


Do Modern Japanese Inventory Methods Apply To Hong Kong?

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Abstract

The ability to achieve higher standards of productivity without sacrificing quality is an important goal of a manufacturing firm. A primary reason offered to explain Japanese firms' successes has been the dominant role of the use of the Just-In-Time (JIT) operational philosophy (Mehra & Inman, 1992). If successfully implemented, JIT reduces inventory and ultimately results in reduction in manufacturing costs along with improvement in profitability (James, 1994). There are three main manufacturing objectives for JIT (Suzaki, 1987). One is increasing the organization's ability to compete with rival firms and remain competitive over the long run. JIT allows companies to develop optimal processes for manufacturing their products. A second is increasing the degree of efficiency within the production process. JIT allows greater level of productivity and minimizes the associated costs of production. The third is reducing the level of wasted materials, time, and effort involved in the production process. Elimination of unnecessary waste can significantly reduce costs of production. Much of the literature concerned with the implementation of JIT deals specifically with elements that are crucial to successful implementation (Karen & Anthony, 1993). This study looked at three of those elements; namely, management commitment, JIT production strategy, and JIT vendor strategy. If these "critical" elements are not present, the potential level of JIT implementation may be low. The Hong Kong electronics/electrical manufacturing industry was chosen as the context for this study. A survey questionnaire based on the three main prerequisites of JIT implementation was developed and sent out in order to investigate whether JIT implementation could be carried out in Hong Kong. Both inferential analysis and descriptive analysis were used to interpret the results. The study found (1) No significant relationship existed between management commitment and the potential level of JIT implementation, and (2) A significant relationship did exist between JIT production strategy and JIT vendor strategy and the potential level of JIT implementation.

I. Introduction

 ver the past few decades, Japanese manufacturing methods such as Kaizen, total quality control (TQC), Six Sigma, and the just-in-time (JIT) system have assumed significant roles in international and U.S. manufacturing (Dertouzos, Lester & Solow, 1989; Hall, 1983; Hayes, Wheelwright & Clark, 1988; Schonberger, 1982). Much has been written by both academics and practitioners extolling the virtues of Japanese manufacturing practices (Hay, 1988; Schonberger, 1982; Susaki, 1985).

The ability to achieve higher standards of productivity without sacrificing quality is an important goal of a manufacturing firm. Consequently, Japanese success in producing high quality goods with lower prices has captured the attention of management around the world. A particularly dominant reason for the Japanese manufacturing success rests on the use of the JIT philosophy of operation (Mehra & Inman, 1992). If successfully implemented, JIT will reduce inventory and ultimately result in reductions in total manufacturing costs with corresponding improvements in profitability (James, 1994). Furthermore, JIT simplifies accounting paperwork by allowing for a back flush costing system. Black flush costing delays recording changes in the production process until finished good units appear. Then, it uses budgeted or standard costs to

work backward to assign manufacturing costs to units produced. Typically, no record of work in process appears in the accounting system, thus greatly reducing recording complexity (Charles, George & Srikant, 1994).

As with many countries, fierce competition – both domestic and offshore – confronts Hong Kong manufacturing companies. Among other factors, the 1997 Asian financial crisis led to deflated currencies in countries such as Thailand, Korea and Indonesia making their products and services relatively less costly than those in Hong Kong, since Hong Kong maintained its “peg to the US dollar.” Also, Hong Kong residents saw a loss in purchasing power. Hong Kong was no longer seen as a 'shopper's paradise'. In order to regain its competitive edge, some have argued that Hong Kong manufacturing companies should try to implement proven Japanese management systems. In short, Hong Kong firms should attempt to establish practical and flexible systems capable of multi-product and small lot production – in essence, JIT systems.

Much of the literature dealing with the implementation of JIT deals specifically with elements that are crucial to successful implementation (Karen & Anthony, 1993). In other words, if these so-called "critical" elements are not present, the potential level of JIT implementation may be low. In this project, these critical elements are used to investigate whether JIT could be carried out in the Hong Kong manufacturing sector.

II. Theory Development - Literature Review

The literature notes a lack of consensus concerning the interpretation and meaning of JIT implementation. The definition varies based on authors' backgrounds and different foci with regard to features (Narender, Satish & Mark, 1995). Notwithstanding such differences, JIT is basically a Japanese management philosophy applied to manufacturing based on planned elimination of all wasted resources and continuous improvement of productivity. The primary objectives involve having only the required minimum amount of top quality inventory in the proper place at the exact time when needed. This involves as seamless an integration as possible of all activities in all departments in all parts of the organization in order to maintain the flow of materials through the company. JIT is also referred to as stockless production, lean production (Womack, et. al., 1990), zero inventories, short cycle manufacturing (Kang, 1994) or continuous flow manufacturing (Voss, 1987).

JIT was first developed and perfected within the Japanese Toyota Motor Company by Taiichi Ohno as a means of meeting customer demands with minimum delays in the 1960s (Goddard, 1986). It has been widely reported that the proper use of JIT manufacturing has resulted in increases in quality, productivity and efficiency, improved communication and decreases in costs and wastes. In the case of Toyota, JIT has been in operation for over 25 years and is still being refined (Monden, 1983).

