

# Chapter 85

## Influence Mechanism of Lean Production to Manufacturing Enterprises' Competitiveness

Hong-liang Zhang and Zhan-wen Niu

**Abstract** The success of Toyota as well as other enterprises of Japan has proved that lean production can improve manufacturing enterprises' competitiveness greatly. However, lean production's application in other countries is not ideal. One of the reasons is that lean production is treated as a tool set not as system engineering, so under such background, this paper studies the influence mechanism of lean production to manufacturing enterprises' competitiveness upgrading from systematic perspective. In this paper, lean production is not merely confined to improvement tools, but is treated as a system, including improvement tools, lean culture and staff factor. The direct and indirect effect of the three aspects to manufacturing enterprises' competitiveness is analyzed by SEM using SMOS17.0. Analysis result demonstrates the influence mechanism of LP to competitiveness clearly. The study of this paper has practical sense to lean implementation in China and meanwhile it enriches lean production theory.

**Keywords** Competitiveness upgrading · Influence mechanism · Lean implementation · SEM

### 85.1 Introduction

Lean production (short of LP) is from Toyota Production System, whose superiority has been proved by success of Toyota Motor Corporation as well as other Japanese manufacturing corporations. Because it integrates the characters of Ford

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production Mode and handicraft production mode—low cost with high quality, and can satisfy the diversified need of customer-focused marketing, so it is regarded as the third production mode. After 1990s, especially after the publication of book named the machine that changed the world, more and more enterprises outside of Japan began to learn and apply LP. From theoretical point of view, LP can upgrade manufacturing enterprises' competitiveness greatly, but its 20 years' application process is not smooth, not a few enterprises claim their lean implementation is failure or didn't gain desired outcome. Atkinson, Hines et al., Sim and Rodgers dictated that less than 10 % of UK organizations have accomplished a successful lean implementation (Bhasin 2012). Famous IE expert of China Er-shi Qi also pointed out lack of lean environment, enterprises of China encountered high failure rate in lean implementation process. The reason leading to this phenomenon may be complicated, but the fact that treating LP as merely a tool set may be one of the key factors.

Under such background, this paper will regard LP as an engineering system and aims to study the influence mechanism of lean implementation to competitiveness of manufacturing enterprises, finding out direct and indirect effect of LP's different dimensions to manufacturing enterprises' competitiveness upgrading.

## 85.2 Related Theory and Hypothesis

LP as one new production mode is not just a set of improvement tools or technology; in essence, it is complicated system engineering. Many researchers have aware that besides improvement tools, lean implementation should include lean culture and staff factor, and some of them have researched single dimension's part to manufacturing enterprises' competitiveness, but few has studied the relation of the three dimensions as well as their synthetic effect to enterprises' competitiveness.

### 85.2.1 *Improvement Tools*

The viewpoint that improvement tool is one main component of lean implementation is accepted by many researchers and lean practitioners. Because improvement action must be implemented by some means of tools and lean thought needs improvement tools to identify, so many researchers paid attention to it. Monden (2008) pointed out that LP is the compound of JIT production, including field management, resource management, TQM and information system management (Monden 2008). Shah and Ward (2007) pointed out LP comprises three aspects tools, including tool set about supplier management, tool set about customer management and tool set of inner operation management (Shah and Ward 2007). Fullerton and McWatters (2002) did appraisal to LP using 10 tools, they are

focused factory, group technology, Single Minute Exchange of Die, TPM, multi-skills operator, level operation, purchase on time and TQM (Fullerton and McWatters 2002). Kojima and Kaplinsky (2004) thought LP system mainly contain three aspects technology, flexibility, quality and persistence (Kojima and Kaplinsky 2004). Based on the introduction above, this paper gets the following hypothesis.

H1: application of improvement tools has active influence to manufacturing enterprise's competitiveness.

