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ASSESSMENT OF ORGANIZATIONAL MATURITY FOR LEAN CHANGE

AVALIAÇÃO DE MATURIDADE ORGANIZACIONAL PARA A MUDANÇA ENXUTA

Guilherme Luz Tortorella[a]; Flávio Sanson Fogliatto[b]

[a] **Universidade Federal do Rio Grande do Sul** (UFRGS), Porto Alegre, RS, Brasil - Programas de Pós-Graduação em Engenharia de Produção

Resumo

A implementação de Sistemas de Produção Enxuta (SPE) é reconhecidamente essencial para as empresas que desejam obter elevado nível de competitividade. No entanto, além dos fatores técnicos, a implementação de um SPE depende fortemente dos fatores de aprendizagem organizacional (AO), os quais apoiam e auxiliam na sustentabilidade da mudança organizacional enxuta. Este artigo tem como objetivo apresentar um método para a avaliação do impacto dos problemas AO em cada fase do roadmap de implementação enxuta. O método proposto complementa uma metodologia existente por meio da adição da etapa de cálculo de QFD reverso. Esta abordagem complementar permite que as empresas em implementação enxuta identifiquem e antecipem problemas futuros, bem como compreender quais fases são as mais afetadas por deficiências em questões voltadas ao AO. O método é ilustrado em uma empresa de autopeças que está em processo de implementação enxuta por mais de nove anos e ainda apresenta dificuldades em sustentar o SPE.

Palavras-chave: Sistema de Produção Enxuta, Cálculo Reverso de QFD, Aprendizado Organizacional

Abstract

The implementation of Lean Production Systems (LPS) is admittedly essential for companies that want to obtain high level of competitiveness. However, besides the technical factors, the LPS implementation depends heavily on the organizational learning (OL) factors, which support and provide sustainability for the organizational lean change. This article aims to present a method for for assessing the impact of OL problems on each lean implementation roadmap phase. The proposed method complements an existent methodology through the addition of the QFD reverse calculation step. This complementary approach allows companies under lean implementation to identify and anticipate future problems, as well as understand which phases are most affected by deficiencies in OL issues. The method is illustrated on an autoparts company, which has been in lean implementation process for more than nine years and still presents difficulties in sustaining the LPS.

Keywords: *Lean Production System, QFD Reverse Calculation, Organizational Learning*

1. INTRODUCTION

According to Biazzo *et* Panizzolo (2000), a work perspective supported by lean principles depends heavily on people's flexibility and involvement. Thus, change management in an LPS (Lean Production System) should focus on factors such as the impacts of changes on people, effect of positive leaderships and effectiveness of communication channels (Bessant *et* Francis, 1999). With that in mind, reorganization of manufacturing according to lean principles can ignite radical technical and organizational changes towards a leaner company, with a new structure, strategy and culture (Flott,

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2002). However, organizational learning aspects are not emphasized in the existent literature on LPS implementation (Pettersen, 2009).

Bessant *et al*. (2001) report that most literature dealing with lean production systems and continuous improvement does not cover behavioral aspects of the change process. In their view, many aspects related to LPS are poorly addressed in the literature. One such aspect relates to deficiencies in LPS implementation roadmaps that closely correlate results with the exposure to lean techniques, neglecting elements such as the construction of a behavior. Moreover, much of what is found in the literature assumes a binary division between having or not an LPS, rather than viewing it as an emerging behavioral pattern to be developed alligned with a management philosophy (Pollitt, 2006).

The transition to an LPS heavily depends on a change of organizational culture (Sawhney *et* Chason, 2005). Moreover, the success of any management practice implementation depends on organization's characteristics and, thus, practices application may vary according to those (Shah *et* Ward, 2003). An organizational culture is the sum of people habits in relation to the way they perform their activities. Those habits are resultant of a management system and must be the focus of an LPS change (Mann, 2005).

Silva (2008) notes that one of the major elements for an LPS operating leverage is the ability to continuously learn, innovate, and change existent in the system. Thus, the appropriate understanding of this capacity is essential in an LPS implementation.

This article aims at presenting a method for assessing the impact of organizational learning (OL) problems on each lean implementation roadmap phase. The proposed method complements an existent methodology through the addition of the QFD reverse calculation step. This complementary approach allows companies under lean implementation to identify and anticipate future problems, as well as understand which phases are most affected by deficiencies in OL issues.

The proposed methodology is applied in a company from the autoparts industry. The company is under lean implementation process, which is supported by the company´s executive committee. Despite some lean practices already known and adopted, the company does not have an integrated and sustainable lean change approach, especially regarding organizational learning factors.

