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Impact of Lean Production Initiatives on Quality: Theoretical Analysis and Empirical Research

Sergei TITOV*, Evgeny NIKULCHEV**, Gregory BUBNOV***, Alexander BIRYUKOV****

Abstract

Lean production is a well know managerial framework for optimization of organizational processes through waste elimination and cost reduction. Though many researchers pointed to the similarities between lean production and total quality management they do not usually proceed to conclusions about the possible impact of lean production practices on quality issues. The article undertakes the comparative theoretical analysis of lean production and TQM on two levels – on the level of general theoretical principles and on the level of the practical tools and techniques. The authors conclude that lean production practices not only can but should lead to the improvement of the quality of processes and products. The empirical analysis of the results of lean production improvement initiatives in 74 Russian companies leads to the same conclusion. The survey of the participants of lean production introduction projects in Russian companies shows that the number of the defects detected and corrected on the later stages of the value streams in these companies decreased. Hence, lean production can be considered as a set of tools not only for cost reduction but also for quality enhancement.

Keywords: *quality management, lean production, TQM, cost reduction, waste elimination, quality of processes, quality of products*.

1. Introduction

Lean production (also known as lean manufacturing, lean management or just lean) is a very popular managerial framework used for organizational improvement and focused on waste elimination and cost reduction. Lean production has been attracting considerable attention among academics and practitioners since late 1970s (Sugimori et al., 1977) and early 1980s (Monden, 1983) when researchers started to describe the results of successful management experiments and initiatives at Toyota Motor Company (Ōno, 1988). At first, publications on lean production were devoted primarily to the analysis of the elements rather than the whole system of the lean production – on such practices and tools as Kanban, just-in-time production, people involvement, pull system and so on. But relatively later, in the 1990s, the publications explaining the guiding principle and the underlying management philosophy appeared (Womack and Jones, 1996; Spear and Bowen, 1999). Hence, we can distinguish two streams in the literature on lean production which reflects two different levels of conceptualization of this framework. On the theoretical level lean production is described primarily as a methodology based on the general principles and approaches. On this level lean production is usually conceived in much broader terms rather than just waste elimination and cost reduction in internal processes. Here lean production focused on enhancement of customer value through optimization of the whole organizational system (sometimes including the processes outside of the organization (Naylor et al., 1999)). On the practical level lean production presents as a set of different tools and techniques that can be used mostly for the optimization of the processes through waste elimination.

The effectiveness of lean production has been analyzed in a huge number of publications (Shah and Ward, 2003; Browning and Heath, 2009; Corbett, 2007). Up to now there is considerable evidence that lean production principles and tools can really bring about improvements in organizations in terms of process optimization and cost reduction (Monden, 1981; Krafcik, 1988; Cagliano et al., 2004). Therefore, among researchers and practitioners there is no doubt about the positive impact of lean production on the efficiency of the operations in organizations.

However, the existing body of research does not shed light on the potential impact of lean production practices on quality of processes and products. The main reason why researchers are not very interested in analyzing the impact of lean production on quality is quite simple. It is Total Quality Management (TQM) framework which has been considered up to now as the main methodology used to improve quality in organizations (Aucoin, 2000). Nevertheless, some researchers pointed to the theoretical and practical affinity between TQM and lean production (Andersson et al., 2006; Näslund, 2008) and it is possible to anticipate the influence of lean production tools and techniques on quality. However, they usually do not proceed to the conclusions about the potential impact of lean production on quality of products and processes in organizations.

This article attempts to compensate for the deficiency in the current research on the probable consequences of lean production implementation for quality. The main task of the article is to analyze the possible impact of lean production practices on quality in organization. The first task is to compare TQM and lean production on two levels – on the level of methodological principles and concepts and on the level of practically used tools and techniques and eventually to conclude which impact we can expect from the lean production on the quality in organizations – and to discover the similarities between two frameworks which can allow us to conclude about the potential impact on lean production on quality. The second task is to undertake the empirical research based on the survey and investigate into the practical results of lean production practices in Russian companies in terms of their impact on quality of products and processes.

