Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

XLVSBPO

16 a 19
Setembro de 2013
Natal/RN

METHOD FOR ASSESSING ORGANIZATIONAL LEARNING FACTORS IN A COMPANY UNDER LEAN MANUFACTURING IMPLMENTATION

Guilherme Luz Tortorella

Universidade Federal do Rio Grande do Sul
Av. Paulo Gama, 110 – Porto Alegre, RS – Brasil
gtortorella@bol.com.br

Flávio Sanson Fogliatto

Universidade Federal do Rio Grande do Sul
Av. Paulo Gama, 110 – Porto Alegre, RS – Brasil
ffogliatto@producao.ufrgs.br

ABSTRACT

The implementation of Lean Production Systems (LPS) is admittedly essential for companies that want to obtain high level of competitiveness. There are several examples in the literature regarding lean roadmaps implementation, however, since they prioritize the technical factors of lean change, the organizational learning process tend to be neglected. This article aims to present a methodology for evaluating the factors of organizational learning in a company in lean implementation. This methodology combines the concepts of organizational learning to lean implementation roadmaps and enables the company maturity analysis regarding the dimensions of organizational learning at different levels of contextualization. The method is illustrated on an automotive company, which has been in lean implementation process for more than nine years and still presents difficulties in sustaining the LPS.

KEYWORDS. Organizational Learning, Lean Implementation Roadmap, Maturity Analysis.

Main Area: IND – PO na Indústria, ADM – Apoio à Decisão Multicritério

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

XLVSBPO

1. Introduction

A work perspective supported by lean principles depends heavily on people flexibility and involvement (BIAZZO; PANIZZOLO, 2000). Thus, dealing with the impact on people is essential to a change management approach in a LPS (Lean Production System) (BESSANT *et al*., 2001). The manufacturing reorganization, according to lean principles, can initiate technical and organizational changes towards a leaner company with a new structure, strategy and culture (FLOTT, 2002). However, organizational learning factors are not usually emphasized in the existent LPS literature (PETTERSEN, 2009).

Hua (2007) suggests the change factors separation in two areas: (*i*) technical factors and (*ii*) socio-cultural factors. The technical factors refer to tangible or logical components that are considered critical for improving organizational performance. The socio-cultural factors relate to emotional or intangible components that are usually neglected, but cited as critical in improving organizational efficiency. Moreover, these factors include the organizational learning factors which contribute to build a behavior that supports the change process (JIMMIESON *et al*., 2008).

Few organizations fully understood the philosophy behind lean techniques already known (Baker, 2002). Araújo and Rentes (2005) commented that although many companies from various sectors have achieved significant benefits by adopting the techniques of lean production, many managers have wrongly applied isolated techniques without understanding the whole lean system (flow and systemic impacts on the organization).

Bessant *et al*. (2001) report that most of the literature involving lean production systems and continuous improvement do not cover behavioral aspects of the change process. Moreover, criticize that many aspects related to the topic are poorly addressed in the literature. One of these aspects relates to the gaps in the LPS implementation process description. Once this process is not explicitly described, it tends to exclusively assume the correlation between lean techniques exposure and the obtained results in the process, neglecting other elements such as the construction of behavior. Much of which is found in the literature assumes a binary division between having or not a LPS, rather than view it as an emerging behavioral pattern to be developed in line with a management philosophy (POLLITT, 2006).

This article aims to assess the factors that promote organizational learning in a company under lean implementation process by proposing a method to systematize this assessment at each stage of lean implementation. The method consists of a combination of complementary techniques that allows identifying deficiencies related to these factors during the lean change process and drive improvements in order to sustain it.

The proposed methodology is applied in an automotive company. This company is on the beginning of its lean journey, which is supported by the company´s executive committee. Despite some lean practices are already known and adopted, the company does not have an integrated and sustainable lean change approach, especially regarding organizational learning factors.

2. Theoretical Reference

2.1. Organizational Learning

Learning at an organizational level is not the sum of various individuals learning (MARSICK; WATKINS, 2003). Learning takes place in the individual, working teams, organization and in the communities which the organization influences, being a process strategically used and integrated into the daily work activities. This learning results in knowledge, beliefs and behaviors change, which increase organizational capacity for growth and innovation (ORTENBIAD, 2002).

Organizations learn from direct experience with failures through two mechanisms that incorporate learning as part of individuals and working teams, increasing organizational performance. First, the direct learning occurs through trial and error. As organizations accumulate experience with activities such as production, operations and other events, its individuals generate new knowledge concerning the improvement of these activities. Second, since

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

organizations accumulate experience with failures, knowledge is stored in organizational memory. This memory is used to improve performance in subsequent iterations of similar assignments, consisting of routines, symbols or work procedures (DESAI, 2011).

