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Full Length Research Paper

Critical success practices (CSP) toward implementing lean production among international companies in Malaysia

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With emerging globalization and adverting huge competition among the companies, all participants are looking towards improving their core competency, and follow a way to make a better profit margin for them, through the elimination of waste and increase in their productivity which can be achieve through a concept of lean production and especially just-in-time (JIT) practices. In Malaysia, it is still a new concept and many local companies are not as good as their international counterpart, which are active in Malaysia. As a result, in this paper we are going to examine critical success practice (CSP) for implementing lean production among international firms, which are active in Malaysia and through a survey on leaders in lean production in Malaysia extract a general pattern for other Malaysian companies for improving their lean practices.

Key words: Lean production, just-in-time (JIT), critical success practice (CSP), information requirement determination, industries, Malaysia.

INTRODUCTION

Since the 1980s, awareness regarding the implementation of lean production and the practices associated with total quality management (TQM), just-in-time (JIT), experience an upward trend, however, there is no careful examination for implementing a common and unique practices associated with this program. In this paper, we develop a framework for lean production (LP) and apply JIT practices in different industries in Malaysia and determine the required practices for implementing LP in each industry. Within the lean production TQM, JIT have similar fundamental goals of continuous improvement and waste reduction (Schonberger, 1986; Nakajima, 1988; Ohno, 1988).

Besides, in LP there are number of practices for TQM, JIT, which form a comprehensive and consistent set of manufacturing practices directed towards continuous improvement. Therefore, manufacturing plants are likely to combine the implementation of TQM, JIT practices.

However, most of the studies on TQM, JIT, investigate these programs separately. In terms of Malaysia, the practice of LP is still a new concept. Since the mid-1980s, the Malaysian economy has metamorphosed from a commodity-based to a manufacturing-based economy. Therefore, in this paper we make a survey on successful international companies in Malaysia to reach a general pattern for implementing JIT practices.

Just-in-time (JIT) objectives

It is not possible to look at JIT like other investment projects and assess the benefit with conventional methods of evaluation such as return on investment(ROI) or payback period (PBP), because this method usually focuses on short term, while JIT looks beyond the short run to the long-term optimization of the entire

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production/distribution network (Jones, 1991).

Successful JIT implementation should accomplish two major objectives: improve quality and control the timeliness of the production and delivery of products (Davy et al., 1992; Monden, 1981; Walleigh, 1986). By emphasizing on quality, companies should experience less defect, rework and more effective communication among departments and employees as well as the higher productivity (Im et al., 1988). In addition, long-term commitments with fewer suppliers should result in fewer inspections. The achievement of these results requires an even production flow of small lot size, schedule stability, product quality, short setup times, preventive maintenance, and efficient process layout (Chapman and Carter, 1990).

This work is therefore organised as follows; review of literature and integrated framework; theoretical framework and hypotheses; data used for the analysis; method of analysis; results and conclusions.

LITERATURE REVIEW

The term “lean production” was coined by the researchers who conducted the international motor vehicle programme (IMVP) study of management practices in the world motor industry (Womack et al., 1990). They write that lean production as: “combines the advantages of craft and mass production, while avoiding the high cost of the former and the rigidity of the latter. Toward this end, lean producers employ teams of multi skilled workers at all levels of the organization.

As a part of LP, JIT is a manufacturing program aimed at continuously reducing and ultimately eliminating all forms of waste (Ohno, 1988; Brown and Mitchell, 1991) through JIT production and involvement of the work force (Schonberger, 1986, 1996; Ohno, 1988). A comparison of six recent empirical studies on JIT (Davy et al., 1992; Mehra and Inman, 1992; Sakakibara et al., 1993; McLachlin, 1997; Sakakibara et al., 1997; Ahmad, 1998) leads to the identification of nine practices that are frequently cited as JIT practices. These are set-up time reduction, pull system production, JIT delivery by supplier, functional equipment layout, daily schedule adherence, committed leadership, strategic planning, cross-functional training, and employee involvement.

Two major forms of waste — work-in-process inventory and unnecessary delays in flow time (Brown and Mitchell, 1991) — can be addressed through the implementation of JIT practices, such as set-up time reduction and pull system production. These JIT practices, however, require be involved in the improvement efforts. To further support JIT, leadership must be committed to the programs and employee development.