2. Total Quality Management

TQM is a well known, widely used and globally recognized managerial framework which initially started in Japan, although as a result of influence from the ideas originally developed by

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some American thinkers (especially, Deming and Juran) participated in rebuilding Japanese economy after World War II. In the early stages of its development, TQM was focus primarily on quality management tools and techniques. However, during the 1990s TQM evolved as a general managerial philosophy and an organizational change approach pertaining not only to improving quality of products, services, but also to enhancing overall organizational performance. It is true that quality issues are very important within the TQM framework. But from the 1990s TQM has been usually defined in much broader terms rather than just quality management. For example, Dean and Bowen (1994) defined TQM as philosophy or an approach to management that can be characterized by three main principles – customer focus, continuous improvement, and teamwork. Sitkin et al. (1994) educed within TQM framework similar three guiding precepts – focusing on customer satisfaction, stressing continuous improvement, and treating the organization as a total system. International Organization for Standardization in its standard ISO 8402: 1994 saw TQM as 'based on the participation of all its members and aiming at long term success through customer satisfaction and benefits to all members of the organization and society' (Pfeifer, 2002). British Standards Institution in standard BS 7850-1:1992 defined TQM as 'a management philosophy and company practices that aim to harness the human and material resources of an organization in the most effective way to achieve the objectives of the organization' (Hoyle, 2007). The last definition is especially revealing because it shows that TQM nowadays is understood as a general approach to organizational development and change in very broad terms.

On the level of practical tools TQM can be considered as a rather amorphous set of different techniques and models that are used not only to improve the quality of the products and services but also to generate new ideas, streamline processes, optimize decisions, and cut costs. Tauge (2005) in her 'quality toolbox' included 149 different tools grouped into six categories. Tari (2005) also identified a plethora of tools within the TQM arsenal. Most of the authors agree that many of the tools and techniques of TQM can be considered as common for many other managerial frameworks such as six sigma, lean manufacturing, business process re-engineering, just-in-time, Kaizen and so on. For example, Shah and Ward (2007) grouped all the practices associated with such 'fads' as six sigma, lean, TQM, JIT etc. into 25 general groups and came to conclusions that all of them in theory and practice are associated with more than one framework. In particular, eleven enlarged TQM techniques can be easily considered as lean production tools at the same time.

3. Lean production

On the level of general principles lean production has been originally understood as the systematic removal of waste by all participants of the value streams in the organization (Womack and Jones, 1994). Phillips also emphasized waste as a focus of lean production: 'lean manufacturing is aimed at the elimination of waste in every area of production including customer relations, product design, supplier network, and factory management' (Phillips, 2002). The definition in NIST is quite similar: Lean production is 'a systematic approach to identifying and eliminating waste through continuous improvement, flowing the product at the pull of the customer in pursuit of perfection (NIST, 2000). It is true that the notion of waste in variety of its forms is in the center of the lean production framework. However, it is difficult to agree with Achanga (2006) and Bicheno (2004) who consider lean production as a cost-reduction mechanism. Many authors except that cost reduction is one of the important aims of lean production, However, they add that the cost reduction is not the most important aim and is not the only one aim of lean production. Nave (2002), Snee (2004), Womack (2006) and many others emphasize that the focus of lean production is customer value and that lean process starts from definition of customer value and identification of value streams in organization. They all agree (for example, Worley and Doolen, 2006; Bhasin and Burcher, 2006) that customer value can be improved not only by cutting costs, but also by enhancing customer satisfaction (for instance, by reducing the number of defects, by cutting waiting times, etc.).

Though the variety of tools available in lean production is not as impressive as in TQM, the lean techniques comprise quite a few different approaches. The most known lean tools are value stream analysis/ mapping/ modeling (Hines and Taylor, 2000; Womack, 2006), total productive maintenance (Katayama and Bennett, 1996), Kaizen (Bhasin and Burcher, 2006), Kanban cards (Liker, 2004), 5S (sort, set, shine, standardize, sustain) (Liker and Yu, 2000). In Näslung, 2008 and Andersson et al., 2006 it is persuasively shown that all operational lean tools and techniques are used in JIT and TQM initiatives. Though lean practices bring primarily waste reduction, they can help to improve quality of products and processes as well.

4. Comparing TQM and lean production

It is clear that TQM and lean production while being quite different theoretical and practical frameworks have many similarities and do not contradict and exclude each other. Of course, the main focus of TQM is quality and of lean production – waste. At the same time, in recent years TQM and lean production has been evolving the more and more holistic and systemic approaches. TQM has been emphasizing the perspective of customer satisfaction which includes not only quality aspects. Lean production has been underscoring more and more the significance of customer value which cannot be reduced to solely elimination of waste. Customer value can be understood as a ratio of quality to cost and therefore it can be created either by cutting costs or by improving quality.

