Lean supply chains and sustained successes of JIT/Lean organizations*

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Abstract

Although JIT or lean system has been attracting the world attention since the 1980s, and has been reportedly implemented with various successes in different companies of different industries in major industrialized countries, not a single firm can be pinpointed outside Japan that has sustained successes in terms of consistent growth, product quality, reliability, improvements, etc for decades thanks to the JIT/lean system the way some Japanese companies (including Toyota, of course) have. In fact, a keen observation shows that companies failing to sustain JIT successes consider JIT as a pure production method and implement thus the system only from that point of view. The contention is that only those companies implementing the JIT/lean system from an integrated supply chain (SC) approach can and/or do sustain their success over decades. The paper aims thus at showing that JIT is more than a set of production methods. It is rather an integrated system of logistics and supply chain management.

Keywords: JIT, Lean, Kanban, Lean SCM, Supply chain management and integration, Logistics

Introduction: Limited successes of JIT outside Japan

Of the many plants I visited in France and Germany, only in the former country I could identify clearly the implementation of JIT that took place years ago, especially during the 1980s. Companies introduced some JIT techniques. Unfortu-

* This is a slightly revised paper presented at the Annual Conference of Production and Operations Society in Dallas, Texas, 2007.

nately, for most of them, what remains to be witnessed are just vestiges of tentative trials of JIT implementation.[1]

A number of companies in the West tried, especially in the 1980s, to switch to the JIT in order to respond to the competitive pressure from Japanese firms, by adopting and using the same methods Japanese companies were (have been) using as powerful and ruthless competitive weapons. After all, production methods are not specific to a particular company or country. The best practices can be adopted and rapidly spread all over the world. Mass production methods were initiated by Ford in the USA and soon became the standard production methods not only in the USA but also in Europe, Asia, etc.

Concerning the Japanese production methods, especially the JIT system, we have shown that its industrial engineering elements might be applied in any management and cultural setting. They would work successfully, when properly implemented, the same way they do in Japan. The setup reduction method, for example, is not characteristic of a special Japanese work environment. However, JIT elements relating to the Japanese management and workers' multi-skill development program could hardly be applied outside Japan. The concluding observation was that JIT could not have exactly the same output in Japan and outside Japan (Kupanhy: 1995, 2000).

On the other hand, we made the contention that the success of JIT improvement activities was a function of a successful and permanent institution of QCC and SS structures. Very few companies outside Japan, especially in France and Germany, do have permanent QCC and SS structures. The implied idea or thesis was that JIT improvement activities could hardly be as successful as they

[1] I have in mind the cases of Caterpillar, Grenoble; SteelCase, Sarrebourg: GM Powertrain, Strasbourg, etc that we audited in the framework of Insead's Industrial Excellence Award, in 1999 and 2000.

were (are) in Japan (Kupanhy: 2006) at Toyota for example.[2]

Third, even though one would have, in the Western company, set up permanent instances of improvement activities, i.e., QCC and SS, he would need to assign the company asymptotic objectives (Kupanhy: 2006) in order to keep improving and improving continuously. Asymptotic goals are by their nature unrealistic since they can never, by definition, be achieved. Nevertheless, it is a strategic vision that drives JIT endless success. It is the engine of the sustained performance of JIT companies. This is, unfortunately, another point missing in the typical western company's strategic approach to JIT endless success. It is therefore almost impossible for a Western company to sustain JIT improvements even though the TPS/kanban system might have been implemented successfully.

At last, this paper tries now to show that a Western company even though it introduces the JIT system, from the point of view of SC management, the implementation is realized mainly at the central SC stage that assembles the final product, for example. The lean system does not span, in the majority of cases, the whole SC, especially the upstream stages which contribute in a substantial manner to value adding, to quality control and improvement, and to manufacturing costs.[3]

Identifying the critical stage of SC

The shortest SC sequence SCM can deal with is a pair of stages directly connected to each other by the flow of both materials and information.[4] It might, for example, be supplier and manufacturer; manufacturer and distributor; distributor and wholesaler; and wholesaler and retailer, etc. Materials flow from the pair's

[2] This was fact confirmed by Insead's "Industrial Excellence Award" data, 1999 & 2000 editions.
[3] See the case of the SC involved in the fabrication of the can of beer (see Womack & Jones: 1996).
[4] There is also the financial flow that should not be lost of sight.

upstream component, i.e., the supplier, to its downstream constituent or the customer of the former. The shortest and simplest SC structure can be qualified as consisting thus of only one pair of elements.

