The Role of People Systems in Lean Production in Enhancing Performance Perceptions and Work-Related Attitudes

Anahita Salari, Hassan Farsijani, Behrouz Dori, Mohammad Reza Hamidizadeh

Department of Management and Accounting, Shahid Beheshti University, Tehran, Iran

Abstract

The purpose of this research is to study which people systems of lean production can have an influence on performance, the perceptions of department performance, and work-related attitudes. A model was developed suggesting that people systems will predict department performance, perception of department performance, and work-related attitudes. Two manufacturing facilities from the automotive industry participated in the study. A total of 100 employees provided survey data. The responses to this survey were used as a measure of people systems of lean production. A total of 40 supervisors provided survey data regarding perceived department effectiveness attributable to the implementation of lean production. Department performance measures included the number of employees to make at least one suggestion for the 2012 calendar year by department and shift as suggestion participation rate. The results of this study suggest that people systems predict work-related attitudes and influence perceptions of department performance by employees. Specifically, people systems were significantly related to commitment to lean strategy, job satisfaction, learning environment, and team efficacy. The people systems composite was significantly related to employee perceptions of department performance, but not people systems lean training. In contrast, the reverse relationship was shown for management perception of department performance.

Keywords: Lean production, people system, performance, manager perceptions

Introduction

The manufacturing around the world is currently undergoing a transformation of historical significance. In the late nineteenth and early twentieth centuries, manufacturing went through the transformation from craft to mass production (Womack, 1990). Now, as we enter the twenty first century, mass production is giving way to a new paradigm described variously as lean production (Womack, 1990), innovative-mediated production (Kenney, 1993), and sleek production (Handyside, 1997). Understanding the core elements of this new approach to manufacturing is critical to the competitive success of any industry, especially automotive industry. This pressure on manufacturers is driven by global competitive pressure. In many segments of manufacturing, lean production has been viewed as the key to Japanese competitive success (Womack, 1990). As such, lean manufacturing has become a critical global business strategy for many manufacturers. However, others argue that it is not the mastery of manufacturing that explains the success of Iranian manufacturing industry. Rather, it is the capability of Iranian companies to continuously create organizational knowledge as well as the intangible elements of the work system. By ignoring these people elements of lean production, organizations may be undermining the catalyst for achieving a competitive advantage. Yet, many manufacturers continue to benchmark and attempt to incorporate the technical aspects of the emerging production system and largely ignore or fail to fully appreciate the people elements.

What is curious about the current transformation is how few manufacturers have successfully imitated the Toyota Production System (TPS) (Spear, Bowen, and Kent, 1999). For example, GM, Ford and Daimler-Chrysler have independently created major initiatives to develop world-class production systems based on the TPS model. Yet, few organizations have reached the levels of manufacturing performance of Toyota. This latest wave in the adoption of lean manufacturing is a system-wide perspective (Kenney, 1993). This strategy attempts to adopt the entire lean production system and not borrow disconnected components of

Corresponding author: Anahita Salari, Department of Management and Accounting, Shahid Beheshti University, Tehran, Iran. Email: anahita_salari70@yahoo.com

a larger system (Cutcher- Gershenfeld, and Michio, 1998). The elements of lean manufacturing, often discussed in the popular press including Quality Circles, Employee Involvement, Statistical Process Control, Just-in-Time Inventory, Total Quality Management, Total Productive Maintenance, and Teams-Based Work Systems (Toyota, 1992).

Manufacturers have increasingly adopted various components of lean manufacturing processes and practices with various levels of success (Keller, 1992). There has been considerable debate regarding what cultural components and human resource management practices and processes are consistent with, promote and sustain lean manufacturing (MacDuffie, 1995). There is some evidence that team-based work systems and "high commitment" HR practices – including extensive training.

The necessity of research

This shift to lean production has been wide spread and has spurred increased research (Klein, 2002). Much of this research activity has focused on the Japanese transplants. Another sector that appears to be making progress in adopting lean manufacturing is auto suppliers (MacDuffie, 1997). The big three auto companies in the U.S. have all initiated activities to adopt lean manufacturing as the predominate production system — in an effort to replace "Taylorist" mass production.