If we look at the operational practices and practical tools of TQM and lean production we can spot many commonalities. Such general practices of TQM as just-in-time principles, employee involvement, continuous improvement, statistical process control, group problem solving, cross functional team, workforce commitment, preventive maintenance, supplier involvement, customer involvement, simplicity in product design are widely used in lean production initiatives (Shah and Ward, 2007). On the other hand, such lean practices and tools as value stream analysis, setup time reduction, lot size reduction, Kanban cards and pull systems, Kaizen are often a part of TQM improvement projects.

Hence, it can be concluded that lean production initiatives should bring improvements not only in terms of waste and cost reduction, but also in terms of quality enhancement. In truth, if we look at the quality management issues through the lenses of value stream approach essential for lean production, we can conclude that quality and waste are in many aspects intertwined. In particular, the defects produced should be corrected and this takes some time and resources and can be considered as a source of waste (Ôno, 1988; Womack and Jones, 1996; Womack, 2006). The defects that were detected within the later stages of the value stream take even more time and resources rather than defects detected and corrected on the earlier stages. Therefore, lean production not only can, but must improve the quality of processes and products in companies that implement lean production systems.

5. Methods of research

The purpose of the empirical analysis in this study is to assess the impact of lean production initiatives on quality issues in Russian companies. In particular, the study attempts to assess the impact of lean initiatives on quality in terms of the number of defects that were: detected and corrected within the stage of the value stream where they were produced (1), that were detected and corrected on the next stage of the value stream (2), and that were detected and corrected on the stage after the next (3). The more defects are detected and corrected within the stage on which they are produced, the few defects will be transferred to the further stages and ultimately the few defects will be embodied in the finished products and the higher the quality of the finished goods and provided services are.

In Russian segments of social networks LinkedIn.com and Facebook.com there were located 13 different communities focused on the problems of lean production. Through the communications with participants of these communities 74 people from different companies were identified which participated in the lean production improvement projects in their companies and who have the access to the numerical data about the results and consequences of these initiatives. These 74 people were asked to take part in the survey and to assess the changes in the numbers of defects detected and corrected on the different stages of the values streams as a result of lean production improvement initiatives realized in their companies. 34 of these people sent correctly completed questionnaires. The data collected was analyzed with the help of MiniTab software.

6. The results of the research

The respondents reported that the number of the defects detected and corrected on the stages where they were produced significantly increased. On average, the number of these defects increased on 49.85%. The median value is 46.50%. The minimum increase reported is 10% and the maximum – 95%. None of the respondents reported the decrease in the number of these defects. The distribution of the assessment of the changes in the number of the defects detected and corrected on the stages where they were produced is shown on *figure* 1. Hence, it is clear that lean production initiatives lead to the increase in the number of the defects detected and corrected on the stages where they were produced.

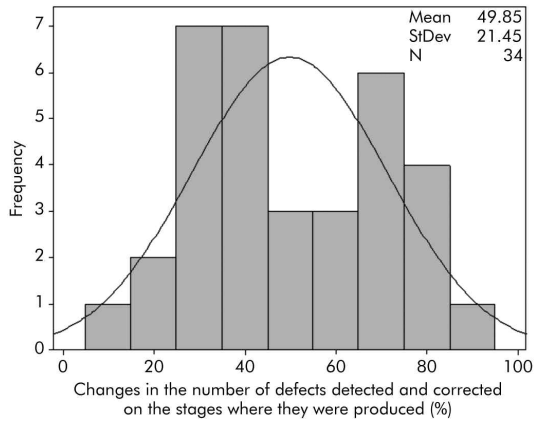

***Figure* 1. The distribution of the assessments of the changes in the number of the defects detected and corrected on the stages where they were produced**

The data concerning the number of the defects detected and corrected on the next stage (after the stage where they were produced) shows the significant decrease of this type of the defects. On average, the number of these defects decreased on 39.00%, with the median value -41.00%. The minimal decrease (modulo) is 5%, the maximum -75%. The distribution of the values of the changes in this type of defects is shown on *figure* 2. Overall, the number of the defects detected and corrected on the next stage dropped visibly.