SC stages belong to different levels. Each level is made up of at least one stage. When dealing with a SC, it is necessary to identify its critical stage, i.e., the most important element. The critical stage can be considered as the central nerve of the SC. This is the instance that takes decisions impacting the SC, and that initiates the SC strategy and/or coordinates its operations. The pivotal element may be the last stage at the downstream end of SC. It may as well be situated, in theory, at any downstream or upstream level of the SC.

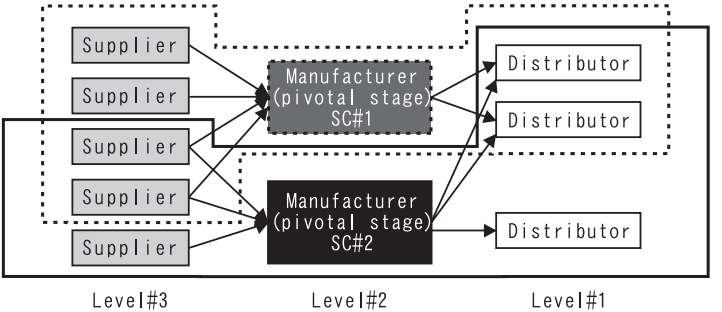
It is worth noting that even though two and more different supply chains may share the same elements downstream or upstream, they remain nevertheless distinct SC, each with its own central stage (Figure 1).

How can one identify the central stage of a SC? The level of the central stage of any SC is usually and always made of a single element, i.e., a single company. It looks like the bottleneck of the SC structure in terms of the number of elements each stage level is made up of. It is very important, when dealing with a SC, to focus on the central or pivotal stage since it is the SC policy maker. Financially and from the economical viewpoint, it is so critical that when it disappears, the whole SC it belongs to disintegrates, collapses completely and disappears also.

Traditionally, manufacturers used to be the central players in the SC. And this is still the case in the automobile and aeronautic industries (Figure 1). In the pure distribution industry, from the moment retailers have become economically and financially more important than manufacturers, the power base in the SC shifted then from manufacturers to supermarkets and department store chains such as Wal-Mart (USA), Carrefour (France), and Daie (Japan).

In the PC industry, the Dell supply chain model is close to the automobile manufacturer one whereas other PC makers, so far as they sell through distribution channels, belongs to the distributor model.

Figure 1: Model of SC where the manufacturer is the central stage



The case of Toyota as a SC's central stage

Since our focus is on the manufacturing sector, and because we wanted to deal, for the sake of simplicity and clarity, with the central stage and its immediate downstream or upstream stage, our highest interest is directed toward stages that create value for the customer as a decisive factor that impacts strongly the supply chain performance. That is why we decided to consider, for analysis, the SC sequence made up of the supplier & manufacturer pair of the most successful Japanese SC. The manufacturer as the central stage model we are going to base our analysis and reflection on is the Toyota Company.

In fact, the paper intends to show that the sustained performance and unrivaled competitiveness of Toyota are due to the SC organization and implementation approach of its lean production system within Toyota itself, within each of its partners and within the Toyota SC as a whole.

In fact, JIT system at Toyota for example drives the whole SC at the stra-

tegic, operational, and logistical level. It contributes thus to reducing operations and logistics cost, increasing value creation operations through the whole chain. It is a strategy to share production technology and knowledge that must be applied at every stage of the supply chain. It is a strategy to work with suppliers. But it is also a logistics system that coordinates the flow of information, the movement and transportation of materials between Toyota and its parts suppliers.[5]

Competing against the Japanese JIT company

Japanese quality products and product quality should be seen as outputs of not a single company, but of a coordinated SC. Finished Japanese products of JIT companies are the visible part of the iceberg. In the West, (as well as numerous conventional Japanese companies), JIT has been approached as a production system only. As such, the accent has been mainly on applying it as (a set of) production techniques (Shingo: 1981, 1988; Schonberger: 1982, 1986) aimed at the elimination of various kinds of muda in order to increase the productivity of the value added activities (Ohno: 1978).