Learning with the accumulation of experiences can be challenging, since organizations are stuck to their original mental models. Therefore, in order to promote learning, it is essential to investigate and understand the nature of interactions between individuals and enhance people management practices (WONG; TJOSVOLD, 2006).

The starting point for choosing the appropriate people management practices must be given by an analysis of business needs and its context. Thereafter, this becomes useful and enables the development of an approach that applies those practices that are most suitable to the business needs (ARMSTRONG, 2006).

Based on studies done by Sharma (2011), Gilley *et al*. (2009), Guest (2001), Pfeffer (2001), Patterson *et al*. (1997) and U.S. Dept. of Labor (1993), Figure 1 groups different people management practices. From this group, 15 best practices were consolidated according to the contextualization and application level within the company: (*i*) individual, (*ii*) team and (*iii*) organization.

Finally, in order to enable the measurement of the learning practices and organizational culture evolution, Marsick and Watkins (2003) developed a diagnostic tool called DLOQ (Dimensions of the Learning Organization Questionnaire). This tool evaluates the individuals' perceptions about the different factors that promote organizational learning. After its application, a qualitative overview of the current situation can be obtained regarding the organization change process and the existing problems of organizational learning.

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

XLVSBPO

Contextualization Level	Group of People Management Practices by Author						Best People Management Practices Consolidation
	Sharma (2011)	Gilley et al. (2009)	Guest (2001)	Pfeffer (2001)	Patterson et al. (1997)	US Dept of Labor (1993)	
Individual	Payment linked to performance status			Recognition according to performance	Income and benefits according to function		1. Formal recognition system
			Work design focused on flexibility, committment and motivation, including steps that allow employee		Shopfloor work variety	Clear task and function definition	2. Clear task and function definition
	"Open book" management style	Employee involvement		Hierarchical levels reduction		High level of participative processes	3. Participative Activities
	360º feedback system		Two-way communication			Attitude monitoring	4. Feedback
		Coaching			Training		5. Coaching
	Positive results celebration	Recognition	Carefull utilization of evaluation tests to identify employees with potential contribution			Incentives that recognize individuals and teams	6. Formal recognition system
	Employee evaluation system				Coeherent evaluation systems	with performance above expectation	7. Performance evaluation system
Team				Sel-directed teams	Teamwork utilization		8. Small group activities
	Information sharing	Communication		Information sharing	Frequent communication	Formal information sharing systems	9. Communication and information sharing
			Continuous training	Provide skills and knowledge to teams	Flexibility on work skills		10. Career and competence planning
Organization	Formal recognition system	Motivational incentives			Recognition and incentives utilization		11. Formal recognition system
						Formal performance evaluation system	12. Performance measurement system
	Formal mechanisms for teamwork incentive	Teamwork promotion	Programs that raise employee ownership in order to correlate his action to business performance				13. Teamwork promotion
	Alignment in company's guidelines management						14. Guidelines deployment
				Long term employment expectation	Sofisticated training processes	Career planning processes	15. Employees skills development policy

Figure 1 - People management best practices according to the contextualization level

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

2.2. Lean Implementation Roadmaps

The selection of appropriate tools and techniques for process improvement, along with their applicability and incorporation into operations, is a major problem for many companies (HERRON; BRAIDEN, 2006).

The Lean Enterprise Institute - LEI (2010) proposes a roadmap to support the establishment of a training sequence in order to develop the principles of lean thinking. This guide stresses that the process must begin with Value Stream Mapping in order to avoid the common mistake of applying the techniques in isolation.

Productivity Inc. (2010) presents a model to guide the LPS implementation divided into five phases. Initially, there is the current situation assessment and goals definition. Then, it is chosen points of the value stream to guide the application of lean techniques. After, it is elaborated a plan to replicate the improvements already tested to other areas. In the fourth phase, it is established an education and employee involvement program. Finally, it is encouraged to evaluate the obtained results and the methods and technologies applied so far.

Crabill *et al*. (2010) describe the Lean Enterprise Model (LEM), which aims to establish a systematic implementation of the lean philosophy and practices and, therefore, integrates perspectives from engineering, human resources and the business itself. The LEM, whose implementation process consists of eight stages (Figure 2), was developed based on the understanding of six existent and already tested transition models. This model stresses the importance of creating a real need for lean change right at Phase 0, but does not detail how to do this. Besides, it does not describe how to evaluate the lean change performance across the organization (SILVA, 2008).