There are three main manufacturing objectives for JIT (Suzaki, 1987). These objectives are universal in nature, i.e. they can be applied and adapted to a diversity of organizations within industries that differ greatly from one another:

1. Increasing the organization's ability to compete with rival firms and remain competitive over the long run. JIT allows companies to develop an optimal process for manufacturing their products.
2. Increasing the degree of efficiency within the production process. JIT allows greater level of productivity and minimization of associated costs of production.
3. Reducing the level of wasted materials, time and effort involved in the production process. Elimination of unnecessary waste can significantly reduce costs of production.

The hoped-for benefits of JIT implementation reported by Ramsay, Sohal and Samson, 1990, and further depicted in Figure 1, include:

1. Reduction of raw materials, work in process and finished goods inventory.
2. Reduction of throughput time
3. Reduction of waste and rework

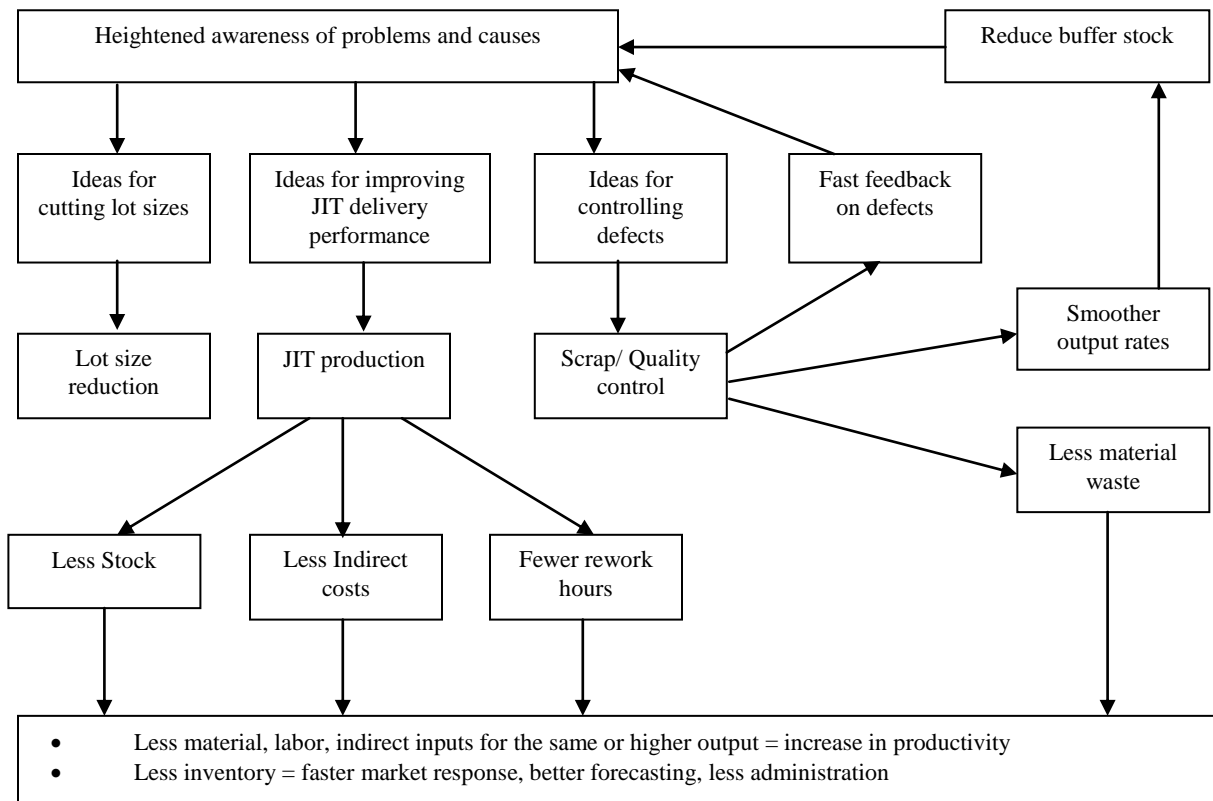
4. Reduction of materials handling costs
5. Labor productivity improvement
6. Product quality improvement

III. Obstacles Of JIT Implementation

While JIT has its benefits, implementers and experts have noted the following obstacles to JIT implementation (Cheung, 1993):

1. Having inadequate time to do the tasks along with other tasks. JIT is an ongoing improvement process, time management plays an important role here.
2. New management role. Managers resist giving up control in terms of allowing decision making to flow downward to the workers and then providing support for what gets decided.
3. Fear of reprisal. For centuries the workers have been told what to do by their superiors. The JIT process requires workers to make many of the same decisions the managers would have made. The first time a mistake is made the manager must not censure the workers, as this may cause them to retract from the whole process.
4. Inaccurate planning data, inconsistent management support, excessive demands on workers' skills, little positive feedback and poor recognition for what employees have already accomplished.

Figure 1 depicts numerous benefits of using JIT



In 1992, Mehra and Inman proposed a model based on 19 elements. They grouped the elements into four key factors by using factor analysis, a statistical data-reduction technique to condense available data into a smaller set of information categories based on underlying similarities in the data:

1. Management commitment
2. JIT production strategy
3. JIT vendor strategy
4. JIT education strategy

Table 1 denotes the 4 key factors along with their corresponding elements.

