What is of particular interest is the fact that a single AKU truck follows a route from the Kasugai Depot that circulates Toyota's plant, the factories of the major parts suppliers in the Toyota corporate group, as well as the 3PL cross dock (see Figure 5). This entails delivering the various parts transported mostly

from Nagano Prefecture in the morning, and in the afternoon, reloading the resultant space in the truck with parts produced in Aichi Prefecture, thereby raising load efficiency. At the same time, the AKU driver operates the forklifts at each of these loading and unloading points, thereby efficiency is further increased. In other words, it is a unique system that melds together the circuit delivery system and the circuit-collection type “milk-run” method, and is extremely efficient in that it utilizes drivers and vehicles for the whole day.

In the case of transport at AKU, the distribution costs are paid the parts suppliers as a lump sum to the company to which distribution was first commissioned, namely AKU. From this amount, agency fees are paid to the individual distribution firms and to the 3PL to which the parts were transferred. In essence, all distribution costs are borne by the parts suppliers, allowing the car assemblers to avoid incurring distribution costs for parts.

However, in recent years, the importance of 3PLs has increased, and then the collection, distribution and inventory management for parts is being outsourced to 3PLs, and the entire cost incurred by the 3PL for distributing parts is being borne by car assemblers. In the next section, the authors will look more closely at the actual conditions for these 3PLs.

4.2. JIT distribution using 3PL

First, the authors will look at some recent studies in economic geography on JIT-based distribution that utilizes 3PLs.

Fields (2006) examined the procurement of parts by the computer manufacturer, Dell. Dell has set up supply logistics centers (SLC) operated by 3PLs near its finished product assembly plants. The 3PL conducts JIT transport of parts in the final sector between the SLC and the assembly plant, and deliveries are of small-lot and high-frequency in nature. The entire costs of loading, unloading and storing parts at the 3PL and SLC are borne by the parts suppliers. Dell has six assembly plants on four continents, and for its globally expanding procurement it stores two weeks worth of inventory at its SLC.

van Egeraat and Jacobson (2005) studied the production and distribution of computers in Scotland and Ireland. In this case, several parts suppliers have consolidated their distribution centers into one or two massive hubs close to the assembly plant. These hubs are owned and managed by 3PLs. The delivery lead time from a hub is no more than 1~2 hours, and high-frequency JIT deliveries are executed. Consequently, the inventory kept on a customer’s premises is extremely small. The entire cost of handling and storing inventories at these hubs is borne by the parts suppliers. Reserve inventories are left near

the assembly plant, and while they remain the property of the suppliers, they are managed at the hubs. The hubs perform the role of regulating the two conflicting functions of procuring parts from overseas and maintaining a high turnover for parts inventory.

In this way, cross docks, referred to as SLCs or hubs, located close to finished product assembly plants, are playing an important role in the procurement of parts in the increasingly global electronics industry. The practice of vendor management inventory has been adopted, whereby all the costs involved in storing and handling parts at these cross docks is borne by the suppliers, and assemblers are exempt from bearing the costs directly.

Next the authors will look at the role of 3PLs in the transport of automotive parts in Japan. We will compare this with overseas, and ascertain if the distribution costs are being borne by parts suppliers or car assemblers.

Figure 6 shows the distribution of 3PL cross docks are located close to Toyota's plants in and around Toyota City. Back in the 18th century, cotton-growing thrived in this area, and the area became a center for the cotton spinning and cotton textile industries. By the turn of the 20th century, technological innovations in production saw automatic looms come into use. Toyota Company was founded as a business of the assembly and production of these automatic looms. Subsequently, a network of parts suppliers for automatic looms was formed around Toyota. These suppliers had mostly switched from the cotton industry. Subsequently, with Toyota's switch to automobile production, conglomerations of automotive parts manufacturers were formed one after another. In this way, when looking at the build-up of automotive parts manufacturers in the area around Toyota City, we cannot overlook the way the automotive industry was formed, or the accumulation of capital and technology based on the cotton and textile machine industries prior to the introduction of JIT systems (Miyakawa, 1977; Takeuchi, 1971; Bian, 2006).

From Figure 6, we can see that two 3PL cross docks companies affiliated with Toyota corporate group are positioned in several locations around Toyota's plants. One of these cross docks is a firm that developed from a forwarding agent of a local railway station, and the other emerged from a local trucking company. In this way, many cross docks have been established as more and more parts suppliers located to this region. This fact shows us that Toyota did not make the local parts suppliers deliver directly to them, but rather required deliveries to be made in a planned fashion, with inventories of parts being stored temporarily at cross docks before being sorted and delivered.

Previously, Toyota promulgated a system of JIT production in which inventories were not held, and in which the entire cost of distribution of parts up to delivery to the 3PL was to be borne by the parts suppliers. However, the Iwate Plant, activated in 2006, and located

some 800km north of Toyota City, was no buildup of suppliers in its surrounding. Toyota consolidates the parts collected at 3PL cross docks from suppliers in and around Toyota City, and sends them in lots to the Iwate Plant by means of a special freight train. As this shows, in recent years there have been instances when Toyota directly manages and incurs the distribution costs for parts.

