

JIT PRODUCTION BY SMALL MANUFACTURING FIRMS IN CHINA: AN EXPLORATORY STUDY

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ABSTRACT

Recently Just-In-Time (JIT) production has attracted increasing interest throughout the Chinese manufacturing industries and its programs have been widely implemented. Currently, there are few studies conducted about JIT manufacturing implemented by small manufacturing firms in China, even though small firms are still dominant in many areas of manufacturing industries in China. This study analyzes survey results of Chinese small manufacturing firms to investigate the present status of JIT manufacturing and its development and perception among them.

INTRODUCTION

Recently JIT production has attracted increasing interest among Chinese manufacturing industries and its techniques have been widely implemented in China. Several studies (Lee and Yu 1997; Lee and Zhou 2000; Pheng and Min 2005) have examined the applicability of JIT techniques to Chinese industries, however, they focused on large manufacturing firms. Little research has been conducted about JIT implementation by small manufacturing firms in China, even though small firms are still dominant in China. Since small businesses are practically very different from large ones in many respects, the studies on large firms cannot be used directly to assess JIT practices in small firms. Moreover, since most Chinese firms are small in size and lag far behind most of foreign competitors in international markets, the motivation for adopting JIT by Chinese small firms is strong. This study analyzes survey results of Chinese small manufacturing firms to examine the present status of JIT and its development and perception among them. Although the U. S. Small Business Administration (SBA) defines a manufacturing firm with fewer than 500 employees as a small firm (Lee 1996), this study considers firms to be small size if they employ less than 300 workers. This definition of Chinese business size is due to Lee (1997).

APPLICABILITY OF JIT TO SMALL MANUFACTURERS

Various studies (Bartezzaghi, Turco, and Spina 1992; Chen 1991; Freeland 1991; Gilbert 1990; Keller, Fouad, and Kara-Zaitri 1991; Lee 1993; Lee and Ebrahimpour 1985; Perona, Spina, and Turco 1991) show that JIT has been implemented most successfully in large repetitive manufacturing firms. However, this does not mean that the application of JIT should be limited to these industries or to large manufacturing firms. Rather, according to some studies (Golhar, Stam, and Smith 1990; Lee 1996, 1997, 2000), size and type of manufacturing pose no particular obstacle to implementing JIT. Actually, there are several articles published on the applicability of JIT and its practices in small firms (Golhar, Stam, and Smith 1990; Lee 1996, 1997, 2000; Sohal and Naylor 1992). Most of these studies focus on whether or not the JIT can be applied to the U.S., Japanese, or Korean small firms, with little thought being given to their applicability to small manufacturing firms in the less developed countries, such as China.

Small firms are very different from large ones in many areas, such as management style, production processes, available capital, purchasing practices, inventory systems, and negotiating power (Lee 1996). However, some studies (Golhar, Stam, and Smith 1990; Lee 1996, 1997, 2000; Sohal 1992) suggest application of JIT to small firms by identifying more attractive conditions in small firms than in large ones for JIT implementation. Some of

the JIT elements appear to be compatible with small manufacturers although JIT implementation has been focused on large manufacturing firms. Some JIT benefits may be relatively more significant for small manufacturing firms. In addition, they indicated that most small manufacturing firms are attractive for applying JIT because of certain basic features of JIT such as its simplicity and no heavy capital investment required. Actually, many small firms all over the world have already implemented JIT (Golhar, Stam, and Smith 1990; Lee 1996, 1997, 2000; Sohal and Naylor 1992).

RESEARCH OBJECTIVES AND METHODOLOGY

The objectives of this study are: (1) to discuss how JIT was introduced to the Chinese small manufacturers and how it was perceived; (2) to determine the present status of JIT and its development among Chinese small manufacturers; and (3) to assess its implementation by them. It also attempts to bring together the findings from the field study and reports on the Chinese small manufacturing industry in conjunction with JIT and its implementation.

