A study on relationship between lean production practices and manufacturing performance

Tsuang Kuo, Ju-Peng Shen, Ying-Mei Chen

Department of Business Management
National Sun Yat-Sen University

Abstract

Our research addresses the confusion and inconsistency associated with “lean production”, “manufacturing performance”. We attempt to clarify semantic confusion surrounding lean production and its connection with manufacturing performance by conducting an extensive literature review and empirical study.

First, we identify key components of lean production and performance including supplier, customer, internally management and lean performance form literatures of lean production, supply chain management and Toyota Production System (TPS). Second, using questionnaires survey and variety statistical processes to demonstrate positively relationship between lean production and manufacturing performance.

In doing so, we provide unambiguous evidences that synergistic effects of lean practices are associated with better manufacturing performance.

Keyword: Lean Production, Lean Manufacturing Performance, Toyota Production System (TPS)

1. Introduction

From Ford Production System (FPS) to Toyota Production System (TPS), it means manufacturers compete in heterogeneous global markets where competitors have access to diverse labor, capital, and supply conditions. Lean production is a multi-dimensional approach that encompasses a wide variety of management practices, including just-in-time, quality system, work teams, cellular manufacturing, supplier management, etc. in an integrated system (Shah and Ward, 2007).

A majority of article on the topic of lean production system focus on the defining lean production, information technology integration and lean practices and concept of lean production. Mid of 1990s, Articles related to lean production as measuring just in time, total quality management and the impact of other organizational variables on their implementation were published in academic journals. After 2000, numerous books and articles written by

practitioners and consultants, and a few academic conceptual and empirical articles highlighting the overarching nature of lean production were published (Shah and Ward, 2007).

Our study will examine the relationship between contextual factors and extent of implementation of a number of manufacturing practices that are key facets of lean system. Specifically, we focus on how three major aspects of lean production (customer, supplier, internally management) effect on manufacturing performance.

2. Literature Review

Reviewing the backgrounds and literatures, lean production is most frequently associated with elimination of waste commonly held by firms as excess inventory or excess capacity to ameliorate the effects of variability in supply, processing time, or demand (Shah and Ward, 2007). In phase of practices, lean practices are generally shown to be associated with high performance in a number of studies of world-class manufacturing (e.g. Sakakibara et al.,1997; Giffi et al., 1990). The most commonly cited benefits related to lean practices are improvement in labor productivity and quality, along with reduction in customer lead time, cycle time, and manufacturing costs (Schonberger, 1982; White et al., 1999). Most of the empirical studies focusing on the impact of lean implementation on operational performance are constrained to facets of lean, often just-in-time (JIT), total quality management (TQM), and total preventive maintenance (TPM) programs (Cua et al, 2001).

Shah and Ward (2007) derived an operational measure from the content and objectives of historical roots in TPS. There were three dimensions from empirical studies included supplier, customer, internally (Fig.1). Supplier related, the connection between supplier and manufacturing performance. As organizations continue to seek performance improvements, they are reorganizing their supplier base and managing it as an extension of the firm's manufacturing system. (Carter, 1996; Cooper and Ellram, 1993). Ragatz et al., (1997) and Slats (1995) pointed out through integration of information and planning with supplier will reduce time cost of designing and solving problems. Benton and Krajewski (1990) reported supplier's lead-time and quality will affect manufacturer production, if supplier could not meet the lead-time and quality requirement of manufacturer.

Customer related, Bleeke and Ernst (1991) suggested customer relationship is strategic partner relationship between supply chain. They have common goals and interdependent relationship. The advantage of partnership means long term, stable and better corporation performance (Sethuraman, et al., 1988). Focus on customer relationship will increase customer satisfaction, quality and production (Ellram,1991；Scott and Westbrook,1991; Turner,1993).

Internally related, as previous described lean practices which included pull (JIT), Flow (continuous flow), setup (setup time reduction), TPM (total preventive maintenance), SPC

(statistical process control), EMPINVE (employee involvement)
(Shah and Ward, 2007).