Im et al. (1988) develop a portfolio model for implementing JIT practices, including set-up reduction, plant compression, quality circles, preventive maintenance, JIT purchasing, kanban, small lot sizing, flexible workforce, dedicated lines, mixed model production, level production, u-shaped layout, cellular manufacturing, autonomation. When JIT practices were first introduced in the United States, there was great skepticism as to whether or not they could be adopted by American manufacturing companies in consideration of a quite different Japanese cultural environment, Nowadays there is such an anxiety for implementing such a practice in Malaysian companies.

Similarly, in a related survey study, (White et al., 1999) collected data from large and small manufacturers to investigate JIT implementations. The instrument used to collect the data measured a set of 10 JIT management practices (representing a holistic understanding of JIT systems) and associated implementation variables. The 10 JIT management practices examined in the study include the following: focused factory, reduced setup times, group technology, total preventive maintenance, multifunction employees, uniform workloads, Kanban, total quality control, quality circles, and JIT purchasing. Upon modeling the data, (Davy et al., 1992; Richard and Victor, 2001) suggested that the results represented the systems perspective and integrative thinking associated with JIT. Systematic integration of the 10 JIT management practices (presented previously) represents.

Holistic just-in-time (JIT) system

Other researchers survey regarding JIT practices is summarized in Table 1 and you can see that every researcher recommended the exact type of practice.

Besides, there are some other practices inside the literature that we collected and tried to make integration which spend a great deal of time to provide a complete literature for reviewing all the possible factor for implementing JIT practices. In Table 2 some other practices has been collected.

THEORETICAL FRAMEWORK

The first step: Define type of Industry

Four types of industry, including computer, electronic, employees to be trained to perform multiple tasks and to automotive parts, and heavy machinery among all the industries, due to the fact that they provide a great number of samples and are successful in implementing the LP and JIT practices inside Malaysia were selected.

Then a number of firms among the International companies was selected as representative, and some

Table 1. Recommended for lean practices.

Framework practice or technique	JIT Literature*							
	1	2	3	4	5	6	7	8
Multifunction employee		X			X	X	X	
Quality circle		X		X	X	X		
Set up time reduction		X	X			X		
5S	X			X		X		
Kanban						X	X	X
Continuous flow	X					X		
Preventive maintenance		X				X		
Small lot size	X					X		
TQC		X				X		
Kaizen(CI)		X	X					
Cell layout			X			X		
Standard operation	X	X						
Training			X				X	
Focused factory							X	
Supplier management			X					
Visual control		X						
Teamwork								

* References: Real et al. (2007), Bonavia and Marin (2006), Gyampah and Gargeva (2001), Gunasekaran et al. (2000), White et al. (1999), (6) Lee (1997), Gupta and Brennan (1995) and Sohal and Naylor (1992).

Table 2. Commonly suggested JIT practices or techniques.

Framework practice or technique	JIT Literature*					
	1	2	3	4	5	6
Setup time reduction	X	X	X	X	X	X
Pull system production	X		X	X	X	X
JIT delivery by suppliers	X		X	X	X	X
Equipment layout	X		X	X	X	X
Daily schedule adherence			X	X	X	X
Committed leadership	X	X		X		
Strategic planning	X	X			X	X
Cross-Functional training	X		X	X		
Employee involvement	X	X	X	X	X	X

* References: Mehhra and Inman (1992), Davy et al. (1992), Sakakiabara et al. (1993), Maclachlin (1997), Sakakiabara et al. (1997) and Ahmad (1998).

survey was done on them, and a general pattern was extracted that will be discussed. So this paper can be useful for this four types of industry and this research provides a guideline for such an industry to follow the general pattern and become successful in terms of conducting of JIT practices.

Critical success practices (CSP) step for lean production (framework)

1) Define type of industry
2) Identify critical success practices (CSP) for JIT
3) Determine requirement practices.

The second step: Identify critical success practice (CSP) for JIT

This step determines the CSP for JIT, guided by the type of industry. Various classification schemes for CSP are similar in terms of the criteria, such as reduction time, short lot sizing, Kanban, etc. Comparatively, the Im and lee model covers the common practices for implementing

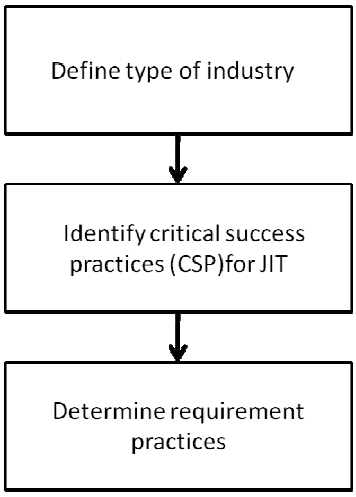

Figure 1. The theoretical framework.