Phases	Input	Output
Phase 0 - Adoption of lean paradigm	Decide to transform the company	Decide to change operating philosophy into lean paradigm
Phase 1 - Prepare implementation	Leadership commitment to lean transformation	Strategic plan to lean implementation that guides leadership and organizational support, the human and cultural issues, targets and training.
Phase 2 - Define value	Strategy defined on phase 1, which establishes where to start lean implementation	Product, customer and value definition to lead distinction between operations that value added and non-value added operations.
Phase 3 - Identify flow of value	Value definition according to lean 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	The current value stream	The production system design ready to start implementing.
Phase 5 - Implement flow	Th LPS design and its implemenation plan	Lean projets implemened on system that guarantee lean flow trough waste reduction.
Phase 6 - Implement pull system	A production system with operation flow implemented	A production system that responds to customer demands with appropriate mix and quantity.
Phase 7 - Look for perfection	Leadership commitment to lean transformation	Improvement on lean transition processes to any other phases

Figure 2 - LEM roadmap inputs and outputs (CRABILL *et al*., 2010)

2.3. Process Maturity Concept

For Dooley *et al*. (2001) maturity is the level which a process or activity achieves inside a company. Thus, the maturity level identifies the degree of sophistication, stability, practical skills, techniques and standard procedures related to a specific area (JUCA JR; AMARAL, 2005). Fraser *et al*. (2002) categorize the maturity models according to their structure: (*i*) process maturity grids, (*ii*) process capacity models and (*iii*) mixed models.

The maturity grids are structures that present a qualitative description of strategic process areas according to their sophistication levels. The capacity models consist of a more robust framework which sets practices and goals to be achieved by each area in each level (CRISTOFARI, 2008). The mixed models group some characteristics from both types of maturity models and represent the simplest form of maturity models. These models are constituted by a best practice development questionnaire (FRASER *et al*., 2002).

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

3. Proposed Method

The proposed analysis strategy relates the LEM lean roadmap phases (CRABILL *et al.*, 2010) to the frequency of incidence of the typical Organizational Learning (OL) problems (MARSICK; WATKINS, 2003). Subsequently, it is compared these problems to the people management best practices. The method is divided into two macro-steps: (*i*) data collection and maturity analysis and (*ii*) generation of an improvements portfolio.

3.1. Identification of OL Problems Frequency

To identify the frequency of occurrence of OL problems, it has been adapted the DLOQ, which presents 43 questions related to OL factors split into the individual, team and organizational levels. The rating is measured using a scale from 1 to 6, where 1 designates a situation which rarely occurs and 6 a situation which often occurs. Based on the questionnaire answers, it establishes an average frequency for each question and these are rescaled in the range from 0 to 1, represented by f_j ($j = 1,..., 43$). Because the way questions are prepared, a high value of f_j reinforces a desirable condition. Thus, the frequency of problems occurrence in the company is given by h_j using the following expression:

$$h_j = 1 - f_j, j = 1,...,43 \qquad (1)$$

3.2. Maturity Levels Analysis

The values h_j are used as input data in a matrix called maturity index matrix (**M1**). In this matrix, the lean implementation phases (matrix rows), according to LEM roadmap, are related to the OL problems (matrix columns) existent in the DLOQ. In the body of the matrix **M1** there are the relationships intensities r_{ij} for each pair of phase and problem at intersections between rows and columns. Such relationships were determined by experts through interviews, lasting an average of two hours each.

Seven experts with at least 15 years of experience in LPS implementation in automotive companies were consulted to establish the relationship intensities in the matrix **M1**. Experts answered the following question: "what is the relationship intensity between lean implementation phase *i* and problem *j*?" The answers established the relationship r_{ij} on a continuous scale of 9 points, where 0 indicated no relationship at all and 9 indicated a ratio of maximum intensity. In order to consolidate the experts responses, establish relationships and eliminate atypical responses, it was used the responses median. Based on this information, the matrix **M1** uses two indicators:

- Importance of the problems (ip_j): represents the relevance of the problem for the LPS implementation, considering the sum of relationship intensities through the following expression:

$$ip_j = \sum_{i=1}^{8} r_{ij}, j = 1,...,43 \qquad (2)$$

- Criticality of the problem for the company (cr_j): given by the product between the importance of the problem and the incidence of the problem in the company:

$$cr_j = ip_j \times h_j, j = 1,...,43 \qquad (3)$$

The cr_j values are used as input data in the maturity matrix **M2**, which lists the problems with the people management best practices (MP$_k$, $k = 1, ..., 15$). Analogous to the **M1** analysis, **M2** is developed based on the relationship intensity g_{jk} and a number of indicators.

The relationship intensities g_{jk} were defined during individual interviews with a group of 8 experts in people management. These specialists have a minimum 12-year experience in people management and best practices implementation. Moreover, each one has already managed cross-functional teams in large automotive companies, which adds practical knowledge to the relationships analysis.

Each expert answered the question: "what is the contribution of the full adoption of best practice *k* in the occurrence of the problem *j*?" Respondents used a 9-point continuous scale, where 0 represented no relationship and 9 a relationship of maximum intensity. The median of responses from individual interviews with experts established the relationship intensities g_{jk},

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

XLVSBPO

which are the basis for **M2**.