Clearly, there are significant efforts by many organizations as well as entire industries making the shift from mass to lean production and these efforts to become lean are not limited to the manufacturing industries. The technical elements of lean production have been extensively studied (Womack, 1990). However, few empirical studies have directly studied the people elements of lean production among automotive industry in Iran.

Purpose of the Study

The purpose of this study is to increase understanding of the people elements that foster the diffusion of lean production. While the research and practitioner literatures are beginning to understand the management practices and processes that are necessary to encourage lean manufacturing, little empirical evidence is available to support their findings or define how individual and group attitudes relate mutually with the production system. Additionally, there is little empirical evidence that supports the position that investing in the people aspects of lean production has a positive impact on performance beyond the technical elements of lean production. This study will examine the relationship between the people elements of lean production as well as the integration of these elements in the implementation of lean production.

The people elements of lean production will be defined by 13 factors, which include the following: (1) supervisory behaviors; (2) management support; (3) cooperative union-management relations; (4) development focus; (5) managing change; (6) teamwork; (7) involvement/psychological participation; (8) process focus; (9) proactive problem solving; (10) workplace trust; (11) workplace bonding; (12) workplace bridging; and, (13) conflict resolution climate. The mediating variable for assessing the level of integration is based on four items, which includes (1) The performance of standardized work; (2) Team work adjustments to match time; (3) Problem solving is used and consistently followed; and (4) That problem solving has become a methodology for management change. The dependent variables include department performance data, and individual and group work-related attitudes. Department archival effectiveness factors will include suggestions and productivity measures as well as perceived department performance. Department and individual work-related attitude factors will be defined by four factors including (1) commitment to lean strategy; (2) job satisfaction; (3) perceived learning environment; and, (4) team efficacy.

Research Hypotheses

H1: People systems of lean production are positively and significantly related to department performance.

H2: People systems of lean production are positively and significantly related to perceived department effectiveness.

Review of Literature

Origin of Lean Production

From the early days of manufacturing, dating back to the early 1900s, there has been a persistent effort aimed at improving production. The industrial revolution in the late 19th century coupled with new techniques of manufacturing fueled these efforts. More recently, a number of new approaches to production management have emerged. Just In Time (JIT), Total Quality Management (TQM), value based management, process reengineering, world-class manufacturing, and concurrent engineering are some of them (Koskela, 2000).

When analyzed closely, all of the above management approaches seem to have a common core, but perspectives vary. For instance, JIT stresses the elimination of wait times, whereas TQM aims at the removal of non-value adding activities; however both try to improve the flow of work, material and information (Koskela, 2000). Generalizing these approaches led to a new production philosophy called lean production, which is modeled after the successful Japanese automobile manufacturer Toyota. The concept of Lean was developed by Toyota, led by engineer Ohno, to cut waste and improve efficiency.

The three objectives observed by Toyota engineer Ohno for a lean production system are (Kaufman Consulting Group, LLC, 2000):

1. Delivery of product that meets the requirement of customer
2. Produce with zero waste
3. Maintain minimum inventory

Types of production processes

The world of manufacturing/production has seen many types of production processes over the past two centuries. Two of the successful kinds of production techniques were craft and mass production. The 19th century and early 20th century have witnessed craft production and then came Henry Ford's Mass Production after the industrial revolution.

Lean production is the newest type of production. Lean production has also evolved in the car manufacturing industry and lean applications have shown tremendous results in the manufacturing sector, revolutionizing the production systems and forcing manufacturers to reassess their current production systems. This innovative production system is better understood in contrast with the other two kinds of productions (Craft and Mass production) that human beings have devised to make things.

Craft production uses highly skilled workers and simple but flexible tools to make exactly what the customer ask for–one item at a time. For example, exotic sports cars and custom furniture provide current day examples. Anyone would like the idea of craft production, but the problem with it is obvious: Goods produced by the craft method cost too much for most of us to afford. So, mass production was developed at the beginning of the twentieth century as an alternative (Womack, 1990).

Mass-production uses narrowly skilled professionals to design products to be mentioned using expensive single-purpose machines. Due to the high costs of machinery, mass production designs are standardized such that higher volumes are produced at lower costs but at the expense of variety. This means of producing goods is monotonous and uninspiring to workers.