Next, the authors will introduce the example of Logicom (LC). LC is a company that has set up cross docks in close vicinity to various car assembly plants throughout Japan (see Figure 7). LC's headquarters is located in Hiroshima City. The company was originally a warehouse operator founded in 1954. Hiroshima City is the home of one of Mazda's car assembly plants. Mazda has a relatively small market share, and its location is far away from any metropolitan districts in Japan where there is already an accumulation of automotive parts manufacturers. As a result, Mazda lacked the necessary production volume and capital strength to nurture an extensive range of suppliers locally. Therefore, in sourcing its parts, it mostly relied on small deliveries from far-away metropolitan districts or from parts suppliers affiliated with other car assemblers. At the end of the 1950s, the parts suppliers that supplied Mazda made joint deliveries to Mazda's car assembly plant by utilizing LC's warehouses in Hiroshima from where parts would be loaded together onto trucks for shipment. This was the trigger that brought LC into the distribution of automotive parts.

In 1972-73, LC installed a computer system and completed an inter-system information translation system to connect the parts suppliers with car assemblers. In this way, LC promoted the online exchange of order/supply information between suppliers and car assemblers. LC then established distribution depots in various regions around Japan. They perform a vendor consolidation function, where parts are collected from each supplier by means of the "milk-run" method, and they are then consolidated onto trucks and transported between centers along main lines. LC has also established cross docks near car assembly plants throughout Japan, and is practicing punctual and frequent delivery by storing and sorting parts which are brought in by truck.

Particularly noteworthy was that, from the late 1970s, in order to compensate for a labor shortage, Toyota and Nissan established new plants in Kyushu, the far southwest of Japan. LC also expanded cross docks to the same area. In doing so, LC undertook a lot of long-haul transport of automotive parts which were being supplied from parts suppliers in eastern Japan, namely, the existing parts suppliers in the Tokyo metropolitan area and those in and around the Toyota City, to the new car assembly plants in western Japan. This is also demonstrated by the fact that a large variety of parts were being handled in particular at

LC depots located in western Japan, as shown in Figure 7.

In terms of capital, LC is an independent company, and has no affiliation with any of the car assemblers. Because of this, it is able to do business in an impartial way with all car assemblers and several hundred parts suppliers. Also, in recent years, Mitsubishi, Mazda and Nissan have begun to outsource the distribution of parts to LC as a 3PL. On such occasions, the distribution costs incurred in collecting parts from each supplier using the “milk-run” method are being borne by the car assemblers. Figure 8 shows how in November 2006, in order to make deliveries to Mitsubishi Motors’ Mizushima Factory, LC collected parts from a wide area and brought them to a nearby cross dock.

From Figure 8, we can also see that parts are being supplied to Mitsubishi Motors’ Mizushima Factory not only from neighboring districts, but also via long-haul transport from the Tokyo metropolitan area, the Toyota City area and Kyushu, and that they are being collected for distribution at LC’s cross dock near the Mizushima Factory. This reflects the fact that Mitsubishi Motors is not in full and firm command of parts suppliers within its corporate group, and that, for this reason, it has to resort to sourcing parts suppliers belonging to other corporate groups.

Furthermore, car assemblers have been increasing their imports of parts from Europe and the U.S.A. – Mazda through its affiliation with Ford, and Nissan through its affiliation with Renault. LC has also been in charge of these international exchanges. For this reason, LC is in the process of expanding its information system network for sourcing parts to overseas. In addition to increasing the lead time for sourcing parts from overseas in this way, since many large-lot deliveries are arriving by container, the planned storage and sorting at LC’s cross docks and the subsequent punctual and frequent delivery are becoming increasingly important.

In the previously cited study case, where parts in the electronics industry are being sourced globally, the entire distribution costs, up to the inventory management of parts at the cross docks, were being borne by the parts suppliers. In other words, the vendor management inventory policy has been adopted, and assemblers are avoiding the direct incurrence of distribution costs. However, in the case of distributing automotive parts in Japan utilizing 3PL cross docks, there has been an increase in recent years in the number of instances where the car assembler has paid the 3PL the entire distribution cost from the stage where the 3PL collects parts from suppliers via the “milk-run” method. In the case of the automobile industry, there is a growing trend for the entire cost of distributing parts to be borne directly by the car assembler. This point is at odds with the electronics industry in which vendor management inventory is practiced.

5. Conclusion

In geographic research overseas, it has been made clear that, in various regions around the world, the practice of JIT has been embedded into business-to-business networks in a variety of forms, and that the practice is also evolving in a variety of ways. How then should we view the JIT-based distribution of automotive parts in Japan, which has been raised in this paper?