### ***85.2.2 Staff Factor***

Famous management expert Peter F. Drucker once said to staff is the only resource of enterprise, thus management's crucial purpose to mine staff's potential. To lean implementation, staff also plays an irreplaceable role, because staff is the executor of improvement tool and the carrier of lean culture. As to its importance, FujioCho once said a sentence "before making car must first made man". Many researchers also support this viewpoint. In Toyota mode, the internal training material of Toyota Corporation, respecting for people and continuous improvement are treated as two pillars of TPS (Ohno 2001). Lander (2007) also pointed out staff is the most valuable resource of Toyota, so training education and career development is every important to enterprises (Lander 2007). Monden (2008) thought in order to satisfy the need of change, the flexibility of staff is very important (Fullerton and McWatters 2002). Besides direct influence, staff also has indirect influence to upgrading of competitiveness. As the carrier of lean tool, staff will develop and adjust lean technology, making it suitable to demand of specific environment and requirement. So based on the extant research, the following hypothesis is put forward.

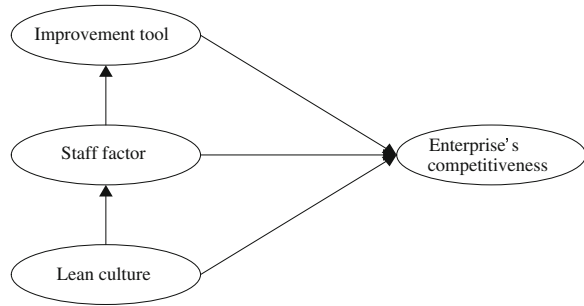
H2: lean staff has positive effect to manufacturing enterprises' competitiveness.

H3: lean staff has active influence to improvement tool's development.

### ***85.2.3 Lean Culture***

Lean culture cultivation is one important factor to propel lean implementation. Without dense lean culture, LP can't be implemented completely for lack of abiding impetus. Cho (2003), former president of Toyota Motor Corporation, said Toyota's strong lies in its shared culture, which means staff of Toyota own the same values and consciousness (Cho 2003). Koole (2005) also pointed out that although LP's outward manifestation is improvement tool, its core is organization's learning ability, so lean implementation effect will be damaged greatly if too much emphasis is put on tools while lean culture is ignored. Liker (2008) said to merely applying lean tools or methods is far from enough, only through setting up

**Fig. 85.1** Concept model of study



talent cultivation system and fostering lean culture can enterprises' competitiveness will be improved everlastingly (Liker 2008). Besides this aspect, dense lean culture will make staff more actively taking part in improvement and provide strong dynamic to ensure the improvement is unremitting. On the base of above discussion, this paper put forward one hypothesis:

H4: lean culture cultivation has positive direct effect to manufacturing enterprises' competitiveness.

H5: lean culture will has active influence to lean staff.

Based on the analysis above, the concept model of this paper is got, see Fig. 85.1.

## 85.3 Methodology

### 85.3.1 Method

This paper will apply structural equation modeling (short of SEM) to verify above hypothesis. Through seeking variables' inner structure relation, it can verify whether the model assumption is reasonable and if theoretical model has fault, it can point out how to revise. SEM is a group of equations reflecting relation of latent and observed variables, through measuring observed variables it can infer latent variables' relation and verify model's correctness (Gong et al. 2011). Observed variables can be measured directly, which is signified by box in path chart, while due to things' complexity and abstraction, it is difficult to measure latent variables directly and in path chart it is signified by elliptic. SEM can substitute for multiple regression, path analysis, factor analysis as well as covariance analysis and so on (Zhang and Gao 2012), its application began at late of twentieth century in society, psychology, education, management, economy as well as other fields.

In studying relation between LP and manufacturing enterprise's competitiveness, traditional quantitative methods are not applicable, because they can not analysis the relation between multiple latent variables and multiple observed variables as well as the relevance among latent variables, so SEM is used in this paper.