We contend that the competition against a JIT-company like Toyota is not a competition against a single company. It is rather a competition against the whole SC of Toyata. As a matter of fact, Toyota has a solid, efficient, responsive and lean SC its performance and competitive power are based on. In addition, Toyota itself, as the SC pivotal element, is the main source of that overwhelming competitive power means it shares with and instills into the members of its SC. A single company (Japanese or foreign) may be using the same production methods that Toyota does as a competitive weapon. But so far as its power base is not SC-based and not SC-coordinated, the issue of the competition is quite foresee-

[5] Kupanhy (1995, 2007) considers Kanban production methods as making up a consistent system.

able: Toyota will win; its competitor will lose.

Toyota and its Japanese competitors in Japan

In Japan, Nissan used to be the number one car maker. It lost its leadership to Toyota decades ago. Since then, it contents itself being the number two (or three). Toyota is far from losing that leadership in the near future. In fact, in the very competitive Japanese market of cars with eight manufacturers, one can hardly identify any company that may be posing the leadership threat to Toyota who controls more than 40% of the Japanese market share of cars.

Toyota and the Big Three

The long-term outcome of the 1980's war in the car market place (battle field) between Toyota as the world number four car manufacturer on the one hand, and on the other hand, Chrysler, Ford and GM, the number three, two and one respectively, was quite predictable.[6] It was (like) a war between a group-supported individual or a group of individuals and a single individual. From the number four, Toyota has now become the number one producer of cars in the world. It is not the result of a miracle. It is just the normal and predicted results of the competition between a SC based strategy and a single company-based strategy.

Japanese companies and SC strategy

Interesting, when Honda and Toyota setup production sites in the USA, they started also building their American SC base. As result, they have been making in the American soil and cultural setting products of higher quality than their American competitors.

[6] Chrysler and GM have just gone bankrupt.

Catching the whole meaning of JIT

JIT, i.e., the Kanban system may be and has been misread and/or misunderstood at different levels. Many companies have just reduced it to a set of unrelated production techniques only. This is a profound misunderstanding of the system. Concerning that point, we found in France companies that pretended to have adopted JIT. But their JIT was rudimentary consisting of a single or few elements such as TPM, setup time reduction, etc.

For some others, JIT is a production system whose elements are logically interrelated and interacting with each others. This is a good but partial understanding of the system (Kupanhy: 1995). Such an understanding leads to internal integration of processes. It needs to be extended to include and integrate upstream SC stage so as JIT can fully play also its role of SC production control and logistics system.

Lessons from JIT implementation at Toyota

A brief look at the history of JIT shows that Toyota implemented its production system first at its own plants, then assisted its first-tier suppliers switch to the JIT production. The latter in their turn taught the system to their own suppliers, i.e., Toyota' s second-tier suppliers.[7]

This reveals in fact the important and necessary steps in the full implementation of the JIT system that can sustain, over an exceptionally long period of time, the performance and success of the SC in terms of both efficiency and responsiveness (Chopra and Mendl: 2007). It suggests different levels of integration.

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[7] See T. Ohno, Toyota Seisan hoshiki (in Japanese), 1978, p. 228−229; Y. Monden, Toyota Production System 1998, p. 37;, J. P. Womack and D. T. Jones, "Lean Thinking", 1996, p. 237.

Lesson 1: Intra-company intra-plant integration

JIT can be initiated and implemented at any stage of a supply chain (SC) as an operation strategy and especially as a set of production techniques. In other words, companies can and do switch to the JIT production techniques without any regard to and/or any concern for their being part of a SC organization. The adoption of the JIT techniques is realized from the point of view of operations efficiency and process productivity. It consists in the identification of different kinds of muda and then in targeting each of them by specifically designed JIT techniques in order to eliminate all of them.

The reduction of the setup time, the breaking of physical barriers between processes, the elimination of inventories and warehouses, the freeing of spaces at the production site, etc are some of the objectives JIT techniques aim at. Achieving these objectives are considered as the prerequisite to the kanban-pull system of production (Kupanhy: 1995, 2005).

A substantial number of the reported successful cases of JIT are just the results of the implementation of some of the elements described above. But this is only an initial step. The second phase addresses the issue of integrating the different production processes so as to create within the plant or production line a flow, ideally a continuous flow of materials, i.e., a one-piece-at-time flow of materials. We refer to this as an *intra-company intra-plant integration* (Table 1). It consists in linking by a chain of kanban or kanban system the different process.