2. ORGANIZATIONAL LEARNING

Organizations learn from direct experience with failures through two mechanisms that incorporate learning as part of individuals and working teams, increasing organizational performance. First, there is the direct learning that occurs through trial and error. As organizations accumulate experience with activities such as production and operations, its individuals generate new knowledge concerning the improvement of these activities. Second, since organizations accumulate experience with failures there is the knowledge stored in the organizational memory. Such memory is used to improve performance in subsequent iterations of similar assignments, consisting of routines, symbols or work procedures (Desai, 2011).

According to behavioral theories of organizational learning, knowledge is embedded in organizational routines and processes that serve to guide and constrain the actions of individuals. Thus, organizational learning through experience is typically represented as a change in organizational performance, resultant from its experience (Desai, 2010).

Organizational learning situations are determined by work elements, work organization and social context inserted into the learning environment (Dehnbostel *et al*., 2005). Amores *et al*. (2005) summarize the types of knowledge transfer in two ways: (*i*) prospective (feed-forward), when knowledge flows from individuals and teams to the organization, renewing it, and (*ii*) retrospective, when the knowledge flows from organization to teams and individuals.

A learning environment, which is idealized by the leaders of the organization, must be constructed in order to support such OL situations (Dehnbostel *et al*., 2005). However, Tjosvold *et* Wong (2006) emphasize the difficulties in the learning process. Learning with the accumulation of experiences can be challenging since organizations remain adherent to their original mental models. In addition, some individuals may not discuss and learn from their experiences due to inhibition, thus remaining opposed to new realities and rigidly committed to their current practices.

Learning at an organizational level is not the sum of learning from various individuals (Marsick *et* Watkins, 2003). A learning organization is the one that continuously learns and transforms itself. Learning takes place in individuals, working teams, organizations and in the communities influenced by them, being a process strategically used and integrated into daily work activities. Such learning results in knowledge, beliefs and changes in behavior which increase the organizational ability to grow and innovate (Ortenbiad, 2002).

Thus, individuals perceive knowledge with the accumulation of successes and failures; without the existence of the error, the possibility of learning is also limited (Brito,

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2004). Moreover, the development of ideas and knowledge through the process of learning and experimenting is key to maintain the appearance of new production techniques (Minoura, 2003).

Finally, to enable the assessment of learning practices and organizational culture evolution, Marsick *et* Watkins (2003) developed a diagnostic tool named DLOQ (Dimensions of the Learning Organization Questionnaire). The tool evaluates perceptions on different factors that promote organizational learning, correlating it with the organization´s financial performance. In Table 1 the DLOQ dimensions are defined; questions in the DLOQ are stratified according to the activity contextualization level (individual, team or organization). The questionnaire, which comprises 43 problem statements, provides a qualitative overview of the organization change process' current status, and existing problems in the area of organizational learning.

Table 1. DLOQ dimensions

Dimension	Definition
Create continuous learning opportunities	Learning is designed in a way that individuals learn by working; opportunities are provided for growth and education
Promote dialogue	Individuals obtain skills to express their vision and capacity to listen to others vision; culture is changed to support questioning, feedback and experimentation.
Encourage collaboration and team learning	Tasks are conceived so that teams present different ways of thinking; it is expected that teams learn to work together; collaboration is culturally valued and recognized.
Create systems to capture and share learning	Technology system are created and integrated to tasks; systems are maintained and its access is provided.
Empower individuals into a collective vision direction	Individuals are involved I establishing and implementing the vision; the decision process is decentralized and the responsibility is distributed in order to stimulate individuals to own the change.
Connect organization and its environment	Individuals are helped to see the effect of their job in the organization as a whole; the organization is connected to its community.
Provide strategic leadership for learning	Leadership use learning in a strategic way to generate results to the business.

Source: Marsick *et* Watkins (2003)

3. LEAN CHANGE

The advent of fundamental changes in production processes towards LPS coincides with a period of transition in the field of people management (Womack *et al*., 1992). Thus, it is required the adoption of an entire system in a holistic way and not just the application of isolated techniques in a timely manner to initiate change (Crute *et al*., 2003). Moreover, it must be considered the relationship between the advantage in productive performance and adherence to three key principles: (*i*) improve flow of material and information through the business, (*ii*) emphasis on customer demand, and (*iii*) commitment to continuous improvement enabled by people development (Womack *et* Jones, 1996).