The decrease in the numbers of the defects detected and corrected on the stage after the next is noticeably smaller than the decrease in the numbers of the defects detected and corrected on the next stage. On average, the decrease of the third type of defects is 9.12%. Maximum increase is 10.00%, maximum decrease is -35.00%, and the median value -6.50%. It is clear that the lean production initiatives lead to the moderate reduction of the defects detected and corrected on the stage after the next.

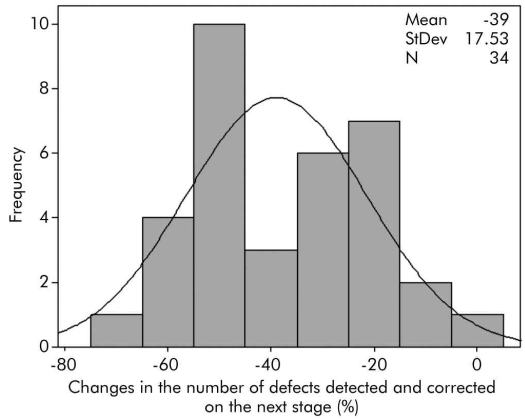

***Figure* 2. The distribution of the assessments of the changes in the number of the defects detected and corrected on the next stage**

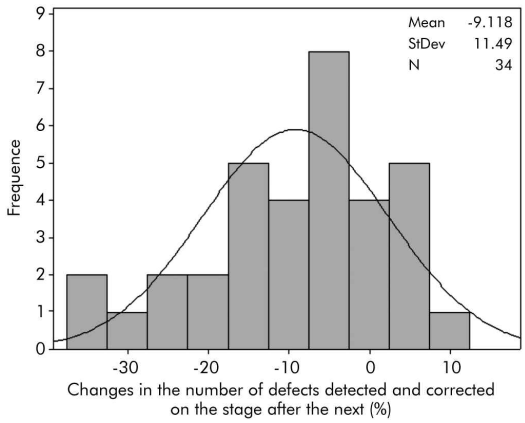

***Figure* 3. The distribution of the assessments of the changes in the number of the defects detected and corrected on the stage after the next**

The basic statistics about the assessments received from the respondents are summarized in *Table* 1. Variable C1 is the change in the number of the defects detected and corrected on the stage where they were produces. Variable C2 means the change in the number of the defects detected and corrected on the next stage, and variable C3 stands for the change in the number of the defects detected and corrected on the stages after the next.

The magnitude of the change in the number of the defects of the first type is the biggest while the change in the number of the defects of the thirds type is the smallest one.

7. Interpretation of the results

The results show that the implementation of the lean production practices brought about the notable improvement of

***Table* 1. Basic statistics on the assessments of the changes in the number of the defects**

Variable	Number of variables	Mean	Minimum value	Q1 (first quartile value)	Median value	Q3 (third quartile value)	Maximum
C1 (%)	34	49.85	10.00	33.75	46.50	68.00	95.00
C2 (%)	34	-39.00	-75.00	-53.50	-41.00	-22.75	-5.00
C3 (%)	34	-9.12	-35.00	-15.00	-6.50	0.00	10.00

the quality in terms of the decrease in the number of the defects detected and corrected on the later stages of the value streams. The more defects are corrected on the earlier stages of the value streams the lower is the probability that the defects will be incorporated into the finished goods and delivered to the clients. Furthermore, the defects that are passed to the later stages of the value streams usually are more difficult to correct without compromising the quality of the finished goods. The earlier the defects are detected the less resources and time are needed to correct them, and therefore the more time is available for the employees to satisfy or even exceed requirements of the clients and consequently to improve the perceived quality of the products and services.

Therefore, the data received from 34 Russian companies which have implemented the lean production practices allows us to make the conclusion that lean production can bring about not only the elimination of waste and reduction of costs but also improvements in quality.

8. Conclusion

The literature overview shows that lean production and TQM have many commonalities not only on the level of the practical tools but also on the level of the theoretical conceptions. The main focus of lean production is the elimination of waste and reduction of the non value added costs. But the impact of lean production initiatives on the quality of products and processes is not very clear. The analysis of the theoretical basis and practical techniques of TQM and lean production allows us to conclude that lean production should lead to the improvement of quality. The empirical study supports this conclusion. The analysis of the results of the lean production implementation in Russian companies indicates that lean production initiatives reduced the number of the defects detected and corrected on the stages after the stage of the value stream where they were produced. Therefore, lean production can be considered as a set of tools not only for cost reduction but also for quality enhancement. **Q-as**

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