Lean production combines the best features of craft production (high-quality, individualized, custom-made products) and mass production (manufacturing at great quantities to satisfy broad consumer needs at lower prices). Lean uses multi-skilled workers at all levels of the organization. Flexible and increasingly automated machines are used to produce volumes of products with reasonable variety.

Lean principles have been applied successfully worldwide in the automobile industry. Manufacturers like Toyota have strived to work towards the ideal, which is 100% value added work with zero (or minimum) waste. These lean principles are being increasingly employed in many other industrial sectors with a lot of success. The best results can be obtained when used in a repetitive or continuous production environment.

Defining Lean

While lean production is based upon the Toyota Production System, it cannot be equated with the Toyota Production System. Lean production was originally proposed as a set of tools and techniques that eliminate waste. When Womack *et al.* wrote their book, The Machine that Changed the World (1990), which was the catalyst for the lean revolution, they believed that the ideas implemented at Toyota could be transferred directly to other facilities and greatly improve productivity. Observers of the Toyota Production System tended to become enamored with the tools that were developed at Toyota. Toyota was quite open about sharing its knowledge and tools, but people who visited tended to leave with only the tools (Spear & Bowen, 2004). Western observers, in particular, equated lean with the tools and techniques, believing that using these tools and techniques resulted in a lean organization. What many the observers failed to grasp initially was that the tools and practices were contextually developed to fit the unique needs of Toyota's specific customers. The Toyota Production System was developed over many years to compete in a market where customers demanded diversity in the products they purchased (Ohno, 1978). The tools and practices found in the system were not fundamental to the success of the system. These tools and practices addressed the market needs at that time and were not universal or static (Spear, 2004). Toyota's philosophy is to use and discard tools depending on the ways the tools address the organization's need.

While the elimination of waste through the use of lean tools is a core concept in the establishment of a lean system, it is not the primary goal (Schoenberger, 2009). The real goal of the Toyota Production System is to create value for the customer (Ohno, 1978). All of its systems, people, and decisions are directed at creating that value through organizational learning and continuous improvement (Liker, 2004).

Methodology

Research Site

In this study, there are two manufacturing sites including Saipa and Iran Khodro that participated in this study. Both plants have a history of workplace innovation. Like many other plants, these facilities adopted workplace innovation in a piecemeal approach. The common history of these adoptions is the failure to maintain these innovations. For example, each plant has adopted such innovations as statistical process control (SPC), quality circles, team-based work systems, just-in-time, and standardized work. The common cause cited in interviews of key personnel as to why these innovations were not maintained is the lack of a clear vision or systematic understanding of lean production as well as an understanding of how the pieces of lean production fit together into a cohesive whole.

Subjects

The sample of subjects included 100 hourly employees and 40 supervisors or managers of Saipa and Iran Khodro car manufacturing industry. Employees from all functional areas were included in the pool of subjects for survey administration.

Measurement of Variables

The data sources for this study were based on a combination of sources. The data collection instruments include an attitude survey, an assessment of perceived department effectiveness, archival department performance, and interview data.

Independent Variables

The independent variable include the people systems of lean production. The people elements of lean production were measured by a questionnaire. The independent variables assessed in the questionnaire include the following constructs: (1) Supervisory practices; (2) Management support; (3) Cooperative union-management relations; (4) Developmental focus; (5) Managing change; (6) Teamwork; (7) Involvement/psychological involvement; (8) Process focus; (9) Proactive problem solving; (10) Workplace trust; (11) Workplace bonding; (12) Workplace bridging; (13) Conflict resolution climate; and (14) Lean training. The scales are all five-point items except lean training, which is a yes/no response to specific lean training items.

Results and discussion

In this chapter, the results of each hypothesis are presented. The chapter also includes descriptive statistics, correlation analysis, and factor analysis as well as a summary of the research findings.

Perceptions regarding the implementation of lean production

The mean, standard deviations, and correlations for each scale are presented in Table 1. The reliability coefficients (alphas) are presented on the diagonals. The people systems scales were created in a two-step process. First, the data was aggregated at the individual level. Second, mean responses were created at the work unit level. All questions are based on a five-point scale, except team efficacy (item 18), which is based on a seven-point scale. The measure for lean training is calculated based on a series of yes/no (ordinal) responses for specific lean training participated in by each survey respondent. Mean responses were then created for each department. There are eight lean training questions in total. Hence, the range of responses for any respondent varies between zero and eight (0-8). There is no reliability coefficient for lean training (item 19).