### ***85.3.2 Construction of Variables***

Based on extant research and considering the characters of LP and manufacturing enterprises, this paper designs the observed variables. In the process of designing questionnaire, this paper first constructs preliminary questionnaire, and then invests 5 experts of LP and 4 practitioners of LP to give out amendment suggestion, after proper revision, the final questionnaire is got, which adopts 5-rank Likert scale. Based on the acceptance degree, all the items will provide 5 different rank answers, 5-completely agree, 4-basically agree, 3-difficult to determine, 2-don't quite agree, 1-completely disagree.

As to improvement tools, by referring extant research, this paper designs 4 indexes to investigate it, including tools in product design, tools of production process, tools of field management and tools about supplier management. Under lean culture, this paper designs the following indexes, supporting of organization, reward system of improvement, improvement atmosphere and sharing of value. To staff factor, the investigation indexes include enthusiasm of participating improvement, career development plan and team work.

As to competitiveness of manufacturing enterprises, not a few researchers got the conclusion that LP can improve enterprises' operation efficiency. Liao (2005) pointed out that lean implementation can make enterprises have many aspects of advantages, such as lowering WIP, upgrading production flexibility, strengthening quality control ability and so on (Liao 2005). Besides operation efficiency, LP also has an active impact on financial performance. Fullerton et al. (2003) got the conclusion that lean implementation can brought enterprise high profitability, including return on assets, return on sales and cash flow margin (Fullerton et al. 2003). The third aspect is non-financial performance. Although this aspect was often ignored by researcher but it relates to enterprise's long term development. M. Barad and D. Even Spair aware that Toyota Corporation had more stable relation with supplier than enterprises of western countries (Barad and Even Spair 2003). Liker also pointed out that putting much attention to business partner and gave them help as could as possible is one main principle of LP. The study of Gary Andrew O' Dell (2003) showed that Japanese manufacturing enterprises implementing LP performed much better on indexes such as pollutant emission, generation of pollutant and other environmental indexes. So In this paper, manufacturing enterprise's competitiveness will be studied from 3 aspects, including operation efficiency, financial aspect and non-financial aspect.

### ***85.3.3 Data Collection***

In data collection, three main ways were used. Firstly, the MBA of Tian Jin University, who engaged in production management, are investigated in written form. Secondly, the questionnaire is emailed to potential respondents, located in

Tian Jin, He Bei, Shan Dong, An Hui and Jiang Su province. Thirdly, field survey. In this manner chief of production management and employee engaged in lean improvement are invited to fill the questionnaire. 500 questionnaires are given out, and 245 effective questionnaires are collected, the recovery rate is 49 %.

## 85.4 Empirical Study

### 85.4.1 Data Reliability and Validity

Based on application procedure of SEM, we need to check the reliability and validity of data. In this paper software SPSS18.0 is used to check data’s reliability and validity. Firstly, factor analysis is realized by SPSS18.0 and the common factors are got by principal component analysis. During this process, KMO and Bartlett’s test are chose to analyze every index. The calculation result shows that KMO of data sample is 0.826 and Bartlett’s test’s F value reaches significance level at 0.001, which means the data is suitable to factor analysis. Meanwhile, all observed variables’ loading coefficient is above 0.69 and common factors’ reliability coefficient belong to interval (0.709, 0.815), the contribution rate of accumulative total of variance of the 4 common factors is 76.782 %, these means that the data validity and reliability is favorable. Besides, the analysis result shows the coefficient of Cronbach  $\alpha$  to every index is above 0.8, which means the internal consistency of data is good. Analysis result is showed in Table 85.1

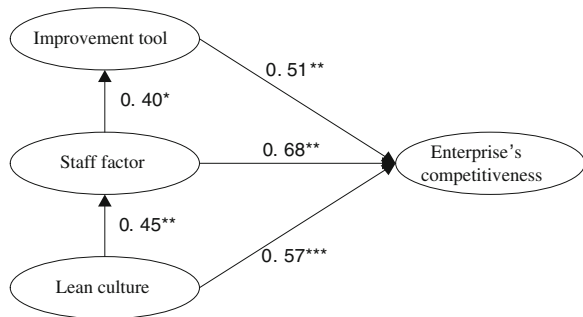
**Table 85.1** Reliability coefficient and factor analysis result