Table 1: Hierarchical Structure of JIT Elements

Factor	Elements
Management Commitment	<ul style="list-style-type: none"> - Means for listening - Investigate suggestions - Authority to halt production - Quality circles
JIT production strategy	<ul style="list-style-type: none"> - Set-up time - Group technology - Cross training employees - Preventive maintenance - In house lot sizes
JIT vendor strategy	<ul style="list-style-type: none"> - Vendor lot size - Sole sourcing - Vendor lead time - Quality certification of suppliers
JIT education strategy	<ul style="list-style-type: none"> - Pilot project - JIT team - Outside consultant - JIT champion - Vision of future - Management education

Management commitment is a group of implementation elements related to communication and decisions about JIT. JIT production strategy is a group of implementation elements that are directly related to the production area or the transformation process. It strives to achieve excellence in manufacturing by reducing set up times and in-house lot sizes through the use of group technology and sound preventive maintenance. Likewise, JIT vendor strategy is a group of implementation elements that are directly related to the procurement process. It yields higher levels of productivity and quality by minimizing vendor lot sizes and their lead time through the use of single sourcing and quality certification of suppliers. JIT education strategy is a group of implementation elements related to the transfer of knowledge regarding JIT (Mehra & Inman, 1992).

This project focused only on management commitment, JIT production strategy and JIT vendor strategy as prerequisites of JIT implementation. JIT education strategy relates to how to educate employees and management to initiate JIT implementation. Given time and feasibility considerations with regard to how to operationalize Education Strategy, it was not addressed directly in this research. The three remaining factors led to the following hypotheses.

- H₁:** Management involvement is significantly related to the potential level of JIT Implementation
- H₂:** A JIT production strategy is significantly related to the potential level of JIT Implementation
- H₃:** A JIT vendor strategy is significantly related to the potential level of JIT Implementation

IV. Research Methodology

The research design employed in this study was a cross-sectional survey. Data were collected from electronics/electrical (repetitive) manufacturing companies in Hong Kong. A total of 124 questionnaires and accompanying cover letters were mailed and faxed to the production / plant / purchasing manager of the companies. The managers were requested to complete and return the questionnaires in a stamped, self-addressed envelope, or by facsimile. The fax number and address of each company was selected randomly from Hong Kong Directories.

A survey was assembled using questionnaires that were developed and modified based on The Just-In-Time Self Test: Success Through Assessment and Implementation, by Dennis Fisher, 1995. The three-page questionnaire instrument (see Appendix A) constituted the primary data source. Respondents were asked to evaluate each item with respect to how well it possessed JIT critical elements on a 5-point Likert-type scale ranging from 5, "Strongly Agree", to 1, "Strongly Disagree".

Electronics or electrical manufacturers were chosen for this research since repetitive manufacturers have the relatively greatest potential to implement JIT. Returns were screened to include only those companies employing more than one hundred people. Only medium or large firms were used because they have relatively enough resources for investment in a new JIT system.

A total of 25 usable questionnaires were received, representing a 20.16 % (25 usable / 124 deliveries) response rate. The 20% response rate was thought to be adequate for the objectives of the study as it was exploratory in nature.

Multiple linear regressions in the Statistical Package for the Social Sciences (SPSS) were used to examine and test the relationship between the three proposed factors (independent variables) and the potential level of JIT implementation (single dependent variable). Table 2 shows the results.

Table 2: Summarized Regression results for JIT implementation elements regressed on the potential level of implementation

Multiple R	.73533				
R Square	.54071				
Adjusted R Square	.47510				
Signif F =	.0008				
Variables in the Equation					
Variable	B	SE B	Beta	T	Sig T
MANAGEME	-.126316	185208	-.150424	-.6820	.5027
PRODUCTI	.438342	149385	.589130	2.934	.0079
VENDOR	.346260	165421	.385651	2.093	.0487
(Constant)	-1.763065	448432		-3.932	.0008

The resulting regression equation for data shown in Table 2 is noted immediately below:

$$\text{Potential Level of JIT Implementation} = (- 1.76) + (- 0.13) \text{ Management Commitment} + (0.44) \text{ JIT Production Strategy} + (0.35) \text{ JIT Vendor Strategy}$$

The output shown in Table 2 indicates that management commitment at a significance level of 0.5027 is not significant and thus hypothesis 1 ($p > 0.05$) is rejected. This research showed no statistically significant relationship between management commitment and the potential level of JIT implementation in the Hong Kong firms reporting.

On the other hand, the significance levels for JIT production strategy and JIT vendor strategy at 0.0079 and 0.0487 respectively were significant. As a result, hypotheses 2 and 3 ($p < 0.05$) were not rejected. Thus, for the firms involved in this study, statistically significant relationships did exist for JIT production strategy and JIT vendor strategy with respect to the potential level of JIT implementation.

The R-Square for the regression equation as a whole approximated 54% of the variability in the potential level of JIT implementation and can be explained by management commitment, JIT production strategy and JIT vendor strategy.

V. Discussion

Management Commitment

With respect to Hypothesis 1, no significant relationship was found between management commitment and the potential level of JIT implementation. Possible explanations for such findings are analyzed by examining the elements of Management Commitment as noted in Table 3.