A survey questionnaire was developed with four parts: (1) company's demographic information; (2) company's manufacturing system; (3) company's experience with JIT techniques; and (4) company's inventory management profile. It consisted of 30 questions each with five answers. After a pretest and a pilot study, the questionnaire was mailed to 500 small manufacturers in China, 112 were returned; the response rate was 22.4 percent. Given that the subjects were required to answer 30 questions, covering both manufacturing and materials aspects, and that many Chinese firms declined to participate in this study citing company policy against such involvement, the 22.4% response rate (112 out of 500) should be regarded as satisfactory. Samples were fairly well distributed across a wide spectrum of firms from food processing firms to computer-equipment manufacturers. Overall, it does not seem that the sample data were significantly biased by a specific type of industry.

After the mail survey, several field trips were made to gather more comprehensive data directly from top executives and managers in Chinese small manufacturing firms who have hands-on experience of JIT implementation. Ten small manufacturing firms from different industries were selected for the on-site visits. Each visit lasted an average of three days. The on-site visits consisted of in-depth personal observations and interviews with plant managers, quality control managers, manufacturing managers, material managers, and top executives including presidents and vice presidents.

RELATIONSHIP BETWEEN JIT AND TYPE/SIZE OF FIRMS

The survey data shows that Chinese small manufacturers who were affiliated with foreign firms technically or financially are well ahead of most of local firms in the development of JIT systems. They indicated that they had learned JIT from their foreign partners. Specifically, all fifteen firms in the category of more than 5 years of JIT implementation in TABLE 3 are either a joint venture or a subsidiary of multinational corporations. If a firm has a more close relationship with foreign firms financially or technically, it tends to have longer JIT experience. However, the size of firm has no significant relationship with JIT experience among the responding firms, which have all fewer than 300 employees. All twenty four automobile-parts manufacturing firms in the data (TABLE 1) have collaborative agreements with foreign partners. They were all well aware of JIT techniques, and are busy in implementing them.

TABLE 1: Demographic Characteristics of Sample Firms

Types of Firms	Frequency	Percentage
joint ventures	49	(43.75%)

subsidiaries of multinational firms	38	(33.93%)
local firms	25	(22.32%)
total	112	(100%)

Types of Products

electrical and electronics	38	(33.92%)
machinery	25	(22.32%)
automobile parts	24	(21.43%)
instruments and related products	17	(15.18%)
food processing	6	(5.36%)
others	2	(1.79%)
total	112	(100%)

Sizes of Firms (in the number of employees)

less than 50	7	(6.25%)
50 - 99	19	(16.96%)
100 - 199	45	(40.18%)
200 - 299	41	(36.61%)
total	112	(100%)

RELATIONSHIP BETWEEN JIT AND MANUFACTURING SYSTEM

Chinese small manufacturers well implement JIT regardless of manufacturing process, either repetitive or job shop production (TABLE 2). It does not pose any particular problems in applying JIT techniques to all different manufacturing systems. Rather, the real obstacle is the size of manufacturing operations. During the field trips, many managers from all different manufacturers indicated that they faced size-related difficulties in implementing JIT techniques. It is desirable for them to try to improve internal conditions, which are not highly related with the size of operations, to obtain JIT benefits more effectively.

TABLE 2: Manufacturing Profile of Sample Firms

Types of Manufacturing Process	Frequency	Percentage
repetitive production	43	(38.39%)
batch production	38	(33.93%)
job shop (process type) production	19	(16.96%)
flow process production	9	(8.04%)
others	3	(2.68%)
total	112	(100%)

Top Priority of Manufacturing Competitiveness

low cost	54	(48.21%)
good quality	49	(43.75%)
on-time delivery	6	(5.36%)
high output	3	(2.68%)

total	112	(100%)
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Most Critical Competitive Advantage over Competitors

lower total cost	69	(61.61%)
higher quality product	37	(33.03%)
shorter delivery time	6	(5.36%)
total	112	(100%)