JIT, among the all criteria discussed in literature review, their model was most practical in terms of all industries and thus, it was adopted here (Figure 1).

The third step: Determine requirement practices

The CSP are then used to extract the requirement for implementing the LP and JIT practices in four types of industry. In this paper, the major focus is on the relationship between type of industry and the requirement practices determination of JIT. This process was developed from a literature review, and therefore for additional verification using empirical data was needed. Consequently, the following two hypotheses were proposed.

Hypothesis 1: The type of industry has a positive impact on identifying CSP for JIT.

Hypothesis 2: CSP have positive impact on the performance of requirements determination.

METHODOLOGY

This research involves a cross-sectional field study using survey methodology in different manufacturing environments across a variety of international manufacturing organizations which are active in Malaysia. Unfortunately, most organizations are prone to publicize and perhaps exaggerate examples of successful implementation while downplaying or hiding instances of failure. Therefore, to avoid bias about the success of implementing specific JIT management practices, we surveyed well-informed middle and upper-level managers with hands-on experience with JIT manufacturing. These respondents were sought because of their broad perspective of the organization's activities and because of their knowledge of associated implementation issues.

Target population

The data analyzed in this study were collected from members of the small and medium enterprises (SME) corporation Malaysia (www.smecorp.gov.my). SME corporation members represent all types of production processes and all functions within those operations. In this study we investigate JIT implementations in international manufacturers in Malaysia. The methodology for this work overlaps the one used by Im and Lee (1988) because the variable analyzed for this study used the same model.

Questionnaire

A three page questionnaire for writing questions and constructing the questionnaire was followed for developing the survey instrument. The structure of the questions used to collect information on each of the key variables assessed in this study included industry type, implementation status of JIT practices, and sequences associated with JIT implementations.

The survey instrument contains a four-part questionnaire. The first part uses a nominal scale, while the rest use seven-point Likert scales.

Basic information

Information was collected about organizational characteristics, including industry, annual revenue, number of employees, and implementing JIT practices, together with respondent's characteristics, including education, age, experience, and position.

Industry Category

Items used to collect information for type of industry consisted type of production process. Definitions of types of production processes based on popularity of four industry including computer, electronic, automotive part industry and heavy machinery inside Malaysia among pioneer international firms were included in the questionnaire.

Critical success practices (CSP)

This was adapted from the descriptions discussed in (Im et al.,1988), it developed a portfolio model for implementing JIT practices, including 13 criteria such as plant compression, quality circles, preventive maintenance, JIT purchasing, kanban, small lot sizing, flexible workforce, dedicated lines, mixed model production, level production, U-shaped layout, cellular manufacturing, autonomation.

Implementation status of JIT practices

Each of the 10 JIT practices that represent the holistic understanding of JIT systems formed an item used to collect information on implementation status of JIT practices. Definitions for each of these JIT management practices were used in data collection to reduce any misunderstandings that may exist (White,

1999).

Assessment of practices requirement

This part was adapted from the measurement of assessing information requirements elicitation given in the Teng and Sethi's (1990) study. Thus, it includes five items: accuracy and free bias, completeness, shortening of user determination time, in addition to usefulness and ease of use for practices.

Pretest validation

Pretest and a pilot study were used to clarify items on the questionnaire and further develop the comprehensiveness of the instrument (White, 1999). In addition, follow-up interviews with the respondents from the pretest allowed for additional clarification of ambiguous items. Follow-up interviews of the respondents allowed for feedback which was reviewed and necessary revisions were made to the questionnaire prior to data collection.

To measure reliability and validity, the pretest used a representative sample of 74 companies. It is reliable if it supplies consistent results, as measured by Cronbach alpha (Cooper and Emory, 1995). According to Price and Mueller (1986), a value of 0.60 or higher is generally viewed as acceptable for the measure. In this study, validity is of two types: content and construct validity. The content validity is the extent to which it provides adequate coverage of the topic. The construct validity attempts to identify the underlying construct(s) being measured and determines how well the test represents them. Factor analysis was used for the analysis of construct validity. The rule of eigenvalue greater than 1 as the criterion extracts the factors.

The second, third, and fourth parts of the questionnaire were all adapted from the literature and have been reviewed carefully by practitioners; thus, content validities should be relatively acceptable. Construct validities were confirmed using principal component analysis as the defined factors/criteria in the second and third parts of the questionnaire: they all have eigenvalues greater than 1.98 and the percentage variance accounted for greater than 70.3. The Cronbach's alpha is 0.72 and above. The fourth part of the questionnaire was converged to one factor with eigenvalue of 3.18 and the percentage variance accounted for of 74.5%. The Cronbach alpha is 0.88.