Table 3: The average score of elements in management commitment

Management commitment		Mean score
(i)	Means for listening	3.08
(ii)	Investigate suggestions	3.32
(iii)	Capacity planning	3.68
(iv)	Authority to halt production	1.24
(v)	Quality circles	3.48

Scale: 1 = strongly disagree, 5 = strongly agree

(i & ii) Means for Listening and Investigate Suggestions

JIT requires bottom-up communication as employee involvement in any new system at the earliest stages will reduce the possibility of resistance. If immediate feedback along with “openness” to criticism is provided from higher-level management, employees will be willing to give comments and pinpoint mistakes about the day-to-day operation. As a result, if any problem exists, it can then be surfaced and tackled promptly. Moreover, feedback provides employees with knowledge of their performance and allows to make adjustment if necessary. As shown in Table 3, the somewhat favorable responses to means of listening and investigation of suggestion indicates that management has probably at least tried to listen and encourage suggestions.

(iii) Capacity Planning

One primary technical reason for JIT system failure has to do with inaccurate records. Such inaccuracy, for instance, can mean that parts will not show up in the right place at the right time if there are errors in the inventory records. If top management continuously monitors the accuracy of inventory, shortages become highly visible (Dennis, et. al., 1995). The favorable response shows that top management has tried to participate in and commit to a realistic capacity planning.

(iv) Authority to Halt Production

In JIT operations, each worker is responsible for product quality in his/her work section. If a worker finds nonconforming parts or a defective process, he/she has the authority to shut down the line until the problem is resolved (Dennis, et. al., 1995). The unfavorable result derived from this research regarding this element implies that management of the Hong Kong firms involved in this study exert absolute control over the working environment. They resist delegating authority to workers to halt production even if defective processes occur.

(v) Quality Circles

Quality circles are small groups of people who meet regularly for the purpose of uncovering and solving problems concerning the quality of items produced, process capability or process control (Ross & Ross, 1982). They are not usually given the authority to implement their problem solutions; they just develop a set of recommendations for a final decision by the managers. The favorable response from this survey shows that department or team-solving problem groups in most Hong Kong electronics/electrical manufacturing companies will meet regularly to identify, analyze and solve product-quality issues. The costs of quality such as prevention, appraisal and failure costs may then be lower because of proper quality control. If defect-free parts from the supplier can be delivered directly to production plants, inspection costs will become lower.

Management commitment should be a critical factor to JIT implementation. The insignificant management commitment statistical result found here seems to fall in line with previous research noting less than successful implementations of JIT. If management does not commit with respect to the elements, then the JIT implementation will fail. Specifically, a possible reason surfaced from this research for the insignificant result is that Hong Kong managers are not willing to commit to JIT particularly with regard to the element of “authority to halt production”. This would go a long way to explain the low potential level of JIT implementation in Hong Kong in general.

JIT Production Strategy

In this study, JIT production strategy and the potential level of JIT implementation were highly correlated with potential for JIT implementation. This implies that the potential level of JIT implementation may be highly sensitive to the critical elements in this prerequisite.

Table 4 depicts the means of JIT Production Strategy elements.

Table 4: The average score of elements in production strategy

JIT production strategy	Mean score
(i) Set-up time	2.24
(ii) Group technology	3.76
(iii) Cross-training employees	2.28
(iv) Preventive maintenance	2.93

Scale: 1 = strongly disagree, 5 = strongly agree

(i) Setup time

Setups are non value-adding activities, costly and potentially wasteful. The measurement of setup time is the time taken to change over a given piece of equipment from the last good part from the preceding batch to the first good production part from the succeeding batch. Time measures are not taken if the machines are idle (Dennis, et. al., 1995).

In a JIT system, a common approach for setup reduction is to do as much of the setup as possible while the machine is running. Internal setup refers to any activity that can only be done with machine shut down, while external setup refers to any element that can be done with the machine still running. The ideal goal of setup reduction is zero time, or at least it should be such a minimum time that it wouldn't hold up the flow of other parts through the cell. A setup that takes less than 10 minutes is usually a reasonable time (Dennis, et. al., 1995).

As seen in Table 4, the unfavorable response of set-up times shows that Hong Kong electronics/electrical manufacturers will have less flexibility for adapting to changes in the market because long set-up times will result in long production lead times.

On the other hand, the ultimate goal of JIT continuous improvement is to obtain a balanced set of equal cycle times throughout the entire manufacturing flow of a product. Cycle time is the time between completions of two consecutive parts from a process. If the cycle times are matched with their upstream and downstream lines, work processes are likely to see improved throughput. The improvement in a bottleneck is a direct improvement in throughput, (Dennis, et. al., 1995). When bottlenecks are reduced, daily rates and level schedules will more likely meet due-dates.

(ii) Group technology

Group technology means identifying the "sameness" of parts or processes. It groups parts into families that will process through manufacturing "cells" of groups of equipment that process similar family parts. By grouping all those parts that use the same type of machinery of assembly, it is much faster and easier to change schedules, setups, and raw materials to support customer needs. Manufacturing cells may be composed of a single machine, several machines, or several operators or assemblers using the same tools or equipment (Dennis, et. al., 1995). The favorable response of group technology techniques means that most of the respondents have high potential to reduce workspace demands and provide flexible changeovers.