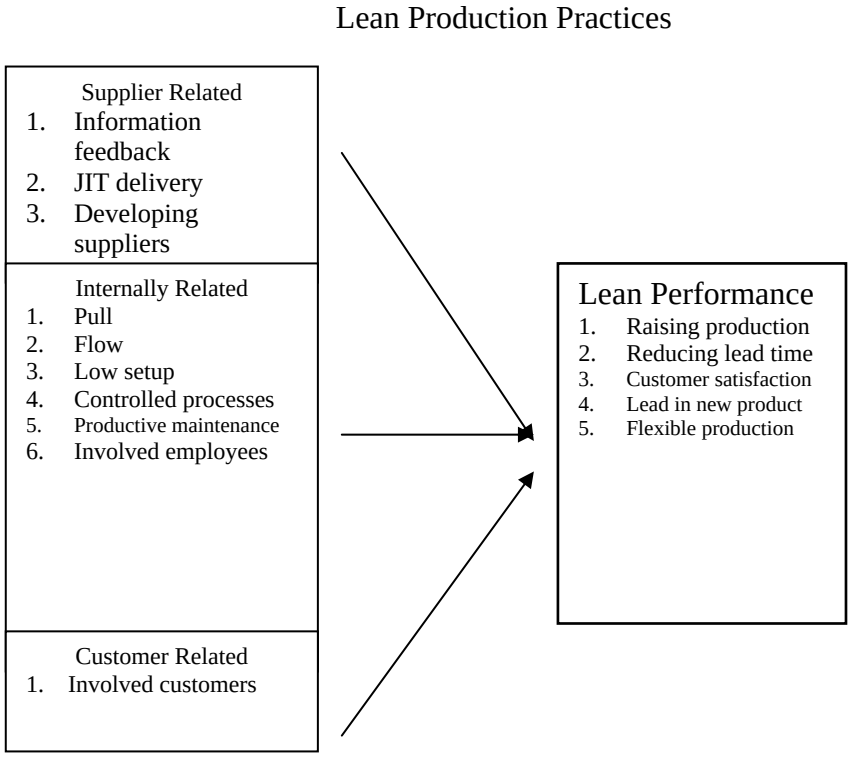

Figure 1 Conceptual framework of research

3. Methods

The empirical objective of this study is to explore how lean production affects manufacturing performance. In this study, we will focus on investigating the relationship between lean practices and manufacturing performance. The important point is how to measure lean practices in terms of its relationship with manufacturing performances. The organizational performances is not only measuring products and services but also including factors of employee, organization, administration and environment. Venkatraman (1990) identified three dimensions of enterprises performances as finance, operation, and organization. There also were measures for plant performances adopted from existing studies.

Because our review of the related literatures exposed considerable overlap in theoretical and operational concepts, we used past research to obtain general insights into measurement. Our study will contain references to Shah and Ward (2007) for definition of lean production and Mckone et al., (2001), Cua et al., (2001), Shah. et al., (2003) for measurement of lean performance.

3.1 Sample

The ranges of observation for this study were sampled Taiwanese traditional manufacturing industries, which included textile, garment, paper, steel, motor and mold. We surveyed the high-level administrators and senior employees of each firms. The instruments were measured on 5-point Likert type scale and data collected from late 2007 to 2008. The questionnaires were mailed to 190 manufacturing managers/senior employees form Taiwanese traditional manufacturing industries, and 186 usable questionnaires were returned.

3.2 Pilot study

The pilot study used 49 responses from manufacturing managers/senior employees in the same ranges of industries for the large-scale study. The analysis included: Corrected Item to Total Correlation (CITC) for purification purposes, exploratory factor analysis within each construct to access the internal rule of unidimensionality, correlation analysis for convergent and discriminable analysis and Cronbach's alpha for reliability.

The analysis results of pilot study, Cronbach's alpha of control variables (customer relationship, supplier relationship, internally management, manufacturing performance) were 0.81、0.74、0.93、0.86, which all met standard 0.7 of Hair et al., (1998), and all items with CITC values were above 0.30.

4. Data Analysis and Discussion

Reliability, Cronbach's alpha in pilot and large-scale studies were above 0.7, as customer relationship (0.842), supplier relationship (0.773), internally management (0.929) and manufacturing performance (0.903) ($P<0.01$). Validity, the construct validity issues were measured by principle component analysis and average come out at 0.7, if which was over 0.3, it would be significant according to Zaltman and Burge (1975).

Correlation, we used Person's *r* to find the relationship between the construct. Result of Person's *r* showed supplier and internally management (0.661), customer and internally management (0.544), customer and supplier (0.667), supplier, customer, internally management and manufacturing performance (0.664, 0.712, 0.490). As Person's *r* is near +1, all constructs will be positively correlated.

Multiple regression and path analysis were adopted for further modeling our research variables' relationship. As the path analysis results, Beta and R^2 of variables relationship were directly and positively; e.g. manufacturing performance with supplier relationship (Beta: 0.644, R^2: 0.411), internally management (Beta: 0.712, R^2: 0.504), customer relationship (Beta: 0.490, R^2: 0.236). The relationship between each other also was directly and positively,

as internally management with supplier (Beta: 0.661, R^2: 0.434) and customer (Beta: 0.544, R^2 : 0.292), customer and supplier (Beta: 0.667, R^2 : 0.442).