All responding firms had a high expectation of the JIT benefits: reduced cost, improved quality, high output, and on-time delivery, etc. Among those benefits, 48.21% of responding firms (54 out of 112) gave the top priority to "low cost", rather than to "good quality", which got 43.75%. On-time delivery and "High output" are followed with 5.36% and 2.68%, respectively. This result can be used to explain why Chinese small manufacturing firms adopt JIT techniques. To Chinese small manufacturing industries, cost is still the most important concern in competitiveness priority. It is also evidenced by TABLE 2 indicating that 61.61% of responding firms regard lower cost as the most critical competitive advantage over competitors. Therefore it is not surprising that many Chinese small manufacturers adopt JIT as a cost-saving tool rather than a quality-improving tool.

CHINESE SMALL MANUFACTURERS' PERCEPTION OF JIT

The survey found that 50.89% of the responding firms (57 out of 112) regarded JIT as an inventory reduction tool (TABLE 3). Chinese small manufacturers, knowing that raw material costs constitute high percentages of the total cost, as shown in TABLE 4, would be unlikely to underrate the importance of saving costs through better inventory management. This perception is common even among the U.S. manufacturers.

TABLE 3: JIT Profile of Sample Firms

Major Sources of JIT Knowledge	Frequency	Percentage
affiliated foreign partners	75	(66.96%)
foreign journals/conferences	16	(14.29%)
friends/business contacts	14	(12.50%)
domestic journals/conferences	6	(5.36%)
others	1	(0.89%)
total	112	(100%)

Initiator of JIT

top management	73	(65.18%)
line manager	19	(16.96%)
staff	17	(15.18%)
employees	2	(1.79%)
others	1	(0.89%)
total	112	(100%)

Perception of JIT

an inventory reduction tool	57	(50.89%)
a production planning tool	34	(30.36%)
a supplier's performance evaluation program	11	(9.82%)
a manufacturing principle	10	(8.93%)
total	112	(100%)

Major Reasons for Adopting JIT

to improve long-term cost competitiveness	57	(50.89%)
to be a long-term quality leader	38	(33.93%)
to meet customer's demand	7	(6.25%)
to improve production operations	6	(5.36%)
others	4	(3.57%)
total	112	(100%)

Experience of JIT Implementation

less than 1 year	34	(30.36%)
1 - less than 2 years	34	(30.36%)
2 - 5 years	29	(25.89%)
more than 5 years	15	(13.39%)
total	112	(100%)

JIT Elements Used*

total quality control	68	(60.71%)
setup time reduction	61	(54.46%)
small lot size	47	(41.96%)
multifunction employees	45	(40.18%)
JIT purchasing	32	(28.57%)
total preventive maintenance	31	(27.68%)
group technology	29	(25.89%)
focused factory approach	25	(22.32%)
uniform workload	18	(16.07%)
kanban	13	(11.61%)

* Firms typically implements more than one JIT elements.

Most Significant Benefits from JIT Implementation

reduced waste/inventory thus cost competitive	55	(49.11%)
advanced warning of quality problems available	32	(28.57%)
ability to produce small batches economically	19	(16.96%)
a pull system ensuring on-time shipment	6	(5.36%)
total	112	(100%)

Sixteen firms out of 56 responding firms (30.36%) perceived JIT as a tool for production planning and control. As a result, many interviewees commented that it would be hard for them who perceive JIT as another production planning tool to justify implementing JIT when their firms use MRP II, a computerized production planning and control tool.

Since successful JIT production depends largely on assembling a few cooperative and reliable suppliers, manufacturers implementing JIT tend to make vigorous assessment of potential suppliers. Thus it is to be expected that manufacturers perceived JIT as a suppliers' performance evaluation program. Actually, eleven out of 112 responding firms (9.82%) have this perception of JIT.