(iii) Cross-training employees

Under JIT production, the plant layout is arranged for maximum worker flexibility. This type of layout requires the use of "multi-function workers". Workers should have skills necessary to perform many tasks rather than one or two highly specialized tasks (Dennis, et. al., 1995). The unfavorable response indicates that Hong Kong manufacturing workers tend to use highly specialized skills in order to produce a discrete part of the final product. They do not usually perform the tasks of other workers and tend to focus on maximization of output rather than quality because they view quality as an after-the-fact process of inspection. This is contrary to the JIT philosophy that quality is built in through production.

(iv) Preventive maintenance

Preventive maintenance is any action that will prevent machinery breakdown. It ensures the quality and reliability of the process and should be an ongoing and integral part of the workplace. Preventive maintenance is not solely the responsibility of one individual or maintenance department in a plant, rather the responsibility should be spread throughout the manufacturing organization. The organization should ensure that machines are capable of operating at all times within specified tolerances (Dennis, et. al., 1995).

In many manufacturing companies, machinery is generally used for multiple purposes. Sometimes with very costly machines, manufacturers cannot afford to idle the machines even when production orders from a main purchaser are not on hand. Hence, the unfavorable result indicates that cost of machine downtime may be high because of improper preventive maintenance. Downtime is the time from when the process went down until the time it is producing good parts.

On the other hand, workers usually are not free to focus on different tasks and lessen the load placed on equipment. Decreased availability of workers provides less time to participate in team problem solving and to engage in multi-task operations.

Noticeably, Hong Kong electronics/electrical manufacturers could make improvements regarding elements such as set-up time reduction, cross-training of workers and preventive maintenance for JIT implementation. If set-up times are reduced, that would allow for reduction in lead times and an increase in flexibility for line changes. In addition, since JIT requires no excess inventory, machinery should not be operating just to keep workers busy. Workers should be cross-trained in order to be flexible enough to move around to different jobs as needed.

JIT Vendor Strategy

It was revealed that the relationship between a JIT vendor strategy and the potential level of JIT implementation was statistically significant. This suggests that omission of some critical elements of JIT vendor strategy may lead to the low potential level of JIT implementation. The following discussion is an elaboration of elements of this prerequisite of JIT implementation. Table 5 reveals the results with respect to the elements of JIT Vendor Strategy

Table 5: The average score of elements in vendor strategy

JIT vendor strategy	Mean score
(i) Vendor lot sizes	2.44
(ii) Single sourcing	2.72
(iii) Vendor lead time	3.50
(iv) Quality certification of suppliers	2.32
(v) Buyer-supplier relationship	2.08

Scale: 1 = strongly disagree, 5 = strongly agree

(i) Vendor lot sizes

JIT manufacturing is the continuous flow of small lots of materials. As the lot sizes get smaller, it will lead to more efficient use of space, less material handling and greater visibility of problems. JIT demands that inventory be kept to a minimum (Dennis, et. al., 1995). Should manufacturers prefer to buy large quantities as safety stock, extra supply adds extra cost of quality and forces an operation to tie up capital that could be invested elsewhere.

Under JIT purchasing, consistent, daily, or weekly deliveries of small lots can save space, money and people to manage them. The unfavorable response shown in Table 5 implies that Hong Kong manufacturers tend to purchase materials in large quantities to avoid running out of stock and facing other disruptions. It may then be difficult to inspect the large lots and uncover any defect. The flexibility in meeting changes in demand decreases as well.

(ii) Single sourcing

The rule of geographical location of supply source is: the closer the better. If daily deliveries are needed, the freight issues are minimized when suppliers are local. The results show that suppliers of Hong Kong manufacturers are usually local.

Under JIT purchasing, buyers are encouraged to buy from a small number of suppliers, ideally one for each material or class of materials. Single sourcing means to utilize only one supplier of the available sources (The APICS Dictionary; Cox et. al., 1992). A company expects to give all of its business for a part or set parts. If single source suppliers get all of the volume, it should help generate better prices, more commitment and greater loyalty. This single source model also provides incentives for vendors to invest the time and resources needed to improve the products, process and reliability of delivery, and provides for a product with zero defects (Dennis, et. al., 1995).

Most Hong Kong manufacturers are reluctant to put all their eggs in a single basket. Although there is more than one supplier to choose from and the probability of getting one that would perform well is much greater, they will not just depend on single supplier for their materials.

(iii) Vendor lead time

A shorter supplier lead time means greater customer satisfaction. The favorable response indicates that reliable deliveries can be promised in Hong Kong due to geographical closeness to suppliers, particularly in mainland China. Supplier delivery lead-time is usually fast and reliable and is unlikely to suffer from wasteful delays and downtime.

(iv) Quality certification of suppliers

Supplier quality failure is the reason why receiving inspections exist. It must be recognized that JIT cannot succeed without high-quality incoming materials. The majority of incoming materials can simply bypass receiving inspection if the supplier is fully in line with the organization's quality philosophy and can deliver the required quality and quantity (Dennis, et. al., 1995). The unfavorable response shows that suppliers can neither guarantee good quality nor ensure delivery of defect-free products. The quality problem from suppliers may be eliminated if suppliers certified as ISO 9000 compliant are chosen.