The kanban used here is known as the dual kanban which is made of the inter-process and in-process kanbans.[8] The inter-process kanban is the kanban that moves from the downstream process to the immediate upstream process to

[8] Most authors call them inter and in-process kanban, or withdrawal and production kanban. Because we looking at the matter from the SC point of view we thought we needed to be specific in order to avoid confusion between kanban in used in company and those uses in different company. Intra-company is opposed to inter-company kanban.

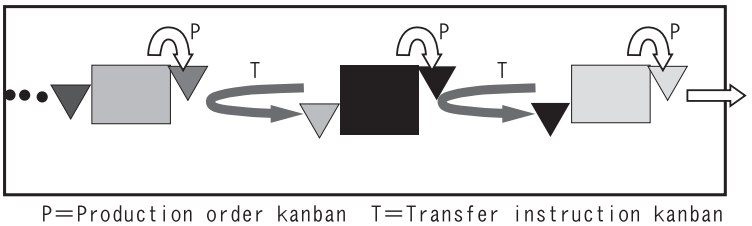
pull parts produced by the latter and needed by the former. On the other hand, the in-process kanban function consists in giving production orders and controlling the production of/at a single process. That is why it is also called the production order kanban.

Since the dual kanban is used within one plant, it may be viewed as a dual intra-plant kanban. If things are looked from both the company and plant viewpoint, then it can be considered as an intra-company intra-plant kanban (see Figure 2).

The dual intra-plant kanban are the means thanks to which the internal integration of intra-plant processes or processes that are geographically close to each others and generally situated within the same production site can be realized. The integration consists in the fact that the kanban plays not only the role of production and logistics management, but also the function of synchronizing, i.e., integrating the different internal processes of a production unit. It is the integration by the intra-plant kanban that creates the continuous flow within a plant.

The internal integration of processes by the kanban has been credited with, among others, the following results: impressive reduction of wip inventories and throughput time, fast velocity of wip, spectacular reduction of defective, high productivity, and above all, the continuous or a-piece-at-time flow of materials (Schonberger: 1982, 1986). Nonetheless, the flow of materials as well as that of information created by the intra-plant kanban, i.e., the intra-plant intra-company is confined within the walls of the production site. It is an isolated flow. As such, its impact is limited within the plant. There is a necessity of synchronizing the flow between the plants. The synchronization is possible thanks to the integration of the supplying and supplied plants that may belong either to the same company or to two different and distinct companies.

Figure 2: Intra-plant process integration in the form of a process chain thanks to kanban