TABLE 4: Inventory Management Profile of Sample Firms

Ratio of Raw Material Cost to Total Cost	Frequency	Percentage
less than 50%	15	(13.39%)
50 – 59.99%	48	(42.86%)
60 - 70%	36	(32.14%)
more than 70%	13	(11.61%)
total	112	(100%)
Inventory Turnover in 2000		
less than 2.0	24	(21.43%)
2.0 – 4.99	33	(29.46%)
5.0 - 10.0	45	(40.18%)
more than 10.0	10	(8.93%)
total	112	(100%)
Suppliers' Delivery Performance		
More than 95% on time	39	(34.82%)
90 – 94.99% on time	27	(24.11%)
80 – 89.99% on time	28	(25.00%)
less than 80% on time	18	(16.07%)
total	112	(100%)
Production Stoppages due to Supplier Late Delivery		
More than 90% of the time	22	(19.64%)
50 – 89.99% of the time	15	(13.39%)
30 – 49.99% of the time	20	(17.86%)
less than 30% of the time	55	(49.11%)
total	112	(100%)

The survey also indicated that 8.93% of respondents considered JIT to be a manufacturing principle and not as a form of quality improvement or inventory reduction program. This perception is quite common among those who know a little about JIT because JIT production does require a collection of manufacturing principles, techniques and systems to make it work (Chen 1991). Those who said they knew JIT was a manufacturing principle came from firms of different sizes, job disciplines and ownership categories. There was no marked agreement in their responses as to materials management and manufacturing systems profiles. This might suggest that each respondent had a somewhat different perception of JIT.

The positive side of these perceptions is that the respondents understood that going into JIT requires a commitment to substantial changes of existing manufacturing practices and procedures. They would not

underestimate the significant changes and the corresponding impacts that implementation would entail. Despite the varying perceptions of JIT, it is concluded that JIT is well received by all respondents.

JIT DEVELOPMENT AND IMPLEMENTATION IN CHINESE SMALL MANUFACTURERS

More than half of responding firms, 75 out of 112 (66.96%), indicated that the major source of JIT knowledge is affiliated foreign partners. Also more firms learned JIT from foreign journals or conferences than from local journals or conferences. The local academic and professional institutions have not taken as strong a leading role in JIT development as they should have. This is supported by TABLE 3 showing that only 6.25% of the respondents learned about JIT development from local journals or conferences.

Almost two thirds of responding firms (75 out of 112, 66.96) indicated that the initiator of JIT in their organizations is top management. Nineteen out of 112 responding firms (16.96%) indicated a line manager as their initiator of JIT. This result makes sense because JIT philosophy requires changes in management thinking and attitudes. Every plan and action must be initiated and supported from the top, with full support at all managerial levels. Top management must be willing to make fundamental changes in the way it operates. At the early initial stage of JIT implementation, a top-down approach is necessary, especially in Chinese small firms where top management usually has the full ownership.

Most of the responding firms seemed to be relatively new to JIT practices. More than 60% of responding firms (68 out of 112) have started JIT implementation less than two years ago (TABLE 3). This may be a reason why many responding firms have little knowledge about JIT and its techniques (TABLE 5). They are still gaining experience of JIT implementation.

The most popular JIT element is total quality control (TQC). TQC has been implemented by 60.71% of responding firms (68 out of 112). Setup time reduction is the next most frequently used practice by 54.46% of responding firms (61 out of 112). This is a critical element of JIT that has been accomplished by many large firms. The same objective could be attained by many small manufacturers at little extra costs. As discussed earlier, small firms have more flexibility to produce in small lots just in time to meet demands. It is evidenced by the fact that 41.96% of responding firms (47 out of 112) adopted small lot size concept in their production.

The concept of cross-trained employees would appeal to small manufacturing firms more than to large ones. Many Chinese small firms, actually 40.18% of responding firms (45 out of 112), have already implemented this practice without knowledge of JIT. Employees in small firms should be multi-skilled workers. They should be able to move from machine to machine to perform a variety of tasks and jobs, since many small manufacturers do not have enough personnel to prevent lost production caused by absenteeism or turnover. JIT purchasing is another popular JIT element among small manufacturers since most small manufacturers usually don't have big size demand steadily. Actually, JIT purchasing is more critical to small firms than to large ones because high-level inventory of raw material is more serious in small manufacturers than in large ones. This is the fifth most popular JIT element among small manufacturing firms in China (32 out of 112, 28.57%).