Just like the examples mentioned here, automotive parts suppliers in Japan are dispersed widely in each region, as a consequence of the diverse historical context of sophisticated technology having been built up and specialized skills having been embedded in local communities. Furthermore, the fact that the rural areas have been able to guarantee a workforce cheaper and more abundant than those in metropolitan areas has also facilitated the dispersion of suppliers. Many suppliers previously dispersed across various parts of Japan concurrently sought economies of scope and economies of scale by consolidating their production factories and making deliveries to various car assemblers through the utilization of a flexible production line that could provide high-mix production. Since individual car assemblers in Japan have set about a five-day lead time from order to delivery, no matter where the parts suppliers are located in Japan, they are able to implement long-distance JIT.

In implementing long-distance JIT, information was brought online, and inventories were transferred, managed and stored in a planned fashion. In other words, one of the philosophies of JIT, namely “surplus inventories are not retained” (Ohno, 1988), does not mean that absolutely no inventories of parts are held; unless a minimum inventory is retained, JIT cannot be executed smoothly.

The following structure was designed for the actual JIT-based distribution of parts. Distribution depots were set up to perform a vendor consolidation function of collecting parts from various suppliers in a certain region using the “milk-run” method. Between depots, mainline transport was operated efficiently by consolidating parts onto large trucks. Distribution depots nearby car assembly plants also serve as the function of a cross dock. Inventories of parts are managed and sorted here, after which punctual and frequent deliveries are made to the car assembly plants. Information on orders and on inventory control has been centrally networked, and handled by supply chain management.

In Chapter 3, we presented examples of AM and NK utilizing AKU for distribution. In these conventional systems, the entire costs for the distribution of parts up until the cross

dock was the responsibility of suppliers; the so-called vendor management inventory system was being practiced. Recently however, as in the example shown in Chapter 4 of distribution using LC, car assemblers have begun to completely outsource distribution of parts and the management of distribution costs to 3PLs. This has resulted in car assemblers bearing distribution costs from the stage where 3PLs have collected parts from suppliers by way of the “milk-run” method. In this way, there is an increasingly strong trend for parts-related distribution costs to be managed directly by car assemblers (see Figure 9).

It is conceivable that these diverse examples of middle-distance and long-distance JIT-based distribution in Japan are also prototypes for the diverse JIT systems developed when Japanese automobile companies began offshore production. At the same time, it is also conceivable that they reciprocally experienced and studied overseas distribution practices utilizing vendor consolidation, cross docks and 3PL, and that these practices are being introduced to Japan.

In other words, the “milk-run” method, long-haul transport, and management of inventory using cross docks, which had been taken up as examples of JIT in geographical studies in the West, was being practiced even in the JIT-based distribution of automotive parts in Japan, and similar to the West, diverse forms of JIT have been developed according to each company’s circumstances.

In Japan, the birthrate is declining and the population is aging, and the population is expected to decrease in the future. Japan’s domestic car market is saturated, and there is little hope of any significant increase in demand in the future. The Japanese automobile industry is being called on to rationalize its excess domestic production capacity, and to stand up to fierce competition from overseas.

One measure is to locate new assembly plants around the fringes of Japan. Another is forging alliances with overseas businesses. It has become necessary for chassis (platforms) and parts to be shared and standardized with overseas affiliates, and for redundant models to be regulated. There is a move also to source parts from overseas suppliers if the required conditions of cost, quality and punctual delivery can be met. With the current trend in Japan, traditional corporate groups (*keiretsu*) are being dissolved, and parts are being procured from non-affiliated suppliers (Ikeda and Nakagawa, 2002).

These changes are likely to have the following effects on parts suppliers. If their customers, namely car assemblers, make inroads to foreign markets affiliated with global corporations and begin to product in overseas, then in response, parts suppliers will also have to expand to global locations. The question of where to locate a supplier’s research and development center in the global network will also become important. Furthermore,

suppliers will also be required to expand their scale of production globally. In response to modularization and other new production techniques, suppliers will be faced with a choice of either expanding the size of their own company or forming affiliations or groups with other companies (Kobayashi and Ohno, 2005).

Moreover, these changing circumstances are also increasing the long-distance trading of parts both domestically and internationally. In other words, it can be said that, in sourcing parts, emphasis is being placed on economizing labor costs on a global perspective and on standardizing quality, rather than on economizing on distribution and transportation costs,

It is likely that the conventional concept of JIT will be significantly changed owing to a notable increase in lead time, and by an increase in the short-term, temporary and market trading of parts that goes beyond, or possibly dissolves, corporate groups (*keiretsu*).

As the Japanese automobile industry becomes further incorporated into global networks, the domestic distribution of automotive parts in Japan will be in a whirlpool of major changes. In the future, geographers will need to give careful consideration to the direction in which these changes proceed, and to the question of whether the examples of JIT-based distribution of automotive parts in Japan can serve as the basic model for supply chain management in the various industries across the world. With regard to this, there will need to be an examination of and comparison with examples of parts procurement in Japan's electronics and electric appliances industries, in which the horizontal division of assembly work with other Asian countries has been promoted. The future themes will be to study how not only JIT but also the new production systems currently being adopted by Japanese businesses, namely *modular production* and *cell production*, are affecting the spatial structures of those distribution systems.

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