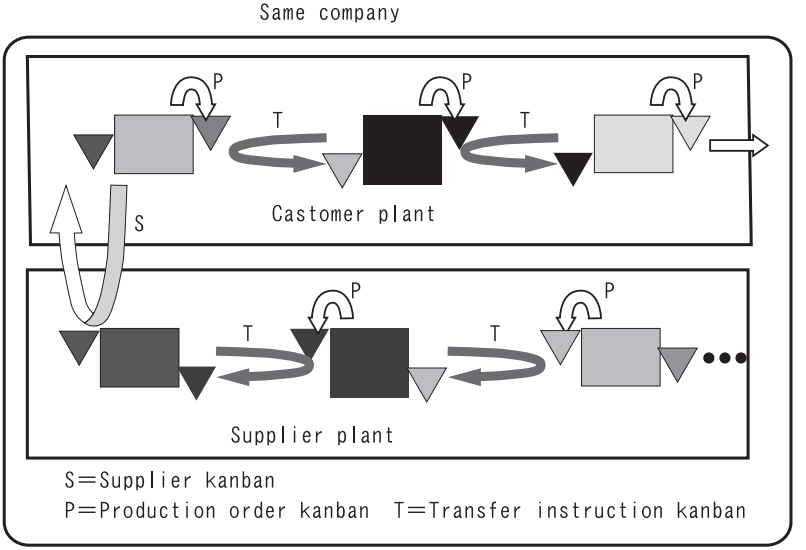


Lesson 2: Intra-company inter-plant integration

Another lesson that might be learned from the very brief but so instructive description of the history of the JIT at Toyota is the fact that, after implementing the system within a company's plants and realizing the intra-plant integration at each factory thanks to the intra-plant kanban, the next thing to do is to link supplying and supplied plants. A kanban should then be introduced to pull materials from the supplying plant(s) in order to direct them toward the supplied assembly line. In other words, it is necessary to integrate the flow of products between different production sites by realizing an *intra-company inter-plant integration* (Table 1) within one company. And the integration, according to what might be observed from the case, is done thanks to that very special kanban which is internal to the firm but external to each of the two plants it is connected. It consists in informing the supplying plants of the needs of the supplied plant and of the time the demands or requirements of the latter should be met by the former. Furthermore, it pulls parts from the supplying plant to the plant that will use them. That kanban linking two plants is clearly the tool that plans, coordinates, and manages the inter-plant logistics of materials and the related information flow of a company's internal SC.

It is in fact a withdrawal kanban. Due to the fact it links a pair of SC stages

Figure 3: Integration by supplier kanban of supplier plant and the customer plant of the same company



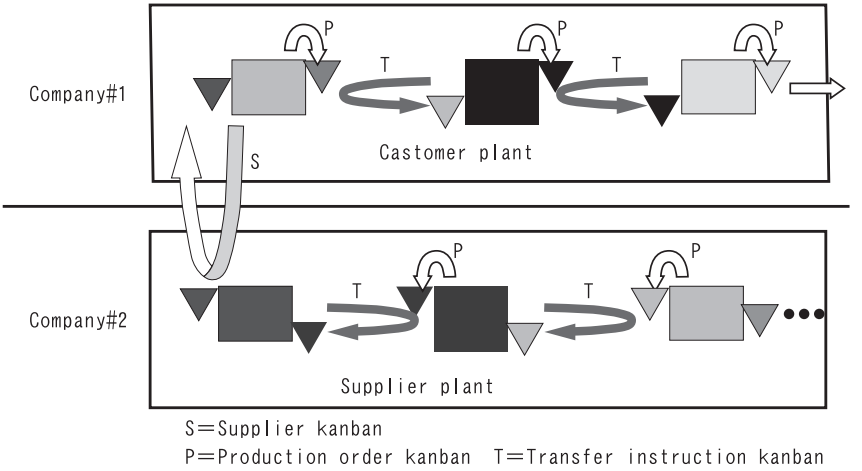
and authorizes the flow of materials and information between two plants in the "supplying and being supplied" relationship, it is usually known as a supplier kanban. For just the sake of concept clarity, such a kanban is tentatively referred to here as an intra-company inter-plant kanban or intra-company supplier kanban. The implementation of this kanban system represents the integration of plants or production units of the same company that are geographically not located at the same place. The use of the expression intra-company or in-company inter-plant kanban seems useful in order to make it clear that the two stages of the SC belong to the same company. The integration by the kanban system means that the pair of internal stages have achieved an internal integration of their processes, i.e., their process are linked and materials are pulled by processes of the downstream stage and not pushed by the upstream stage.

Lesson 3: Inter-company inter-plant integration

Once the kanban system as a SC production and information system linking intra- and inter-plant processes within the pivotal stage of the SC has been realized, one can consider extending it to other suppliers, especially to skeptical suppliers, that do not belong to the manufacturer's company or group.

In order to convince suppliers of the necessity of switching to the JIT system, the most convincing argument would be to get their top management tour the manufacturer's parts plant and assembly line.

Figure 4: Integration by supplier kanban of supplier plant and the customer plant belonging each to a different company



The manufacturer must then assist the supplier in its effort to implement the system. He must sustain that effort by transferring the JIT knowledge, by providing "hands-on-machine" guidance, by training the personnel of his supplier, etc. Employees of the supplier may undergo some training at their own plant or they might be dispatched to the manufacturer's plant to learn by practice and observation how JIT works.[9] This is not a pure academic conjecture. In fact,

[9] According to Mr Funai, the founder of Funai company, the latter dispatched in the 1970s 100employees to go and learn TPS at the Toyota site for three months.

Honda of America (Liker & Wu: Fall 2000) and Honda of China dispatched a team of its knowledge employees to assist its American and Chinese suppliers respectively improve their manufacturing and management capabilities in order to strengthen its SC.[10] Toyota did it in Japan and in the USA (Liker & Wu: Fall 2000). The manufacturer should offer such assistance as an investment and should bear a substantial part of the expenses.