As it is clear from table 1, the majority of the scales are significantly correlated. The table shows that lean training is not significantly correlated with any of the scales, except for a -.26 correlation with workplace bridging at the .05 level. The table also shows that the reliability coefficients (alphas) range from the high of .97 for supervisory behaviors to a low of .68 for both cooperative union management behaviors and for commitment to lean strategy. The average reliability for the entire instrument is .85.

Table 1. Descriptive statistics, correlations and reliability coefficients for people systems of lean production

Variable	M	SD	1	2	3	4	5	6	7	8
Supervisory behavior	3.21	.6357	(.97)							
Management support	2.43	.5233	.53**	(.96)						
Cooperative union management relations	3.35	.4654	.31**	.59**	(.68)					
Commitment to lean strategy	3.10	.3743	.24*	.48**	.30*	(.68)				
Job satisfaction	2.86	.5621	.62**	.65**	.33**	.42**	(.78)			
Perceived learning environment	2.72	.4321	.64**	.59**	.36**	.61**	.66**	(.81)		
Developmental focus	2.72	.4211	.71**	.68**	.49**	.32**	.63**	.59**	(.73)	
Perceived team performance	3.12	.4561	.31**	.70**	.64**	.54**	.61**	.53**	.57**	(.94)
Managing change	2.62	.5032	.51**	.62**	.61**	.49**	.50**	.67**	.66**	.65**
Team work	2.87	.5321	.40**	.53**	.39**	.40**	.32**	.57**	.46**	.40**
Involvement	2.34	.6434	.61**	.47**	.27	.42**	.46**	.63**	.60**	.32**
Process focus	3.12	.4621	.46**	.62**	.49**	.41**	.52**	.56**	.52**	.60**
Proactive problem-solving	2.32	.5124	.49**	.63**	.49**	.43**	.63**	.64**	.62**	.45**
Workplace trust	2.42	.4530	.50**	.59**	.41**	.22**	.51**	.52**	.54**	.35**
Workplace bonding	2.75	.4634	.57**	.34**	.24**	.32**	.40**	.58**	.50**	.26**
Workplace bridging	2.62	.4598	..52**	.67**	.62**	.23**	.58**	.54**	.75**	.56**
Conflict resolution practice	2.73	.4621	.74**	.60**	.41**	.32**	.54**	.56**	.76**	.46**
Team efficacy	4.52	.8324	.13	.32**	.25*	.12	.14	.22*	.21	.27*
Lean training	4.32	.7435	.11	-.04	-.12	.06	-.05	.13	.05	-.15

*correlation is significant at the 0.05 level

**correlation is significant at the 0.01level

Table 1 (Continued). Descriptive statistics, correlations and reliability coefficients for people systems of lean production

Variable	9	10	11	12	13	14	15	16	17	18
Managing change	(.78)									
Teamwork	.53**	(.83)								
Involvement	.51**	.63**	(.82)							
Process focus	.67**	.70**	.52**	(.82)						
Proactive problem-solving	.67**	.79**	.68**	.75**	(.87)					
Workplace trust	.53**	.53**	.42**	.50**	.58**	(.73)				
Workplace bonding	.42**	.62**	.64**	.57**	.66**	.67**	(.82)			
Workplace bridging	.61**	.60**	.51**	.63**	.72**	.63**	.52**	(.84)		
Conflict resolution practice	.53**	.50**	.62**	.43**	.58**	.40**	.49**	.64**	(.80)	
Team efficacy	.32**	.51**	.23	.56**	.43**	.51**	.32**	.34**	.10	(.92)
Lean training	.12	.11	.12	.25	.08	-.05	.06	-.35	-.15	.18