Measurement items	Factors loadings	Loading coefficient	Reliability coefficient	Rate of accumulative total of variance
Improvement tools	Tools in product design	0.723	0.775	76.782%
	Tools of production process	0.832		
	Tools of field management	0.785		
	Tools of supplier management	0.759		
Lean culture	Supporting of organization	0.826	0.709	
	Reward system of improvement	0.867		
	Improvement atmosphere	0.766		
Staff factor	Sharing of value	0.797	0.815	
	Participating improvement	0.782		
	Career development plan	0.771		
Enterprises competitiveness	Team work	0.756	0.759	
	Operation efficiency	0.692		
	Financial performance	0.757		
	Non-financial performance	0.802		

**Table 85.2** Test of model fitting goodness

Fit index	$\chi^2/df$	RMSEA	AGFI	IFI	NFI	CFI
Fitted value	2.21	0.042	0.906	0.931	0.917	0.925
Adaptation standard	<3	<0.05	>0.90	>0.90	>0.90	>0.90

**Fig. 85.2** Path loading coefficient



### 85.4.2 Model-Fitting Degree Analysis

After satisfying measurement requirements, this paper does statistical test to concept model showed in Fig. 85.1, using software AMOS 17.0. Analysis result is listed in Table 85.2, which shows that the fitting degree of concept and the data is favorable.

### 85.4.3 Path Coefficient Analysis

Figure 85.2 shows that except the path coefficient (045) of staff factor to improvement tool merely arrives a = 0.05 significance level, all other coefficients reach a = 0.01 significance level, especially the coefficient of lean culture to enterprise's competitiveness arrives a = 0.001 significance level. So the five hypotheses put forward in this paper are all supported. The Fig. 85.2 shows both the direct and indirect influence of lean dimension to manufacturing enterprise competitiveness. Concretely, to improvement tool, its direct influence is 0.51 and indirect influence is 0, so its comprehensive influence to competitive is 0.51; to staff factor, its direct influence is 0.68 and indirect influence is  $0.40 \times 0.51 = 0.204$ , so its comprehensive is 0.884 and to lean culture, its direct influence is 0.57, indirect influence is  $0.45 \times 0.68 = 0.306$ , so its comprehensive influence is 0.876.

## 85.5 Conclusion

This paper studies the relation of LP and manufacturing enterprise's competitiveness from systematic angle, which no longer confine LP to improvement tool. The analysis result tells us that all the three dimensions have positive effect to manufacturing enterprises' competitiveness. So in implementing LP, the enterprises should not ignore whichever aspect. As to staff factor, it has both direct and indirect effect to manufacturing enterprises' competitiveness, and its comprehensive influence coefficient is maximal in the three aspects, so the enterprises should put much emphasis on this aspect, taking measures to encourage employee to take part in improvement, perfecting their career development plan and encouraging employee to participate all kinds of improvement team. In order to cultivate lean culture, the organization should actively develop dense atmosphere and adjust traditional award system to adapt to lean implementation. Improvement tool, which has been gave much attention by researcher and enterprises, has direct effect to upgrading enterprise competitiveness, but in lean implementation, the implementer should not limit it to production link merely, much more emphasis should be put to improvement tool about facility layout, supplier and customer management.

In a word, the study of this paper will rich the theory of LP and has an active part for successfully implementing LP in China. But confined to ability and time, the study of this paper is not deep enough, related study can be done further. Firstly, the investigation sample mainly distribute in Tian Jin, He Bei, An Hui, Shan Dong and Jiang Su, so if the range of investigation is enlarged the result may be different. Secondly, the study of this paper is done under comprehensive dimension, so if the study refines to specific index under every dimension, the result will be much richer.

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