When the JIT system as a set of pure production techniques has become functional, the internal processes of the plant would need to be integrated thanks to the introduction of the dual kanban. As stated earlier (see lesson 2), the internal integration of processes takes place within a plant in the framework of one company. That is why it is called intra-company inter-plant integration.

This kind of integration is next followed by the synchronization of the outputs of the supplier so that they can timely be received as inputs by the manufacturer. The manufacturer and the supplier being distinct companies, the integration of the flow of materials is thus realized between two plants but at the inter-company level. It is the integration of two sets of processes belonging to two distinct plants. It is also the operations integration of two distinct companies. Therefore, it is an *inter-company inter-plant integration* (Table 1). At the operational level, the inter-company inter-plant process integration can be seen as a synchronization of the processes of the supplying plant and those supplied plant by the fact that they are being linked by a kanban system. It is of course a supplier kanban. it is an inter-process supplier kanban that links not only two different plants but also two different companies. It is an inter-company inter-plant kanban. As we have seen earlier, the supplier kanban is a logistics tool that controls the

[10] The case of Honda of China was reported by an MBA executive student of Euromed/Antai Business School, Shanghai during a class discussion. The student works for Honda of China.

Table 1: Types of integration kanban

	Intra-plant	Interplant
Intra- company	• Inter-process kanban or withdrawal kanban	Supplier kanban
	• Intra-process kanban or production（order）kanban	
Inter-company		Supplier kanban

flow of materials between two stages, i.e., supplier and manufacturer. But it is not a flow of materials and information confined within a single company. It is rather a coordinated inter-company logistics system.

The inter-plant integration consists in synchronizing the timing of the production outputs of the upstream stage with the timing of their being needed as inputs of the downstream stage. The results of such synchronization are the continuous flow between two plants.

It is worth remarking that, all the part making plants, whether they belong to the manufacturer or not, should be treated, as does Toyota, in the same manner in terms of the sharing of information, forecasting, the way of pulling materials by the manufacturer, etc. After all, they are all situated at the same level as first-tier suppliers and contribute directly to the ultimate process of value creation for the customer.

JIT/lean vs. SC structure?

JIT seems to emphasize the identification of different kinds of muda relating to the production activities and their thorough elimination. Lean approach seems to focus on the value creation and value stream. Yet, both JIT and lean systems are said to cover exactly the same semantic field and are considered 100% interchangeable.[11] As a matter of fact, in order to increase the productivity of value

[11] I don't 100% agree with this viewpoint.

creating activities, it is necessary to eliminate the muda.[12] On the other hand, the muda elimination results in lean operations.

But the approach to dealing with the seven muda identified by the JIT and the focus on their elimination lead very often to losing sight of the importance of SC management.

Many look at Toyota only as though it makes 100％ of what it produces! And by introducing the JIT production methods, they think to be as strong as Toyota. One should however understand that what is strong is not only Toyota, but also the Toyota SC which is very efficient and very responsive. Lean value creation is a result of the value creation stream chain and not only an output of a single company's production operations system.

Certain Western companies, with a lot of fanfare, reportedly switched successfully to JIT. Unfortunately, either they did not involve their suppliers or their suppliers did not, even did not care doing so. As a result, we can see that even when Toyota was only number 3 or 4, it was making more profit[13] than the combined profits of its American competitors no 4, 2 and 1. Toyota produces more and more with less and less (operations and resources).

To ensure that a SC structure is supported by the JIT system, one has to check whether there are or there are not symptoms of bullwhip effect (see Lee et al. : 1997; Lee et al. 1992).[14] If there is for instance a significant uneven level of inventories within the supply chain stages, i.e. few inventories at the assembler and piles of inventories at the preceding upstream stage, it would mean that there is no JIT system spanning the whole SC or the value streams.

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[12] Mada are operations that do not create value, that do not add value to the object of production or any waste production.

[13] In 2003, Toyota's profit was larger the combined profits of GM, Ford and Daimler Chrysler.

[14] It is important to pay attention to the bullwhip effects by trying to detect them in any SC.

If the supplier uses a tank of inventories to supply parts from stocks, leaving thus the impression of being switched to the JIT production since he would respond quickly to the customer's demand, by examining his volume of inventory, one would tell that there is a bullwhip effect in the SC and that the JIT deliveries are just illusion. They are, in fact, what some specialists have called the just in case deliveries.