(v) Buyer-supplier relationship

Most suppliers usually have in their schedules a large queue of orders received on a first-come, first-served basis. Although many manufacturers have not made long-term contract agreement with suppliers, their relationships are usually tight and close. Trusting relationships with just a few suppliers will assist in the creation of a more efficient company in terms of timeliness of deliveries.

As noted above, Hong Kong electronics / electrical manufacturers should put more emphasis on reduction of vendor lot sizes, single sourcing and quality certification of suppliers before fully carrying out just-in-time operations. Smaller vendor lot sizes will lower the inventory carrying costs, while single sourcing will generate better quality from suppliers and thus result in lower inspection costs.

VI. Summary And Conclusions

To sum up, JIT production strategy and JIT vendor strategy significantly related to the potential level of JIT implementation but management commitment did not. This project aimed to provide a preliminary insight into the relationship between management commitment, JIT production strategy and JIT vendor strategy and the potential level of JIT implementation in Hong Kong electronics/electrical manufacturing sector. The results obtained from this study suggest that Hong Kong electronics/electrical manufacturers possessed partial

prerequisites of JIT implementation. Consequently, it is likely that only certain levels of JIT implementation are feasible and attainable. JIT production strategy and JIT vendor strategy were found to be critical factors with low-potential levels of JIT implementation. If Hong Kong companies want to adopt JIT, they should direct their efforts and resources to the elements contained within these two JIT implementation strategies.

In fact, JIT implementation is not an easy task and cannot be implemented in a short time period. It would require changes in equipment, management and subordinate training, and organization. Implementation of all these changes for a complete JIT system takes a considerable amount of time and monetary resources. Moreover, each firm has its own business environment and culture such that the JIT elements that are feasible may vary from firm to firm (Lee, 1996). Therefore, management should implement JIT only when expected benefits exceed costs. If management decides to implement JIT, they must support and promote the idea of JIT to all employees and constantly review the results. JIT is a 'whole business' perspective and an on-going improvement process (Brian & Lokman, 1993).

Before implementing JIT, managers should be aware of the potential shortcomings in Hong Kong, identified as follows:

1. The traditional approach to manufacturing in Hong Kong is the use of large inventories with safety stocks to ensure smooth production. While safety stock can act as a buffer for companies to fall back on to offset inaccurate demand forecasts, it suffers from the cost and quality problems widely noted in the literature.
2. Loss of individual autonomy has largely been attributed to limited cycle times or the "time between recurring activities". Buffers such as slack or idle time are significantly reduced in a JIT environment resulting in greater amounts of pressure placed upon workers to perform (Klein, 1989).
3. JIT involves an organizational level of change which will affect almost everyone in the company. Employees, and perhaps particularly middle management, may be resistant to change (Gray & Starke, 1988) because of fear, anxiety and suspicion arising from the inducement of change and lack of necessary information pertaining to the degree to which the change will affect them.

JIT benefits do not just happen. Hong Kong manufacturers should take all the necessary factors into consideration before taking full advantage of JIT. If they implement JIT properly, they can enjoy the favorable financial consequences from cost savings arising from reduced costs of inventory storage, materials handling, breakage and simplification of paperwork.

VI. Limitations

Few researchers (notably, Cheng, 1988; Fong, 1992) deal specifically with JIT implementation in Hong Kong, which limits the comparative scope of this research project. This may be due to the relative newness of the idea in Hong Kong and the length of time necessary to ensure a large degree of implementation.

Meanwhile, there is an enormous amount of information and much opinion about the relative success or failure of Japanese manufacturing practices in the United States (Billesbach, 1991; Celley & Clegg, 1986; Im, & Lee, 1989; Plenert, 1985; Susaki, 1985; White, 1993; Young, 1992) and Western countries. However, the cultural differences between Hong Kong and the U.S. or other Western countries may affect the applicability of these results to Hong Kong.

The most popular approach taken by previous JIT researchers is that of interviewing managers and assessing their experiences with JIT implementation, and then generalizing this information for all firms by the formulation of a series of critical elements for success (Narender, Satish & Mark, 1995). Lack of previous research, and therefore data, as reference points lends great difficulty to the interpretation of JIT implementation through rigorous statistical analysis.

Finally, the results of this study may not generalize to all electronics/electrical manufacturing firms because of the small sample size.

VII. Recommendations For Future Research

As discussed earlier, 54% of the variation in the potential level of JIT implementation was accounted for by the hypothesized variables, implying that 45% is still not explained by the three independent variables. Some variables important in explaining the potential level of JIT implementation have not been considered in this study. Therefore, further research may be necessary to explain more of variables in the potential level of JIT implementation.

In order to preempt nonresponse bias, complete anonymity was promised in order to achieve a high return rate. Consequently, there was no way to track which companies replied. In future research, if the researcher does not ask for names of company to be given, a system of numbering could be devised in order to link responses with companies. Also, follow-up letters on non-respondents could be used to increase the response rates of mail surveys.