Data collection

The data collection process consisted of two mailings. Approximately 5 weeks after the initial mailing a follow-up mailing was performed. Out of the 105 companies were surveyed initially by mailing questionnaire, a total of 74 surveys were completed and returned for an overall response rate of 70.47%. Within this 74 companies, 352 person including production managers, materials managers, production planners of this successful companies in terms of implementation of JIT practices answered the questionnaire completely. Examining the responding data across these three groups of respondents indicates a pattern of relative consistency in the firms' experience.

A review of the data allowed for identification of data omitted from the final sample for the following: completed surveys that had incomplete data pertaining to any of the key variables assessed in this study (N = 4).

Since the focus of the study was on these four types of industry, 10 cases were omitted because they have overlap and cannot put just in one category.

ANALYSIS AND FINDINGS

Demographics

Due to limit number of companies which implement LP in Malaysia, we send the questionnaire to 105 companies, 79 replied, with four incomplete responses deleted, resulting in a total sample of 74 firms for a 75.2% response rate. The responding sample consisted of 25 electronic manufacturing firms (33.73%) and 22 computer firms (29.72%), 15 automotive part and component companies (20.27%) as well as in 12 heavy machinery firms (16.21%). This indicates that in Malaysia mostly electronic and computer firms implement lean production and willing to answer questions. The relatively low response rate raised a concern of non-response bias. A test for it was conducted using two sub-samples: early and late respondents. They were correlated on their JIT practices experiment. There was no significant non-response bias in the sample.

Identify critical success practices (CSP) for JIT

The relationship between Industry category and their critical success practices for implementing JIT can be explained in terms of 13 practices and use them as dependent variables and a portfolio of industry category as one independent variable with four categories. The dependent variables are of metric attribute while the independent variable is not. MANOVA was performed to analyze the relationship structure. The test shows that Wilks' λ is 0.52, and the equivalent F statistic for the Wilks' l value is 18.5 with the probability less than 0.01.

As a result, Hypothesis 1 is accepted and the impact is positive. Univariate F statistics were further examined to understand how the 13 practices varying across the four types of industry. The testing results are reported in Table 3.

It may be seen that autonomation practice is not statistically significant across the four types of industry. This may be explained because firms need a great deal of confidence regarding their quality system and preventive maintenance in Malaysia while there is not such a confidence till now.

Besides, the computer manufacturer relationship was mostly influenced by kanban and other planning related practices including level production and small lot sizing, except in the autonomation. In addition, the electronicindustry mostly the same practices applied while the kanban implemented at the end of the process. On the contrary, in the automotive parts industry the practices dominantly started with quality control practices

Table 3. Univariate tests for CSP across different Industry (adopted from Im and Lee, 1988).

JIT Practice	F	P-value	Different Industry (mean)			
			1	2	3	4
Plant compression	7.83	0.012*	3.92	3.86	1.29	5.33
U-shaped layout	6.63	0.031*	4.04	3.98	2.02	5.12
Cellular manufacturing	13.23	0.000*	5.87	5.81	1.37	3.43
Dedicated line	5.33	0.031*	5.83	6.18	2.76	3.11
Small lot sizing	5.52	0.028*	6.12	5.91	4.65	3.67
Mixed model production	9.34	0.009*	5.93	6.21	4.27	1.88
Level production	6.93	0.029*	6.32	5.87	4.23	1.75
Kanban	7.75	0.013*	6.59	1.28	6.54	3.54
Preventive maintenance	5.41	0.034*	3.27	2.41	6.78	2.87
Quality circle	7.13	0.027*	2.91	5.61	6.85	3.08
Autonomation	2.12	0.21	1.89	1.79	1.27	1.65
Flexible workforce	7.69	0.022*	3.22	3.77	1.42	1.31
JIT purchasing	4.93	0.035*	3.87	3.81	3.25	1.56

(1) Computer manufacturers, (2) Electronic manufacturers, (3) Automotive parts manufacturer; (4) Heavy machinery; * $P < 0.05$.

Table 4. The effect of CSP on the performance of requirements determination.

Variable	d.f.	SS	MS	F	P
Regression	7	32.78	4.68	8.84	0.00
Residual	67	98.07	0.53		
Total	74	158.85			

including quality circle, preventive maintenance, and kanban, this may be because of dissimilarity and varieties of process for automotive parts compare to last two industries and more engagement of human factor and surging the possibility of error take place.