Moreover, the level of implementation n_k for each people management practice must be assessed in the company. This assessment was done through individual interviews with the company directors, in which they scored the practice application intensity on a continuous scale from 0 to 1, with 0 being no application at all and 1 representing full adoption. From the median of the responses, the implementation level of each practice in each contextualization level was established. Thus, the current gap in the company for the full adoption of the practices, represented by q_k, is given by the following expression:

$$q_k = 1 - n_k, k = 1,...,15 \qquad (4)$$

Based on this information, **M2** presents two indicators as output, described below:

- Importance of practices (pr_k): represents the practice relevance for minimizing the occurrence of the problem:

$$pr_k = \sum_{j=1}^{43} g_{jk} \times cr_j, k = 1,...,15 \qquad (5)$$

- Criticality of practice for the company (cp_k): given by the product between the importance of practices pr_k and the practice implementation level in the company n_k:

$$cp_k = pr_k \times q_k, k = 1,...,15 \qquad (6)$$

3.3. Improvement Opportunities Consolidation

Since practices are grouped by level of contextualization, it is suggested the improvement opportunities consolidation within each level. Thus, the improvement opportunities can be directed for each level in parallel way, without, necessarily, a precedence relationship between the practices or levels.

However, despite the improvement opportunities for the company are evident with the cp_k values, the decision-making process may involve other factors, such as investment needs or impact on organizational structure. Therefore, it must be used a tool that support a multi-criteria decision in order to maximize the satisfaction of senior management regarding improvement opportunities prioritization.

3.4. Criteria Weight and Attributes Definition

In this step, leaders are asked to participate in the decision-making process in order to add attributes that include the company´s decision-making characteristics profile to the proposed model results. These suggested criteria and attributes, according to (CRISTOFARI, 2008).

Thus, to evaluate the distinctions between attributes it can be done a multi-attribute framework (Multiattribute Utility - MAUT) (MIN, 1994). The first criterion evaluates the improvement opportunity in terms of the implementation importance and is divided into three main attributes: (*i*) strategic goals achievement, (*ii*) construction of behavior coherent with company values and (*iii*) impact on organizational structure. The second criterion evaluates the improvement opportunity in terms of the implementation effort and consists of three attributes: (*i*) technical risk, (*ii*) need for qualified human resources (HR) and (*iii*) the need for investment.

Then, the leaders of the company are asked to assign weights to the attributes and criteria, by consensus, on a scale of 0 to 100, with 100 being the maximum importance. The weights reported are rewritten in percentage terms, generating the weights pa_n ($n = 1,..., N$).

3.5. Improvement Opportunities Prioritization

For this step, it is used a priority matrix (**Z**), whose lines present the best practices that were evaluated in **M2** and their criticality values. In the columns, there are the prioritization criteria for improvement opportunities. The leaders are required to determine the relationship intensity between the best practices and the prioritization criteria, expressed by the indicator pd_{kn} ($k = 1,..., 15, n = 1,..., N$).

This indicator is built through a directed discussion, which the leaders of the company must answer the following questions: (1) regarding the attributes of criteria the Importance of improvement alternative, "how important is the practice k adoption to attribute n achievement? "and (2) regarding the attributes of the criteria Improvement alternative effort, "what is practice k

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

need in relation to attribute n?". This evaluation is performed using a scale of three values: 9 (strong relationship), 3 (moderate relationship) and 1 (weak relationship). The absence of relationship is indicated by the value 0. The final score for each improvement alternative (z_k) is given by:

$$z_k = \sum_{n=1}^{N} \left(pd_{kn} \times pa_n \right) \times cp_k, k = 1,...,15 \tag{7}$$

The relationship between the importance of the attributes pan and the people management best practices demonstrates the company's expectation placed on each improvement alternative. This expectation is not enough to drive decision making regarding the OL factors of lean implementation. Thus, it becomes important to balance this relationship with the criticality of each practice for the company, which is reflected in the scoring z_k for each improvement alternative.

3.6. Improvement Opportunities Ranking

In the last step, z_k values are ordered and the improvement portfolio is defined. This definition should occur according to contextualization level, since there is not necessarily a precedence relationship between levels and cp_k values are directly affected by the number of problems in each level. Thus, the use of graphic tools, such as Pareto graph, is suggested in order to facilitate and make it visual the decision-making process.

4. Case Study in an Automotive Company

The company presents on its trajectory several initiatives to implement lean techniques and practices in their factory, usually implemented in isolation. The implementation of such techniques and practices presented immediate results. However, with the passage of time and loss of focus, these practices were no longer applied and followed, showing, then, difficulty in sustaining.