Total preventive maintenance is another JIT element that can be applied to small firms as much as to large ones. More than 27% of responding firms (actually 27.68%, 31 out of 112) used this approach for their JIT programs. Also, it is not hard to find that quite a few small manufacturers adopted group technology (29 out of 112). They can adopt it without substantial difficulty because most small manufacturers have organized their shops on the basis of similarity of parts produced rather than on functions of machines. In general, the focused factory approach is adopted by many small manufacturers all over the world since most small manufacturers usually make either one or a few similar products (Lee 1996). More than 16% of the responding firms (18 out of 112) have been implementing this approach. Practically, the above-mentioned elements are all attainable by small manufacturers without a heavy cost. They are all basic elements for a JIT program that can be made by most manufacturing firms,

regardless of size.

Although kanban is a simple and visible tool of planning and controlling production, adopting a kanban system needs substantial changes in the manufacturing process because most small firms are still used to MRP-based system. This is a reason why only thirteen out of 112 responding firms implemented kanban in their manufacturing systems.

JIT BENEFITS IN CHINESE SMALL MANUFACTURERS

Small manufacturers can share with larger ones many of the JIT benefits, such as shorter set-up and lead times, reduced inventory, and higher quality and productivity. Actually, some of JIT benefits are relatively more significant for small firms: (1) less investment in inventory; (2) quality improvement; (3) shorter lead time and greater flexibility; (4) simpler manufacturing control; (5) a path to flexible automation; and (6) manufacturing excellence.

A majority of the respondents indicated JIT provided many benefits for their operations according to the survey. Reduced inventory is the most significant JIT benefit that has been indicated by 49.11% of responding firms (55 out of 112). Obviously work-in-process reduction can be obtained from the early stage of JIT implementation. The next most significant JIT benefit is quality improvement (32 out of 112, 28.57%). It resulted from the fact that many Chinese small firms adopted TQC as a part of their JIT programs (TABLE 3). The third benefit mentioned by responding firms is small lots production (19 out of 112). Small manufacturers have an inherent advantage over large firms in this area. Small firms usually have more flexibility to produce in small lots just in time to meet demands.

However, it is very hard for small Chinese manufacturing firms to expect benefits from the suppliers' delivery performance. This explains why many respondents stated that the successful JIT implementation is often impeded by the supplier's inability to deliver on time (TABLE 5).

TABLE 5: Impeding Factors for Successful JIT Implementation

poor supplier involvement	44	(39.29%)
lack of top management commitment	40	(35.71%)
lack of knowledge	36	(32.14%)
poor worker participation	32	(28.57%)
unstable demand	28	(25.00%)
long setup time	24	(21.43%)
inadequate process control techniques	20	(17.86%)

* Firms were typically asked to identify the two most impeding factors for successful JIT implementation.

JIT AND INVENTORY MANAGEMENT IN CHINESE SMALL MANUFACTURERS

This survey shows that many low-inventory-turnover firms have a much wider safety margin than is necessary to prevent production line stoppages caused by supplier's late deliveries. Almost 50% of respondents (49.11%, 55 out of 112) stated that their lines have to be stopped only less than 30% of the time when suppliers deliver late (TABLE 4).

During field trips, it was found that even though those who regard JIT production as one in which manufacturers leave the necessary inventory to the suppliers have a misconception about JIT, they still perceive that JIT is a progressive inventory reduction program.

Chinese small manufacturing firms can save inventory-carrying cost from improvement in inventory turnover rate (TABLE 4). More extensive use of JIT elements can provide such tangible savings more. Because any savings go directly into the firm's profit, Chinese small manufacturers' implementation of inventory reduction program is of the utmost importance.