References

1. Alan, B. and Duncan, C. (1994). *Quantitative Data Analysis for Social Scientists*, Revised ed., Routledge, New York.
2. Alan, H. (1992). *Just-In-Time Manufacturing in Perspective*, Prentice Hall, London.
3. Ansari, A. (1986). Survey identifies critical factors in successful implementation of just-in-time purchasing techniques. *Industrial Engineering*, Vol. 18, pp. 44-6.
4. Ansari, A. and Modarress, B. (1990). *Just-In-Time Purchasing*, The Free Press, New York.
5. Billesbach, T. J. (1991). A study of the implementation of just-in-time in the United States. *Production and Inventory Management Journal*, Vol. 32, No. 3, pp. 1-4.
6. Brian, C. and Lokman, M. (1993). JIT manufacturing systems: use and application in Australia. *International Journal of Operations and Production Management*, Vol. 13, No. 7, pp. 69-82.
7. Burnham, J. M. (1987). Some conclusions about JIT manufacturing. *Production and Inventory Management*, Vol. 28, pp. 7-11.
8. Celley, A. R., Clegg, W. H., Smith, A. W. and Vondermbse, M. A. (1986).
9. Implementation of JIT in United States. *Journal of Purchasing and Materials Management*, Vol. 22, pp. 9-15.
10. Cheng, T. (1988). The just-in-time production: a survey of its development and perception in Hong Kong electronics industry. *Omega*, Vol. 16, pp. 25-32.
11. Cheung, T. C. E. and Podolsky, S. (1993). *Just-In-Time Manufacturing: An Introduction*, 1st ed., Chapman & Hall, New York.
12. Charles, T. H., George, F. and Srikant, M. D. (1994). *Cost Accounting: A Managerial Emphasis*, 8th ed., Prentice Hall Inc.
13. Crawford, K. M., Blackstone, J. H. and Cox, J. F. (1988). A study of JIT implementation and operating problems. *International Journal of Production Research*, Vol. 26, No.9, pp. 1561-1568.
14. Crawford, K. M. and Cox, J. F. (1991). Addressing manufacturing problems through the implementation of just-in-time. *Production and Inventory Management Journal*, Vol. 32, No. 1, pp. 33-36.
15. David, C. H. and Aldershot, H. (1988). *Just-in-time*, Gower Technical Press, England.
16. Dennis, F. (1995). *The Just-In-Time Self Test: Success Through Assessment and Implementation*, Irwin Professional Publisher, Chicago.
17. Dertouzos, M. L., Lester, R. K. and Solow, R. M. (1989). *Made in American-Regaining the productive edge*, MIT Press, Cambridge, MA.
18. Edward, J. H. (1988). *The Just-In-Time Breakthrough*, John Wiley and Sons, New York.
19. Felix, O. O. and David, A. (1992). Support of successful just-in-time implementation: the changing role of purchasing. *International Journal of Physical Distribution and Logistics Management*, Vol. 22, No. 5, pp. 38-46.

20. Fong, H. S. (1992). *Just-In-Time Inventory System: The Case of Hong Kong*, Hong Kong: Business Research Centre, School of Business, Hong Kong Baptist University.
21. Goddard, W. E. (1986). *Just-In-Time*, Oliver Wight Ltd. Publications, Inc.
22. Gray, J. L. and Starke, F. A. (1988). *Organizational Behaviour Concepts and Applications*, 4th ed., Merrill Publishing Company, Ohio.
23. Guido, N. (1995). Factors underlying operational JIT purchasing practices: results of an empirical research. *International Journal of Production Economics*, Vol. 42, pp. 275-288.
24. Hall, R. W. (1983). *Zero Inventories*, Dow Jones-Irwin, Homewood, IL.
25. Hay, E. J. (1988). *The Just-In-Time Breakthrough*, John Wiley and Sons, New York.
26. Hayes, R. H., Wheelwright, S. C. and Clark, K. (1988). *Dynamic Manufacturing*, Harvard Business School Press, Cambridge, MA.
27. Im, J. H. and Lee, S. M. (1989). Implementation of just-in-time systems in US manufacturing firms. *International Journal of Operations and Production Management*, Vol. 9, pp. 5-14.
28. James, A. H. (1994 January). Performance measures for a JIT manufacturers: the role of the industrial engineering. *Industrial Engineering*.
29. Judith, B. (1993). *Doing your research project - a guide for first-time researchers in education and social science*, 2nd ed., Open University Press.
30. Kang, D. S. (1994). How a leading heavy industries co. limited in Korea implement JIT philosophy to its operations. *Computers and Industrial Engineering* Vol. 27, No. 1-4, pp. 5-9.
31. Karen, L. B and Anthony, I. R. (1993). Relationship with vendors. *Journal of Business and Industrial Marketing*, Vol. 8, No. 1, pp. 5-13.
32. Klein, J. A. (1989). The human costs of manufacturing reform. *Harvard Business Review*, Vol. 67, No. 2, pp. 62-66.
33. Lee, C. Y. (1996). The applicability of just-in-time manufacturing to small manufacturing firms: an analysis. *International Journal of Management*, Vol. 13, No. 2, pp. 249-258.
34. Lee, S. M. and Ebrahimpour, M. (1984). Just-in-time production system: some requirements for implementation. *International Journal of Operations and Production Management*, Vol. 4, pp. 3-15.
35. Marc, J. S. (1993). *Topics in Just-In-Time Management*. Allyn and Bacon.
36. Mehra, S. and Inman, A. R. (1992). Determining the critical elements of just-in-time implementation. *Decision Sciences*, Vol. 23, No. 1, pp. 160-174.
37. Monden, Y. (1983). *Toyota Production System*, Industrial Engineering and Management Press, Georgia USA.
38. Michael, S. S. and Daniel, G. V. (1995). An exploration of the components of JIT. *International Journal of Operations and Production Management*, Vol. 15, No. 5, pp. 72-83.
39. Narender, K. R., Satish, M. and Mark, N. F. (1995). A comparative analysis and review of JIT implementation research. *International Journal of Operations and Production Management*, Vol. 15, No. 1, pp. 38-49.
40. Plenert, G. J. (1985). Are Japanese production methods applicable in the United States?. *Production and Inventory Management*, Vol. 25, pp. 121-129.
41. Ramsay, L., Sohal, A. and Samson, D. (1990). *Just-in-time manufacturing in Victoria*. Centre for Manufacturing Management, University of Melbourne.
42. Robert, S. S. (1992). *Statistics in Plain English with Computer Applications*, Van Normand Reinhold, New York.
43. Ron, M. (1997). Management initiatives and just-in-time manufacturing. *Journal of Operations Management*, Vol. 15, pp. 271-292.
44. Ross, J. E. and Ross, W. C. (1982). *Japanese Quality Circles and Productivity*, Reston Publishing Company Inc., New York.
45. Sabayon, R, Purdy, L., van Engle, R. and Pal, S. (1991). Difficulties of just-in-time implementation: a classification scheme. *International Journal of Operations and Production Management*, Vol. 11, No.7, pp. 27-36.
46. Schonberger, R. J. (1982). Some observations on the advantages and implementation issues of just-in-time production system. *Journal of Operations Management*, Vol. 3, pp. 1-11.