In interviews with the steering committee, most of its members attributed the difficulty of sustaining lean practices to the lack of a complementary approach that involves the construction of behavior consistent with the process of lean implementation. Thus, based on this context, the methodology proposed in this paper was applied.

Based on the DLOQ, it was established a mean value for each problem frequency (Figure 3). The collected sample comprises 120 individuals, representing approximately 10% of total employees.

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

	Questions	Average value	f_j	h_j
Individual Level	In my organization, people have open discussions about errors and ways to learn from them	4,33	0,72	0,28
	In my organization, people identify needed skills for future activities	4,04	0,67	0,33
	In my organization, people help each other to learn	4,58	0,76	0,24
	In my organization, people receive financial help to support learning	4,16	0,69	0,31
	In my organization, people have available time to support learning	3,92	0,65	0,35
	In my organization, people see problems as learning opportunities	4,11	0,69	0,31
	In my organization, people are rewarded by learning	3,66	0,61	0,39
	In my organization, people give open feedback to each other	3,75	0,63	0,37
	In my organization, people listen to others opinion before talking	3,75	0,62	0,38
	In my organization, people are encouraged to ask why	4,24	0,71	0,29
	In my organization, when people say their opinion they also ask others what they think	4,03	0,67	0,33
	In my organization, people treat each other with respect	4,66	0,78	0,22
	In my organization, people use time to build trust among them	4,07	0,68	0,32
Team Level	In my organization, teams are free to adapt their targets according to the need	4,02	0,67	0,33
	In my organization, teams treat their members as equals	4,42	0,74	0,26
	In my organization, teams focus both, the task and how well the team is performing	4,18	0,70	0,30
	In my organization, teams review their opinion according to data or discussions	4,24	0,71	0,29
	In my organization, teams are rewarded by their results as teams	3,95	0,66	0,34
	In my organization, teams trust that the organization will act according to their suggestion	4,09	0,68	0,32
Organizational Level	My organization uses 2-way communication in a regular way	4,32	0,72	0,28
	My organization allows people to have easy and fast access to needed information at any time	4,20	0,70	0,30
	My organization keeps a data base with employees skills	4,18	0,70	0,30
	My organization creates systems to measure expected and actual performance	4,11	0,69	0,31
	My organization keeps available knowledge to all employees	3,86	0,64	0,36
	My organization tracks time and money invested on training	4,06	0,68	0,32
	My organization recognizes people by their initiative	4,23	0,70	0,30
	My organization gives people choice on their tasks	3,94	0,66	0,34
	My organization invites people to contribute to the business vision	4,19	0,70	0,30
	My organization empowers people regarding resources to complete their tasks	3,91	0,65	0,35
	My organization supports employees that risk in a safe way	4,12	0,69	0,31
	My organization aligns vision across different teams and work levels	4,04	0,67	0,33
	My organization helps employees balance work and family time	3,24	0,54	0,46
	My organization encourages people to think in a global way	4,19	0,70	0,30
	My organization encourages people to bring the customer perspective to business	4,33	0,72	0,28
	My organization considers the decisions impact over employees morale	3,88	0,65	0,35
	My organization works with local community to meet common needs	4,46	0,74	0,26
	My organization encourages people to develop problem solving inside the company	4,51	0,75	0,25
	In my organization, leaders generally support learning and training opportunities	4,08	0,68	0,32
	In my organization, leaders share information with employees about market trends, etc.	4,31	0,72	0,28
	In my organization, leaders empower others to help achieve companys vision	4,19	0,70	0,30
	In my organization, leaders are mentors and develop their teams	3,83	0,64	0,36
	In my organization, leaders continuously look for learning opportunities	4,25	0,71	0,29
	In my organization, leaders make sure that attitudes are consistent with company's values	4,36	0,73	0,27

Figure 3 – Frequency of OL problems in the company

During the **M1** maturity analysis, it was created a differentiation index that represents the number of standard deviations of each value in relation to the average of their contextualization level. Thus, Figure 4 highlights in red the most critical problems for the company, since they present the highest number of standard deviations above the average.

For the individual level, problems 2, 9 and 10 present themselves as the most critical problems. For the team level, problem 19 stands out from the others as the most critical to the company. Finally, for the organizational level, problems 35 and 41 are the most critical ones.