The formidable competitive power of the Japanese manufacturing companies has rightly been recognized as resulting from strong ties of the vertical organization of suppliers (Sakai: 1990) and manufacturers (SC) on the one hand, and on the other, from their efficient JIT production methods (Ohno: 1978; Shingo: 1981, 1988; Schonberger: 1982, 1986; Sakai: 1990).

Alternative/successive vs. synergetic use of manufacturing strategic weapons

A historical approach to competitive manufacturing strategic weapons of typical western companies reveals the following patterns. First, in order to compete against the Japanese firms, they introduced the JIT system in the 1980s (JIT, TQM fashion wave). Then, some replaced the JIT by lean methods at the beginning 1990s, since JIT successes was not sustained. Anyway this shows the level of misunderstanding the same system that uses two different names. At the same time, some others switched to restructuring methods disguised as reengineering with its negative effect on the moral of the workforce. At last, since the 1990s they decided to build their competitive strengths by building and developing their supply chain at the expense of the JIT production (Table 2).

As one can see, the chronological alternative use of the different manufacturing strategies has made Western companies weak relatively to its Japanese competitors. Toyota for example uses the JIT/lean productions methods as well

Table 2: Manufacturing competitive strategies: Japanese vs. Western competitor

	Japanese company	Typical western competitor
1980s	• At the plant level (independent stage of SC) : process integration and continuous flow thanks to JIT • At inter-plants level: Continuous and synchronized flow between different plants of the same (intra-company level) company or different companies (inter-company level) as stages the SC • Strong and lean SC	• JIT introduction at SC central stage (the manufacturer) • No organized SC
1990s		• JIT replaced by reengineering or revived as lean methods because JIT results not sustained • No organized SC
1995-		• Organization and development of SC structure at the expense of JIT (forgotten or abandoned) & reengineering (matter of the past)

as all its suppliers' SC synergy (Table 2). The group as a whole, as we have seen it, is linked from the logistical point of view by the same kanban system.

The alternative and successive adoption and use of the production strategy and methods on the one hand, and SC strategy on the other have resulted in a less competitive western company. Both the introduction of the JIT and its integrating function within the SC are not only overlooked but have never been paid any particular and sustained attention to. The competition that has been taking place in the global market for decades and that seems to be handing the victory to the Japanese companies is due to the fact that individual Western companies are not competing against individual Japanese firms, but against well organized and efficient SC whose members are very efficient, lean and "mudaless".

The quality of the created value and the cost of the end product are the result of a synergic collaboration and contribution of all the SC members in creating value, controlling both quality and cost throughout the whole SC. Introducing JIT alone is not enough. Organizing, developing and setting up the SC alone is not enough. Integrating JIT/kanban controlled processes within the plant, be-

tween the plants and between the companies, i.e., within the SC is what matters the most and can assure sustained success and competitiveness. Otherwise, one could get only limited successes.

Conclusion

After pointing to limited successes (historical facts) of JIT/lean methods implemented at a single company (especially in the West), the paper has examined the crucial role of the central stage of any supply chain when the latter has switched to the JIT methods. That role should consist in spreading the JIT/lean methods through the entire supply chain.

The development and introduction of the JIT/Lean methods at Toyota, then at its suppliers and their complete integration have been then analyzed and presented as the model case. It appears that competing against a Japanese JIT/lean organization belonging to an integrated lean supply chain is the same as competing against, not a single company, but against the whole supply chain through which the value for the customer is created.

JIT can, for sure, be thought of as a set of operations techniques and a manufacturing strategy. It is an integrating tool for intra-plant and extra-plant processes.

Furthermore, it is a SC strategy that should be in line with strategies of the different stages of the SC. It is a production information that should be shared by all the elements of the SC. It should be considered as a value creating tool not only at one stage (be it the pivotal one!), but through the entire value stream chain.

As such, it is a formidable competitive weapon that should be used by all the members of the SC. It is a logistics system that creates the time and place values. It is a tool that makes a SC and its stages lean. It is a tool that aims at the

perfection thanks to its kaizen concept. It is the ideal tool for integrating manufacturing operations and the logistics system resulting in an efficient and responsive SC. And Toyota has proved that successes of an integrated lean supply chain are not ephemeral; they can be sustained for decades!

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