IMPEDING FACTORS IN JIT IMPLEMENTATION BY CHINESE SMALL MANUFACTURERS

There are some factors impeding JIT implementation in Chinese small manufacturing firms, even though the pressure for implementation of JIT is increased. TABLE 5 shows that almost 40% of responding firms indicated that the most significant impeding factor in JIT implementation is "poor supplier involvement". This is obviously true since most small firms don't have enough buying power to attain suppliers' full commitment in their JIT implementation, unlike large firms. It is one of disadvantages small firms inherently have against large firms.

The next impeding factor many responding firms (35.71%, 40 out of 112) indicated is "lack of top management commitment" even though 65.18% of responding firms (TABLE 3) indicated that the initiator of JIT in their organizations is top management. Many line managers indicated that top management in Chinese small firms is usually reluctant to make changes in production systems. They are worried about decreasing productivity resulting from the changes.

The next most frequently mentioned impeding factor is "lack of knowledge" with 32.14% of the respondents. With the current lack of direct teaching of the JIT techniques through local professional and academic institutions and of sharing of implementation experience among practitioners, prospects are dim for the full-scale development of JIT. Lack of leadership from these institutions must be remedied immediately to properly equip Chinese small manufacturing firms "just in time" to survive in the competitive global market.

The success of JIT implementation depends heavily on employee participation regardless of size, product type, and location (Lee 1996). This is a reason why employee training/education programs are essential components of any JIT program. Thirty two out of 112 responding firms (28.57%) stated that the impediment to the successful JIT implementation is due to poor worker participation.

JIT implementation should start with work-in-process reduction in a manufacturer's controllable environment. However, unstable demand creates a negative environment in work-in-process reduction with the suppliers' poor delivery performance. Unfortunately, most small manufacturing firms can't solve those problems because those problems are beyond their control. This explains why 28.00% of the respondents (TABLE 5) stated that a successful JIT implementation is often impeded by unstable demand.

CONCLUSIONS

Many Chinese small manufacturing firms face size-related difficulties in implementing JIT. The lack of bargaining power with suppliers and lack of capital are major hindrances encountered by Chinese small firms when implementing JIT. As a result, they focus on internal changes to improve quality, inventory reduction and increasing employee participation. Chinese small firms can achieve these goals by implementing only feasible elements of JIT without too much capital investment. This is a reason why many Chinese small manufacturing firms should consider JIT systems.

A realistic approach for the small manufacturer may be to strive to attain feasible elements one at a time, simply for the benefits of that particular element, and not to implement a total JIT system all at once. For the small manufacturer, individual elements of a JIT system are important and can be extremely beneficial, whether or not a comprehensive total JIT system is implemented. Taken one at a time, these components would be beneficial in virtually any type of manufacturing environment, not just in a repetitive environment. An "all or nothing" approach

to JIT is not the best plan for the small manufacturer. The individual components can provide benefits and should not be dismissed because a total JIT system is not feasible. Also, Chinese small firms should be patient to see tangible benefit and advantages from JIT implementation. The survey shows that almost two thirds of responding firms have less than 2 year experience of JIT implementation. This lack of Chinese small firms' JIT experience data might be another reason why many Chinese small firms are not confident of the success of JIT implementation in their shops.

Although Chinese small manufacturing firms have some obstacles, they can be successful at least in the production and the customer-service function areas by implementing only the related JIT elements. The adoption of JIT philosophy does not require spending large amounts of money. Many important benefits can be expected from the implementation of a simple and inexpensive procedure: rearrangement of tools in the workplace; use of the kanban that doesn't require computerized systems; and participation of workers. These outcomes can be achieved without undue cost by Chinese small firms.

The benefits of JIT implementation for Chinese small manufacturing firms are very simple - the business will be more profitable. Improved quality, reduced rejects and rework, and reduced inventory levels will all lead to lower costs and more effective use of capital, which are needed for Chinese small firms to survive in very competitive global markets. Adoption of JIT can help Chinese small manufacturers to achieve competitive advantages both in domestic markets and international markets.

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