		Individual Level													Team Level						Organizational Level																							
		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16	P17	P18	P19	P20	P21	P22	P23	P24	P25	P26	P27	P28	P29	P30	P31	P32	P33	P34	P35	P36	P37	P38	P39	P40	P41	P42	P43
Roadmap Phases	Phase 0	8	5	2	3	4	6	2	4	4	7	3	8	3	1	3	2	3	1	3	1	2	1	5	5	2	4	0	5	3	7	6	2	9	8	8	5	6	7	7	8	9	9	9
	Phase 1	6	7	6	4	5	7	2	4	5	6	4	8	5	3	9	5	6	4	6	3	9	3	7	6	4	3	2	8	6	8	7	3	8	9	9	5	6	9	6	4	9	9	9
	Phase 2	6	5	5	3	5	5	5	5	7	5	6	8	5	3	4	6	2	5	7	5	5	6	6	3	8	9	9	5	6	6	7	5	9	7	5	6	7	5	9	7	9	9	9
	Phase 3	6	6	6	4	5	6	3	5	5	8	6	6	6	3	6	6	7	5	7	5	6	5	5	6	2	6	2	7	5	7	6	5	9	9	5	7	6	6	6	9	8	8	8
	Phase 4	7	8	7	5	7	6	3	5	7	8	7	7	6	6	8	6	6	8	6	6	6	7	2	9	6	7	9	9	9	9	5	5	9	9	5	7	8	7	9	8	8	9	9
	Phase 5	9	8	8	4	7	7	4	5	7	8	6	7	7	7	8	7	8	7	8	6	8	7	8	7	2	8	3	8	8	8	7	5	8	9	5	8	8	6	7	9	9	9	8
	Phase 6	8	7	7	4	7	7	4	6	7	8	6	8	8	7	9	7	6	7	9	6	8	7	9	8	2	9	9	8	2	9	8	7	9	9	5	8	8	7	8	7	9	9	7
	Phase 7	9	9	9	4	8	9	9	8	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	2	9	5	9	9	9	9	7	9	9	9	7	9	9	8	9	9	9	9	9
	ip_j	58	54	49	27	47	52	28	41	45	59	44	56	48	39	55	46	50	43	56	21	51	19	62	51	61	57	35	67	71	71	42	57	59	54	55	72	68	68					
	h_j	0,28	0,33	0,24	0,31	0,35	0,31	0,39	0,37	0,38	0,29	0,33	0,22	0,32	0,33	0,26	0,30	0,29	0,34	0,32	0,28	0,30	0,30	0,31	0,36	0,32	0,30	0,34	0,30	0,35	0,31	0,33	0,46	0,30	0,28	0,35	0,26	0,25	0,32	0,28	0,30	0,36	0,29	0,27
	cr_j	16	17	12	8	16	16	11	15	17	17	14	12	15	13	15	14	15	15	18	11	16	12	17	20	7	15	7	19	18	19	19	16	20	20	25	11	14	19	15	17	26	20	19
Differentiation Index		0,5	1,0	-1,0	-2,2	0,6	0,7	-1,3	0,3	0,9	1,0	-0,1	-0,7	0,3	-1,1	-0,1	-0,6	0,0	0,0	1,9	-1,2	-0,1	-1,0	0,1	0,7	-2,1	-0,3	-2,1	0,4	0,2	0,5	0,4	-0,1	0,7	0,6	1,8	-1,2	-0,5	0,5	-0,3	0,0	2,0	0,7	0,4

Figure 4 – **M1** maturity analysis for the company

In the **M2** maturity analysis, OL problems expected at the individual level have zero relationship intensity with practices allocated at team and organizational level. Similarly, problems at team level present no relationship with practices from individual and organizational level, and the same logic is used to problems at the organizational level, as shown in Figure 5. Thus, the values obtained for the importance of people management practices are directly proportional to the quantities of problems existent in each level.