Factor analysis for people systems

Exploratory factor analysis using Varimax rotation was used to assess the factorial structure of the thirteen people systems scales and lean training. The principal components method was used and the rotation converged in five iterations upon three interpretable factors. Table 2 shows the rotated factor matrix. Overall, these factors accounted for 75% of the variance in these data. Factor 1 consists of the following scales: 1) Labor management relations; 2) Managing change; 3) Management support; 4) Process focus; 5) Workplace bridging; 6) Problem solving; and, 7) Team work. These seven scales accounted for 31 % of the total variance in these data. For the purpose of this study, factor 1 will be labeled as inter group connections. Factor 2 consists of the following scales: 1) Involvement psychology; 2) Supervisor behavior; 3) Workplace bonding; 4) Conflict resolution; 5) Developmental focus; and, 6) Workplace trust. These six scales accounted for 31.49% of the total variance in these data. Factor 2 will be labeled as intra group connections. Factor 3 consists of eight yes/no lean production training questions that accounts for 9.31% of the variance and will be labeled as lean training.

Correlation analysis was conducted on these three factors and a strong statistical significant relationship between factor 1 and factor 2 (r = .75) was found. Even after factor 1 was limited to include just labor management relations through workplace bridging, and factor 2 was amended to include involvement psychology through conflict resolution, a strong statistical significant relationship was still found between these factors (r = .67). In neither case was lean training (factor 3) found to be significantly correlated with factor 1 (i.e., r = .01) or factor 2 (i.e., r = .05).

As a result people systems is divided into two factors for this analysis. Factor one is based on all those items identified in factor 1 and 2 above and is identified as people systems composite. The second factor of people systems will be based solely on lean training. The correlation is .04 between lean training and people systems composite.

Table 2. Results of factor analysis of lean production people systems scales

	Factor loading		
Variable	1	2	3
Labor management relation	.81	.04	-.17
Management change	.71	.26	.10
Management support	.72	.34	-.06
Process focus	.75	.36	.32
Workplace bridging	.68	.51	-.21
Problem solving	.63	.52	.25
Teamwork	.49	.50	.32
Involvement psychology	.24	.78	.27
Supervisory behavior	.22	.79	-.08
Workplace bonding	.22	.75	.21
Conflict resolution	.36	.72	-.27
Developmental focus	.57	.67	-.25
Workplace trust	.53	.54	.05
Lean training	-.06	.04	.91

Testing Hypothesis 1

Hypothesis 1 asserts that people systems of lean production are positively and significantly related to department performance. In other words, as department ratings of the people systems of lean production increase, department performance measures improve. As stated above, department performance measures include the number of employees to make at least one suggestion per department and shift annually calculated as suggestion participation rate and uptime by department and shift as a percent of uptime over an eight-month period. Table 3 shows the results of the regression analysis. People systems measures include people systems composite (composite) and lean training (training). People systems had no statistical significant impact on suggestion participation or uptime. In fact, Hypothesis 1 is not supported.

Table 3. Regression results of the test for people systems effect on suggestion participation rate and uptime

Independent variable	Suggestion participation	Uptime
Team size	.12	.07
R square	.00	.04
People system Composite (Beta)	-.05	.21
Training (Beta)	.23	.03
R square change	.07	.04

*p<.10, **p<.05, and ***p<.01

Testing Hypothesis 2

Hypothesis 2 states that the people systems of lean production are positively and significantly related to perceived department effectiveness. That is, the adoption of the people system components of lean will result in the perception of improved department effectiveness. The two measures of people systems were used in this analysis including people systems composite (composite), and lean training (training). Table 4 provides the results of this analysis. The two measures of people systems were regressed with perceived effectiveness at the supervisor and managers. The results identify no statistical significant relationship between people systems composite (composite) and perceived improved effectiveness at the management (MGT) level (B = -.11). However, there is a statistically significant relationship between lean training (training) and perceived improved effectiveness as rated by the managers at the .01 level (B = .30). The R square change attributable to the lean training factor of people systems is .12.

Table 4. Regression results of the test for people systems effect on perceived effectiveness and work-related attitudes

Variable	Perceived effectiveness		Work-related attitudes			
	MGT	PTP	CLS	JS	LE	TE
Team size Beta	.17	.05	.01	.07	.11	.10
R square	.05*	.06**	.13***	.03	.13***	.06**
People system Composite Beta	-.14	.43***	.17***	.57***	.62***	.32***
Training (Beta)	.30***	-.11	.02	-.07	.14	.16
R square	.12***	.29***	.08**	.42***	.36***	.10**

* p < . 10, ** p < .05, *** p < . 01

In contrast, when the two measures of people systems are regressed with perceived effectiveness as rated by employees the reverse was found. The people systems composite (composite) is statistically related to perceived performance as rated by department level employees (PTP) at the .01 level (B = .43). However, lean training (training) is not statistically associated with perceived performance at the employee level. The R square change accounted for by people composite systems is .29. Hypothesis 2 was partially supported.