Multiple regression analysis with manufacturing performance and facets of lean production, we could find there also were significant effects on manufacturing performance with supplier involvement, controlled processes and employee involvement (Table 1).

Table 1 Regression analysis with manufacturing performance and lean production

	Beta	Adjusted R^2	t	F	P
Supplier's Information feedback	0.119	0.419	3.031	43.807	0.003***
JIT delivery	0.113		1.409		0.161
Developing supplier	0.442		5.563		0.000***
Pull	0.046	0.579	0.743	40.987	0.458
Flow	0.093		1.320		0.188
SETUP	0.131		1.823		0.070
TPM	0.104		1.891		0.006
SPC	0.300		4.195		0.000***
EMP	0.284		3.957		0.000***
Customer's Information feedback	0.140	0.224	1.918	29.54	0.057
Involved customer	0.411		5.620		0.000***

Dependent Variable: Manufacturing Performance *P<0.05 **P<0.01 ***P<0.001

5. Conclusion

This research suggests four major findings. First, the results from our empirical studies, supplier's involvement and information feedback, would help manufacturing performance of most factors. Krause et al., (1998) also proposed supplier's involvement and development would be positively related to manufacturing performance. In other aspect, Vonderembse and Tracey (1999) found supplier selection and involvement would influence manufacturing performance.

Second, internally management appears to make a substantial contribution to manufacturing performance. Baranson (1987) pointed out internally management included product design, production technology, organization planning and business system, and they were the key factors of enterprise competitive advantage. From results of our study, the factors of internally management; as controlled process, low setup, productive maintenance and involved employees, will be more effectiveness in improving manufacturing performance than others.

Third, in customer relationship aspect, customer involvement will be positively related to manufacturing performance. Kellogg, Youngdahl and Bowen (1977) showed customer involvement would be instead of the role of supervisor, and influence employees' work attitude, behavior. It meant customer involvement help manufacturing performance positively and directly.

Fourth, Bhaskar et al., (1977) suggested the meaning of supply chain management was integration of all tiers in supply chain. It meant the importance of sharing information and planning between all members, and which would decrease waste of uncertain demand in supply chain. This research find there are positively and directly relationships between customer, supplier and internally management. The result shows our research construct meet previous literatures of supply chain management.

References

1. Carter, Joseph R. & Ram Narasimhan, 1996, Purchasing and Supply Management: Future Directions and Trends, *International Journal of Purchasing and Material Management,* fall, pp. 2-12.
2. Cooper, M. C. and Ellram, L. M., 1993, Characteristics of supply chain management and the implication for purchasing and logistics strategy, *The International Journal of Logistics Management*, vol.4, no.2, pp.13-24.
3. Cua, K.O., McKone, K.E. &, Schroeder, R.G., 2001, Relationships between implementation of TQM, JIT, and TPM and manufacturing performance, *Journal of Operations Management*, 19(2), pp. 675–694.
4. Baranson, J., 1987, Technical Transfer: Example from Pakistan, *Multinational Business*, 4, 2, 18-26.
5. Bhaskar, A., K.L. Johnson, G.D. Wood, and J. Woodhouse, 1997, Wheel-Rail Dynamics with Closely Conformal Contact, *Journal of Rail and Rapid Transit*, 211, 1, 11-26.
6. Benton, W.C.& Krajewski, L.J., 1990, Vendor Performance and Alternative Manufacturing Environment, *Decision Sciences*, Vol.21, pp. 403-415.
7. Bleeke, J. & Ernst, D., 1991, The Way to Win in Cross-border Alliance, *Harvard Business Review*, Oct-Nov, pp, 127-135.
8. Cambell,J.P., 1977, *On The Natural of organizational Effectiveness*, Jossey, San Franciscos.
9. De Treville, S., Antonakis, J., 2006, Could lean production job design be intrinsically motivating? Contextual, configurational and levels-of-analysis issue, *Journal of Operations Management*, 24 (2), 99–123.
10. Giffi, C., Roth, A.V., Seal, G.M., 1990, *Competing in World-Class Manufacturing: America's 21st Century Challenge*, Business One Irwin, Homewood, IL.
11. Hair, Joseph et al., 1998, *Multivariate Data Analysis*, 5th ed. Prentice-Hall International, Inc.
12. Hopp, W.J., Spearman, M.L., 2004, To pull or not to pull: what is the question? , *Manufacturing and Service Operations Managemen*t, 6 (2), 133–148.