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

		cr_j	MP1	MP2	MP3	MP4	MP5	MP6	MP7	MP8	MP9	MP10	MP11	MP12	MP13	MP14	MP15
			PEOPLE MANAGEMENT BEST PRACTICES														
Individual Level	P1	16,0	1	0	4	9	0	0	0	0	0	0	0	0	0	0	0
	P2	17,5	0	9	5	0	3	0	0	0	0	0	0	0	0	0	0
	P3	11,6	1	2	7	2	9	0	0	0	0	0	0	0	0	0	0
	P4	8,3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	P5	16,3	0	0	9	1	3	0	0	0	0	0	0	0	0	0	0
	P6	16,4	1	1	3	2	9	0	0	0	0	0	0	0	0	0	0
	P7	10,9	9	0	0	0	4	0	0	0	0	0	0	0	0	0	0
	P8	15,3	2	0	0	9	5	0	0	0	0	0	0	0	0	0	0
	P9	16,9	0	0	1	4	6	0	0	0	0	0	0	0	0	0	0
	P10	17,2	0	1	2	1	5	0	0	0	0	0	0	0	0	0	0
	P11	14,3	1	0	9	5	4	0	0	0	0	0	0	0	0	0	0
	P12	12,5	0	0	2	5	6	0	0	0	0	0	0	0	0	0	0
	P13	15,2	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
Team Level	P14	12,9	0	0	0	0	0	0	9	2	2	2	0	0	0	0	0
	P15	14,5	0	0	0	0	0	2	3	9	1	0	0	0	0	0	0
	P16	13,8	0	0	0	0	0	2	6	3	0	1	0	0	0	0	0
	P17	14,7	0	0	0	0	0	1	0	3	6	0	0	0	0	0	0
	P18	14,7	0	0	0	0	0	9	6	6	2	6	0	0	0	0	0
	P19	17,8	0	0	0	0	0	4	0	6	7	1	0	0	0	0	0
Organizational Level	P20	11,2	0	0	0	0	0	0	0	0	0	0	1	0	6	2	1
	P21	16,2	0	0	0	0	0	0	0	0	0	0	0	0	5	9	0
	P22	12,1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	9
	P23	17,3	0	0	0	0	0	0	0	0	0	0	3	9	1	6	0
	P24	19,9	0	0	0	0	0	0	0	0	0	0	3	0	9	1	5
	P25	6,8	0	0	0	0	0	0	0	0	0	0	0	2	1	0	6
	P26	15,1	0	0	0	0	0	0	0	0	0	0	9	3	7	3	4
	P27	6,5	0	0	0	0	0	0	0	0	0	0	0	0	2	3	3
	P28	18,7	0	0	0	0	0	0	0	0	0	0	0	3	6	3	1
	P29	17,8	0	0	0	0	0	0	0	0	0	0	1	0	2	5	0
	P30	19,1	0	0	0	0	0	0	0	0	0	0	4	1	2	3	3
	P31	18,6	0	0	0	0	0	0	0	0	0	0	0	2	4	9	5
	P32	16,0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3
	P33	20,2	0	0	0	0	0	0	0	0	0	0	0	2	1	3	4
	P34	19,8	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0
	P35	25,1	0	0	0	0	0	0	0	0	0	0	1	3	3	4	6
	P36	10,8	0	0	0	0	0	0	0	0	0	0	0	0	1	6	2
	P37	14,2	0	0	0	0	0	0	0	0	0	0	6	4	6	6	1
	P38	18,9	0	0	0	0	0	0	0	0	0	0	2	0	3	6	9
	P39	15,3	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1
	P40	16,6	0	0	0	0	0	0	0	0	0	0	3	1	7	3	0
	P41	26,1	0	0	0	0	0	0	0	0	0	0	2	0	0	3	7
	P42	19,9	0	0	0	0	0	0	0	0	0	0	0	2	3	1	3
	P43	18,6	0	0	0	0	0	0	0	0	0	0	2	2	3	5	0
	pr_k		229	214	633	573	885	275	331	437	282	146	640	613	1255	1549	1252
	q_k		0,15	0,15	0,60	0,20	0,30	0,15	0,45	0,60	0,80	0,90	0,15	0,15	0,65	0,85	0,90
	cp_k		34	32	380	115	265	41	149	262	226	131	96	92	816	1317	1127

Figure 5 – **M2** maturity analysis for the company

On the next step, the improvement opportunities are consolidated and the ones that present cp_k values with more than 1 standard deviation above average are considered the most critical ones within their level, as shown in Figure 6.

Thus, for the organizational level, the practices of "guidelines deployment" and "employee skills development policy" are the most critical. At a team level, the practices of "small group activities" and "communication and information sharing" presented the highest cp_k values. The practice of "participative activities" and "coaching" stood out, at the individual level, as the most critical ones.

Individual Level			Team Level			Organizational Level		
People Management Best Pracice	Criticality of practice for the company	Differentiation Index	People Management Best Pracice	Criticality of practice for the company	Differentiation Index	People Management Best Pracice	Criticality of practice for the company	Differentiation Index
MP1	34	-1	MP6	41	-1	MP11	96	-1
MP2	32	-1	MP7	149	0	MP12	92	-1
MP3	380	1	MP8	262	1	MP13	816	0
MP4	115	0	MP9	226	1	MP14	1317	1
MP5	265	1	MP10	131	0	MP15	1127	1

Figure 6 - Improvement opportunities consolidation

Regarding the decision-making profile, the company leaders determined that the criteria "importance of improvement alternative" is responsible for 51% of the decision criteria and "improvement alternative effort" for 49% of the decision (Figure 7). For the first criteria, the

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

XLVSBPO

16 a 19
Setembro de 2013
Natal/RN

contribution of the attribute "behavior construction according to company's values" represents 40%. Regarding the second criteria, the attribute "investment need" corresponds to 37% of the decision.

Finally, the improvement alternative score could be obtained at the **Z** prioritization matrix, as shown in Figure 8. The bar graph in Figure 9 organizes the alternatives according to the contextualization level and in decreasing order of z_k. Thus, the company can compose a portfolio of improvement opportunities and focus their efforts on the main OL factors in the lean implementation.