Moreover, in concern with heavy machinery industry, predominant practices are process related including what is called U-shape layout or plant compression. In conclusion, the results indicate that developing different categories of industry would create different effects on the choice of critical success practices (CSP), however to somehow in some industries the practices is similar, but overall different industries need different models.

Determine requirement practices

This step was intended to be used in assessing the significance of relationship among the industry and JIT required practices, in the light of the prior decisions. However, there is a need to validate this framework in terms of the effect of CSP on the quality of requirements determination. Their relationship involves the quality of system requirements analysis as one dependent variable with metric attribute and CSP as 13 independent variables with metric attribute. Multiple regression analysis was used to examine the type of relationship structure. The results are presented in Table 4.

Therefore, hypothesis 2 is accepted and the impact is positive. More specifically, this study purposed at exploring the impact of the different categories of industries on the different practices requirement for implementing JIT systems and lean production.

The overall results are summarized in Table 5. For determining the emphases on the CSP, a t-test for a seven-point Likert scale was used to examine the significance of the CSP for each of the four industry categories. The performance of requirements elicitation was estimated by averaging the data of the clustered firms for each of the four industries. The results were also examined by making a t-test. This indicates that the industry categories significantly influence the practices requirement determination through an intervening factor: the CSP.

Conclusions

While JIT was recognized as an important issue in lean production, the selection of an ideal CSP for

Table 5. The impact of different industry on sequence of JIT practices.

JIT Sequence	Computer industry	Electronic industry	Automotive industry	Heavy machinery
Early stage;	Planning related practices and Kanban (6.11*)	Planning related practices (5.21*)	Quality control-related practices (4.30*)	Process related practices (3.39*)
Middle stage;	Process-related (3.76*)	Process-related (3.85*)	Planning-related (4.06*)	
Final stage;	Quality control-related (2.42*)	Quality control-related (3.71*)	Process-related (1.99*)	Quality control-related practices (2.97*)
Later stages;		Kanban (2.41*)		

Planning practice: Cellular manufacturing, dedicated line, small lot sizing, small lot sizing, mixed model production, level production, Kanban
Quality control practice: Preventive maintenance, quality circle,
Process practice: Plant compression, U-shaped layout, Flexible workforce, JIT purchasing

*: Performance and significances of practices.

implementing JIT would be a major advantage to a firm and a way to achieve competitive advantage. This justifies the need for better choosing CSP. Implementing JIT involves relatively complex processes and without the support of precise selection of CSP, it would not be accomplished easily. Moreover, this selection among the practices, through the different models, which have been provided by different researcher is a tough responsibility for managers.

This approach proposed a three-step process to effectively develop lean production in terms of implementing JIT: define type of industry, identify critical success practices (CSP) for JIT, and determine requirement practices.

In general, the international manufacturing firms in Malaysia use a portfolio of different types of JIT practices in different models rather than rely on only one model. Successful selection of CSP, therefore, should be base of industry categories. There are significant differences in the choice of CSP for various manufacturing firms, the major implication for academicians lies in the particular connection of industry types and their CSP for commonly determining requirement practices of implementing JIT. Moreover, this study contributes not only in developing a well-defined process of user requirements determination but also determining useful techniques to effectively implement it. In conclusion, the new approach fundamentally overcomes the impact of problem unstructured issues associated which give priority to practices domain on user requirements determination for implementing JIT. The implications for practitioners could be discussed this way.

An industry type analysis in terms of the JIT application is important because firms are not able to adopt various practices and their ability is limited and maybe just need some specific practices, so they should know about their priorities to meet their needs. Thus, it should identify the type of industry first. Moreover, the emphases on CSP, which are the underlying determinants of practices required for JIT can, therefore, be determined from this analysis of the relationship between industry categories and CSP. Computer and electronic types of industry both consider the planning oriented as one of the emphasis on CSP. Automotive parts and heavy machineries industry, are against each other in terms of priority to kanban practices, first one gives the most priority to quality oriented practices while it gets the least attention in heavy machinery industry. Finally, the required practices for the particular JIT would be determined in a more efficient and effective way.

Although, this study has produced some interesting results, it has some limitations. First, usually companies want to keep their secret and never share their practices. Second, however production managers, materials managers, production planners from larger firms were chosen to be the participants in this survey; but some questionnaires might have been completed by subordinates and thus the data may include bias and third is limited types of industries that were studied.

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