The existent lean roadmaps present gaps related to both aspects lean change continuity and the realization of short term gains. Regarding the first one, there is the need of a specific approach involving factors that stimulate and motivate people in lean initiatives engagement. For the second aspect, the development of an assessment method that allows the recognition and measurement of lean change evolution is required to minimize it (Aaraujo *et* Rentes, 2005). Furthermore, the establishment of goals, objectives and indicators that help driving people behavior towards change is still an improvement opportunity in current models (Silva, 2008).

The Lean Enterprise Model (LEM) (Crabill *et al*., 2010) aims to establish a systematic implementation of the LPS philosophy and best practices and integrates engineering, human resources and business aspects. The LEM roadmap, whose implementation process consists of eight phases (see Table 2), was developed based on the understanding of six existent and already tested transitioning models. The model stresses the importance of creating a real need for lean change right at Phase 0, but does not detail how to set this need.

Tortorella (2012) presents a method to evaluate the maturity of OL factors in a company under lean implementation. This method enables the identification of the OL critical factors and the definition of the key improvement alternatives to minimize the problems according to activity contextualization level: (*i*) individual, (*ii*) team and (*iii*) organizational. The method is divided into two major steps: (*i*) data collection and analysis of maturity levels and (*ii*) generation of an improvement portfolio. These two are divided into six phases, as shown in Table 3.

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However, this method does not identify which phases of the lean roadmap that would be less supported due to a low maturity of the OL factors. Thus there is a need for developing a complementary methodology to enable a more comprehensive analysis of the current situation of the company. The following section aims to describe the proposed methodology.

Table 2. LEM roadmap – inputs and outputs

Phases	Input	Output
Phase 0: Adoption of Lean Paradigm	Decision to look for a transformation in the company	Decision to change organization philosophy into the LM paradigm
Phase 1: Prepare implementation	Leadership commitment to LM transformation	A strategic plan to LM implementation that guides leadership and organizational support, human and cultural issues, targets and training
Phase 2: Define value	Strategy defined at Phase 1, which establishes where to start the LM implementation	Product, customer and value definition in order to distinguish between value added and non-value added activities
Phase 3: Identify flow of value	Value definition according to LM perspective	Value Stream Map that shows production process and information flow, identifying the amount of value added and waste activities
Phase 4: Design production system	Current value stream	Production system design ready to start implementation
Phase 5: Implement flow	LM design and its implementation plan	Implemented LM projects that improve flow through waste elimination
Phase 6: Implement pull system	A production system with an implemented operation flow	A production system that delivers to customer with appropriate mix and quantity
Phase 7: Look for perfection	Leadership commitment to LM transformation	Improvement on LM transformation at each Phase

Source: Elaborated from Crabill et al. (2010)

Table 3. Proposed method: steps, phases and tools

Main steps	Phases	Tools
Data collection and maturity analysis	1. Determination of OL problems' frequency	DLOQ and interviews
	2. Analysis of maturity levels	LEM and maturity matrix
	3. Consolidation of improvement opportunities	Analysis tools
Improvement portfolio generation	4. Criteria weight and attributes definition	Decision making support tools
	5. Improvement opportunities prioritization	Prioritization matrix
	6. Ranking of improvement opportunities	Graphical tools

Source: Tortorella (2012)

4. PROPOSED METHOD

Tortorella (2012) presents a methodology to evaluate the OL factors in companies unde lean implementation. This study correlates the eight LEM roadmap phases with the 43 OL problems described in the DLOQ through matrix **M1.** This matrix presents the relationship intensity values r_{ij} among phases (rows) and OL problems (columns), whose values were defined based on experienced experts opinion. As output of this matrix, there is the vector **cr**, which represents problems criticality for the company.

Then, the same OL problems are related to people management best practices (MP_k, k=1,…,15) previously defined for a change process. The cr_j values are used as input for matrix **M2**, which is deployed based on the relationship intensity values g_{jk} among problems (rows) and people management best practices (columns). As output of **M2**, there is the definition of the practices criticality values cp_j for the company.

Therefore, the proposed method in this paper comprises an existent framework, in which the QFD reverse calculation presented in Fogliatto *et al*. (2003) is applied on matrices **M1** and **M2**. The objective is two-fold. First, reverse calculations on **M2** enable the analyst to verify the impact of the gap in practice adoption on OL problems criticality. Comparing original and reversed criticality scores it is possible to identify which OL problems are worst affected by the gap in best practices' adoption. Second, reverse calculations on **M1** enable the analyst to verify the impact of corrected OL problems criticality scores on lean roadmap phases, i.e. which phases are most affected by deficiencies in OL issues.