13. Kellogg, D.L., Youngdahl, W.E. & D.E. Bowen, 1997, On the Relationship Between Customer Participation and Satisfaction: Two Frameworks, *International Journal of Service Industry Management*, 8(3), pp.206-219.
14. Krause,D.R., Scannell, T.V.& Calantone, R.J., 1998, An Analysis of the Effectiveness of Buying Firms, Efforts to Improve Supplier Performance, *Proceedings 1998 of the Decision Science Institute*, pp.1200-1202.
15. Mckone, K.E., R.G. Schroeder & K.O. Cua, 2001, The Impact of Total Productive Maintenance Practices on Manufacturing Performance, *Journal of Operations Management*, 19, No.1, pp.39–58.
16. Ragatz G.L., Handfield, R.B. & Scannel T.V., 1997, Success Factors for Integrating Suppliers into New Product Development, *Journal product Innovation Management*, 14,pp.190-202.
17. Rachna Shah & Peter T. Ward, 2003, Lean manufacturing: context, practice bundles, and performance, *Journal of Operations Management*, 21, pp.129–149.
18. Rachna Shah & Peter T. Ward, 2007, Defining and developing measures of lean production, *Journal of Operations Management*, 25, pp.785–805.
19. Scott, C. & R. Westbrook, 1991, New Strategic Tools for Supply Chain Management, *International Journal of physical Distribution and Logistics Management*, 21(1),pp.23-33.
20. Sakakibara, S., Flynn, B.B., Schroeder, R.G., Morris, W.T., 1997, The impact of just-in-time manufacturing and its infrastructure on manufacturing performance, *Management Science*, 43 (9), 1246–1257.
21. Sethuraman, Rajagopalan, James C. Anderson & James A. Narus, 1988, Partnership Advantage and Its Determinants in Distributor and Manufacturer Working Relationships, *Journal of Business Research*, Vol. 17, Iss. 4, pp. 327-347.
22. Turner, J.R., 1993, Integrated Supply chain Management : What's Wrong With This Picture, *Industrial Engineering*, 25(12),pp.52-55.
23. Venkatraman, N., Prescott, J.E., 1990, Environment-strategy co alignment: an empirical test of its performance implications, *Strategic Management Journal*, 11 (1), 1–23.
24. Vonderembse, M.A. & Tracey, M., 1999, Impact of supplier selection criteria And supplier involvement on manufacturing, *The Journal of supply Chain Management*, *Summer*, pp.33-39.
25. White, R.E., Pearson, J.N. & Wilson, J.R., 1999, JIT Manufacturing: a survey of implementation in small and large US manufacturers, *Management Science*, 45 (1), pp.1–15.
26. Zaltman, G. and P.C. Burger, 1975, *Marketing Research: Fundamentals and Dynamics*, Hinsdale, Illinois: Dryden Press.

精實生產與製造績效之關係探討

郭倉義　沈如鵬　陳英美

國立中山大學 企業管理學系

摘　要

當成本、品質、交期、效率、彈性等製造的問題挑戰傳統產業的利潤時，如何在產品生命週期的持續縮短、極端的少量多樣的趨勢下，建構新時代企業必備的兩大基礎競爭力「快速反應」與「競爭優勢」，一直是實務界與學術界關注的焦點。本研究以精實生產管理概念中之『顧客關係』、『供應商關係』、『組織管理技術』來探討其是否會對製造績效產生影響，以及在精實生產的概念中顧客關係、供應商關係與組織管理技術是否彼此有顯著相關，並進一步驗證精實生產管理概念各構面對組織績效之影響力差異。

透過實證研究可得知，製造業管理者欲改善公司的製造績效可藉由精實生產的五項顯著指標變數來進行 (1) 供應商參與 (2) 供應商資訊回饋 (3) 製程管理 (4) 員工參與 (5) 顧客關係。藉由加強供應商關係、組織管理技術與顧客關係的密切程度，可使供應商的品質及交貨績效獲得改善，進而提升本身的製造績效，促進顧客滿意程度，最終以增加企業的競爭力。

關鍵字：精實生產、製造績效、豐田式生產

作者：

郭倉義
中山大學 企管系 專任副教授
E-mail: kuo@bm.nsysu.edu.tw
Tel: 07-5252000 # 4653

沈如鵬
中山大學 企管系 博士研究生

陳英美
中山大學 企管系 碩士