Appendix A

Questionnaire

Part 1: Company Background

Q 1: The total number of employees (both in Hong Kong and overseas)

Q 2: Where do you operate your plant(s)?

Hong Kong China Overseas

Q 3: What is your current situation related to Just-in-time system?

- Implementing
- Plan to implement
- No plan to implement

Part 2: This questionnaire is a list of questions about repetitive manufacturing operating activities, results or business practices within your company. If there is a substantial activity or effort going on in your company for an item then **circle "5"** which means strongly agree. If no real effort or practice exists **circle "1"** which means strongly disagree. You must act as an objective observer, viewing your operations, people, policies, processes and business practices from a distance. Be careful to avoid bias in your answers, particularly if you are tied in some way to the activities being questioned.

<i>Management commitment</i>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Management has a formal means for listening to employees' suggestion.	1	2	3	4	5
2. Compensation and rewards for employees are based on both employee flexibility and team contribution.	1	2	3	4	5
3. Management responds to employees and gives feedback immediately.	1	2	3	4	5
4. Management supports and participates in employee involvement programs.	1	2	3	4	5
5. Management exhibits consistent support for quality procedures.	1	2	3	4	5
6. Management participates in the planning process and commits to a realistic capacity planning.	1	2	3	4	5
7. Management delegates authority to Management delegates authority to process occurs.	1	2	3	4	5
8. Department or team problem-solving groups meet regularly and solve quality problems in their departments.	1	2	3	4	5
9. Quality errors are repaired or prevented at the source where they occur.	1	2	3	4	5

<i>JIT production strategy</i>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Rapid setups are established (less than 10 minutes) for most machines and lines.	1	2	3	4	5
2. Cycle times of each workstation, cell or line are matched to upstream and downstream times.	1	2	3	4	5
3. Production processes are grouped into product family (group technology) cells or lines.	1	2	3	4	5
4. Workers can perform many tasks within the production process.	1	2	3	4	5
5. Manufacturing engineering is located in the production area and is immediately available for problem resolution.	1	2	3	4	5
6. Scheduled preventive maintenance is considered an important part of production performance.	1	2	3	4	5
7. Labor is not "kept busy" by building product when not needed at the next operation.	1	2	3	4	5
8. Equipment is idle most of time to support high customer services level.	1	2	3	4	5
9. Daily rate and level schedules are used and usually meet due dates.	1	2	3	4	5
10. Weekly or daily delivery of 80% or more of production materials is made to the plant and directly to the production line points of use.	1	2	3	4	5
11. Inventories are continually reducing.	1	2	3	4	5
<i>JIT vendor strategy</i>	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Materials are purchased in small quantities with frequent deliveries.	1	2	3	4	5
2. Key volume suppliers are local.	1	2	3	4	5
3. Single source suppliers make up greater than 50% of all suppliers.	1	2	3	4	5
4. Delivery lead time for most parts range from one day to one week.	1	2	3	4	5
5. Suppliers provide on-time and reliable deliveries.	1	2	3	4	5
6. Most paperwork, material handling, transportation, and quality waste has been eliminated between suppliers and plant.	1	2	3	4	5
7. You have long-term contract agreement with suppliers.	1	2	3	4	5

NOTES