To perform the QFD reverse calculation on **M2**, organize weights cp_j in a vector denoted by **c**. The reversed OL

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problems' criticality scores will be given in vector **p** after performing the operation in eqn. (1), where **M2** is the matrix g_{jk} of scores and $\mathbf{M2}^t$ its transpose.

$$\mathbf{p} = \left(\mathbf{M2} \times \mathbf{M2}^t\right)^{-1} \mathbf{M2} \times \mathbf{c} \quad (1)$$

To perform the QFD reverse calculation on **M1**, results in vector **p** will be used. Impact weights f_i for each lean roadmap phase will be given in a vector **f** after performing the operation in eqn. (2), where **M1** is the matrix of r_{ij} scores and $\mathbf{M1}^t$ its transpose.

$$\mathbf{f} = \left(\mathbf{M1} \times \mathbf{M1}^t\right)^{-1} \mathbf{M1} \times \mathbf{p} \quad (2)$$

Impact weights f_i may be ranked using the results in eqn. (2) to identify lean roadmap phases that require attention, given the company's current OL situation. The higher the value of f_i, the less prepared the company is to accomplish phase *i* regarding OL factors. Such ranking allows the company to anticipate future problems and achieve greater sustainability in the lean implementation.

5. CASE STUDY DESCRIPTION

We now illustrate the application of our propositions in a case study. The multinational company under analysis is an automotive parts manufacturer located in the south of Brazil. Level of product customization is medium, and manufacturing processes are organized in assembly lines and cells. A total of 1,600 employees work at the company, and their total annual revenues is around US$ 360 million.

In its trajectory the company made several efforts to implement lean techniques and practices in their shopfloor. The isolated implementation of such techniques and practices offered immediate results; however, they were not sustained in the long run as initiatives were left aside.

In order to address business continuous improvement formally, the company promoted in 2003 a new project named Lean Enterprise. The objectives were (*i*) set a standard approach to continuous improvement in the company, (*ii*) create an environment where individuals were encouraged to identify improvement opportunities, and (*iii*) enable them to solve problems through the use of lean practices.

From 2003 until now there was an evolution in the level of knowledge regarding lean techniques in the company. That is justified by the large number of workshops and training offered to individuals, as well as the practice of kaizen activities in the company. Thus, the technical factors involved along the lean implementation were strongly addressed and discussed with the teams.

However, despite all the structure and support to continuous improvement, the perception of the steering committee and the middle management was that the practices, after some time, did not sustain and were not fully accepted by some individuals. Thus, the sense of frustration was imminent whenever a new attempt to implement a lean practice appeared.

Based on this scenario and using the obtained results from Tortorella (2012) study as input data, the presented method was applied.

6. RESULTS DISCUSSION

Table 4 shows the results of the **M2** reversal. In order to facilitate the differentiation of p_j values, it was created an index that represents the number of standard deviations for the values within each contextualization level, and adopted the threshold value of 1 standard deviation above or below the mean value.

For the individual level, problems 1 ("In my organization, people openly discuss mistakes in order to learn from them") and 13 ("In my organization, people spend time building relationships with each other") are the ones that the company is more mature to address regarding the people management practices. Problems 4 ("In my organization, people can receive financial aid to support learning") and 10 ("In my organization, people are encouraged to ask why") are those with standard deviation above 1 and, therefore, the company is less prepared to address them. For team level, the problem 16 ("In my organization, teams focus both, their tasks and how well the team is performing") stands out as having the most mature management practices to minimize it. Problem 14 ("In my organization, teams are free to adapt their goals as needed") is more likely to occur given the current adoption level of people management practices in the company. For organizational level, problems 22 ("My organization maintains an update database of employee skills") and 39 ("In my organization, leaders share information with their employees about competition, trends, etc") are those that are better served based on people management practices. Moreover, for problem 40 ("In my organization, leaders empower employees to help accomplish the company vision") the company presents practices less mature to minimize it.

Table 5 shows the results for the **M1** reversal. Similarly, it was created a differentiation index for values of the **f** vector. Thus, it was obtained the number of standard deviations above or below the mean value within each level, and one standard deviation above or below the mean value considered as borderline.