The findings in hypothesis 2 provide further support to differences in perceptions of managers and employees in the transformation to lean production. That is, managers perceive no relationship between people systems of lean production and department performance. However, lean training is associated with perceptions of improvement in department performance. The findings in hypothesis 2 suggests that managers perceive the transformation to lean production as phenomenon driven by technological change combined with changes by their employees achieved through lean training. However, the reverse findings found for employees suggest that employees look for changes in management behaviors (people systems) not technological change or training. Or put differently, employees believe changes have occurred when they observe changes in management behaviors.

Conclusion

Manufacturers around the world continue to expend immense effort to implement lean production. However, despite efforts by many manufacturers to implement lean production, few have successfully imitated the Toyota Production System (TPS) (Spear, 1999). The implications in implementing lean production are dramatic for these manufacturers in both short term and long term consequences. Those firms that fail to adequately implement lean production will face significant performance gaps with those manufacturers that achieve a fully integrated implementation of lean production.

Many of these efforts as described by practitioners and the academic community have focused on the people aspects of lean production. In fact, many organizations have begun to make the shift from mass production to a people- centered approach of lean production.

The purpose of this study was to increase understanding of the people elements that foster in the diffusion of lean production. This study examined the role of people system in lean production. Specifically, this study sought to provide empirical evidence that investing in the people aspects of lean production has a positive impact on performance and work-related attitudes of lean production. This study identified key characteristics of lean production and linked these characteristics with effectiveness data and work-related attitudes at the department level. The key findings of this study are as follows:

First, the correlation analysis and the factor analysis of the people systems indicate that key people aspects of lean production at the department level can be identified and measured. Then, I found that these measures of people systems can be analyzed in terms of department performance and work-related attitudes. Moreover, the research indicated that the people systems of lean production can be used to provide a more thorough understanding of lean production as well as differentiate between departments that have adopted a technology centered approach versus an integrated approach in implemented lean production.

Second, the people systems composite measure was a significant predictor of perceived performance as assessed by department level employees (hypothesis 2). People systems lean training was not a significant predictor. The reverse was found for management assessment of performance. That is, people systems lean training was a significant predictor and people systems composite was not significant as rated by management. This suggests that department employees associated people systems (i.e., supervisory behavior, management support, etc.) as a composite with improved perceived department performance. In contrast, management associated lean training efforts with improved department performance. These findings reinforce difference in perceptions by management level and department level employees in the brownfield conversion to lean production.

Third, consistent with hypothesis 2, the people systems composite measure was a significant predictor of work-related attitudes at the department level. This suggests that the investment in people systems have a significant and positive impact on each of the work-related attitudes, which include commitment to lean strategy, job satisfaction, learning environment, and team efficacy, at the department level.

Implications for Practice

This study provided support for the idea that people systems must be integrated to fully capture the full potential of lean production. There are three key implications for practitioners that can be drawn from these findings.

The model for this research entitled A Framework for a Comparative Analysis of Alternative Approaches to the Diffusion of Lean Production in Brownfield Sites provides a conceptual framework to more fully understand factors influencing the successful diffusion of lean production. For many practitioners the transition to lean production is solely a technical systems transformation. The interviews associated with this research suggest that many practitioners do not consider people systems in the diffusion of lean production. However, those practitioners who have worked in a full lean production system – that is a fully integrated model – accept the technical aspects of lean production as a necessary fundamental ingredient, but focus most of their attention on the people aspects of lean production. As such, this model will assist practitioners by augmenting their current understanding of lean production.

Further, this study provided support for the proposition that people systems must be addressed in the implementation of lean production. Work-related attitudes are shaped by the people systems of lean production. People systems also shape employee perceptions of department performance. This study provides an assessment instrument for practitioners to assess the current state of their organizations and measure progress over time as these organizations convert to lean production as well as assess whether these organizations are maintaining people systems consistent with lean production.

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