For the individual level, Phase 6 ("Implement pull system") is the one that presents the OL factors more mature. Phase 3 ("Identifying the value stream") presents lower maturity regarding the OL factors. For the team level, Phases 2

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("Define value") and 4 ("Designing the production system") are the ones that are best addressed regarding the OL factors. Moreover, for Phases 0 ("Adoption of lean paradigm") and 6 ("Implement pull system") the OL factors are less mature to support them. Finally, for the organizational level, Phase 5 ("Implementing flow") is the one with the most mature OL factors for its implementation. Phase 6 ("Implement pull system") presents the lowest maturity regarding OL factors.

Table 4. Results for **p**

Contextualization Level	OL Problems	p	Differentiation Index
Individual	P1	-103	-1,3
	P2	9	-0,3
	P3	194	1,2
	P4	276	1,9
	P5	-21	-0,6
	P6	47	0,0
	P7	-44	-0,8
	P8	47	0,0
	P9	40	-0,1
	P10	246	1,6
	P11	69	0,1
	P12	-2	-0,4
	P13	-97	-1,2
Team	P14	47	1,0
	P15	36	0,8
	P16	-100	-1,7
	P17	-19	-0,2
	P18	17	0,5
	P19	-24	-0,3
Organizational	P20	1.370	0,2
	P21	-671	-0,1
	P22	-6.773	-1,0
	P23	-2.343	-0,3
	P24	591	0,1
	P25	-1.005	-0,1
	P26	1.418	0,2
	P27	4.461	0,7
	P28	-2.598	-0,4
	P29	-6.048	-0,9
	P30	-886	-0,1
	P31	1.733	0,3
	P32	1.237	0,2
	P33	-584	-0,1
	P34	5.396	0,8
	P35	-1.614	-0,2
	P36	837	0,1
	P37	-786	-0,1
	P38	-735	-0,1
	P39	-12.990	-1,9
	P40	25.816	3,9
	P41	-4.346	-0,6
	P42	-1	0,0
	P43	-2.174	-0,3

Source: Author

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Table 5. Results for f

Contextualization Level	Lean Roadmap Phases	f	Differentiation Index
Individual	Phase 0: Adoption of Lean Paradigm	-12	-0,3
	Phase 1: Prepare implementation	19	0,3
	Phase 2: Define value	-18	-0,4
	Phase 3: Identify flow of value	122	2,1
	Phase 4: Design production system	26	0,4
	Phase 5: Implement flow	-19	-0,4
	Phase 6: Implement pull system	-79	-1,4
	Phase 7: Look for perfection	-12	-0,3
Team	Phase 0: Adoption of Lean Paradigm	149.714	1,3
	Phase 1: Prepare implementation	-85.207	-0,8
	Phase 2: Define value	-116.443	-1,0
	Phase 3: Identify flow of value	97.907	0,8
	Phase 4: Design production system	-120.822	-1,1
	Phase 5: Implement flow	-89.136	-0,8
	Phase 6: Implement pull system	117.681	1,0
	Phase 7: Look for perfection	71.594	0,6
Organizational	Phase 0: Adoption of Lean Paradigm	1552	0,4
	Phase 1: Prepare implementation	-166	0,0
	Phase 2: Define value	-496	-0,1
	Phase 3: Identify flow of value	2378	0,6
	Phase 4: Design production system	-3036	-0,8
	Phase 5: Implement flow	-7551	-2,0
	Phase 6: Implement pull system	4662	1,2
	Phase 7: Look for perfection	2592	0,7

Source: Author

7. CONCLUSION

The main objective of this paper was to present a method for assessing a company's maturity level for implementing lean roadmap phases. This method comprises the QFD reverse calculation, which was applied on two maturity matricies. The first matrix correlated lean roadmap phases and OL problems. The second matrix correlated OL problems and people management practices.

The study points out a few conclusions. First, the company's maturity for implementing the lean roadmap phases varies according to the contextualization level, which indicates the existence of different needs and reinforces the importance of specific approaches to minimize OL problems at each level. However, Phase 6 (implement pull system) seems to be a common issue for both team and organizational levels. This fact can be better understood since the trajectory of the studied company is known. Most of the efforts to implement lean techniques and practices made so far are related to the initial phases. Therefore, it is reasonable to present a lower OL maturity on phases that the company did not initiate any activity yet.

Finally, the proposed method can be used as a diagnostic tool for companies that are looking for implementing Lean Production System (LPS). Moreover, the method can be applied for checking the organizational maturity evolution along lean implementation. A larger study, with companies from different segments, sizes and levels of exposure to lean principles and practices, could be performed in order to validate the applicability of this method. Moreover, this study would allow the establishment of benchmarking for organizational maturity levels in companies implementing lean.

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