Decision profile for improvement projects prioritization				
Objective	Criteria	Attribute	Weight	pa_n
Prioritize improvement opportunities	Importance of improvement alternative	Strategic goals achievement	80	32%
		Behavior contruction according to company's values	100	40%
		Organizational structure impact	70	28%
		Importance of first criteria	250	51%
	Improvement alternative effort	Technical risk	80	33%
		HR qualification need	75	30%
		Investment need	90	37%
		Importance of second criteria	245	49%

Figure 7 – Criteria weight definition

People Management Best Practice		Importance of improvement alternative			Improvement alternative effort			Criticality of practice for the company	Improvement alternative ponctuation
		Strategic goals achievement	Behavior contruction according to company's values	Organizational structure impact	Technical risk	HR qualification need	Necessidade de investimento		
		32%	40%	28%	33%	30%	37%		
Individual Level	MP1	3	9	1	0	0	1	34	179
	MP2	9	3	9	3	3	1	32	284
	MP3	1	3	1	3	1	3	380	1596
	MP4	3	9	0	3	3	1	115	782
	MP5	3	9	0	3	1	1	265	1651
Team Level	MP6	3	9	1	0	0	3	41	245
	MP7	9	3	1	1	3	9	149	1327
	MP8	9	3	1	1	0	0	262	1230
	MP9	3	9	0	1	3	9	226	2060
	MP10	1	1	9	3	9	3	131	1053
Organizational Level	MP11	3	9	1	1	3	9	96	902
	MP12	9	3	0	0	0	3	92	477
	MP13	3	9	1	0	0	1	816	4249
	MP14	9	3	1	3	1	0	1317	7439
	MP15	3	3	1	3	9	1	1127	7326

Figure 8 – **Z** prioritization matrix

Figure 9 – Improvement alternative ranking

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

XLVSBPO

16 a 19
Setembro de 2013
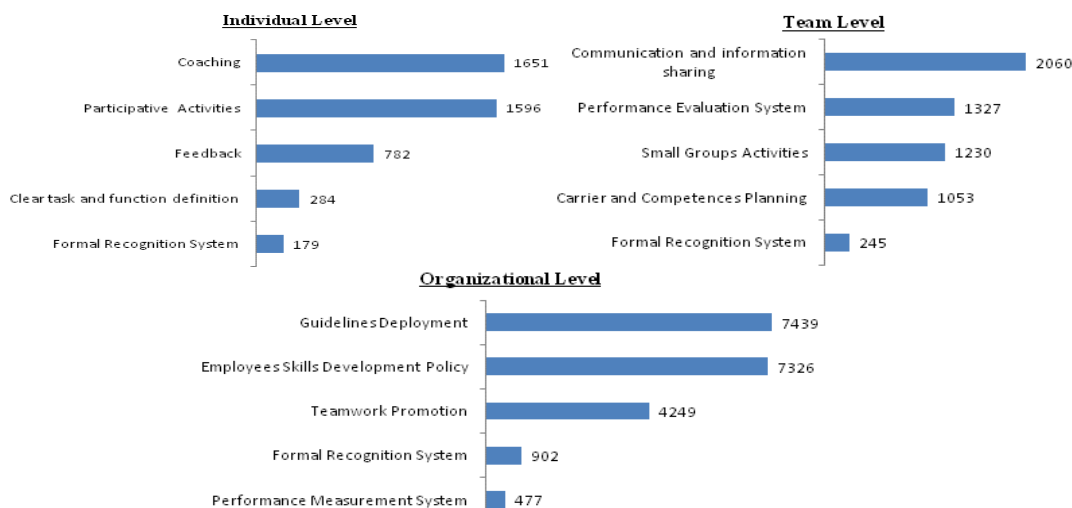Natal/RN

5. Conclusions

The main objective of this paper was presenting a methodology for assessing the organizational learning (OL) factors in a company which is in the process of implementing a Lean Production System (LPS).

The study points out that the utilization of the presented methodology does not provide an optimal solution, but a direction of improvement alternatives that can be developed in parallel within 3 contextualization levels. The methodology presents in the improvement opportunities ranking step the most critical people management practices for the company, according to the contextualization level. This portfolio represents the beginning of the improvement process, since the solution of OL problems is still pending.

Thus, the development of a methodology that would lead and guide the implementation of people management practices would broaden the research scope of this paper, since not only the improvement alternatives would be generated, but also its application conducted on a methodological approach.

References

Araújo, C. and Rentes, A. (2005). A metodologia kaizen na condução de processos de mudança em sistemas de produção enxuta. In: *Encontro Nacional de Engenharia de Produção*, 25.

Armstrong, M. (2006). *Human Resource Management*. London: Kogan Page.

Baker, B. (2002). Why is lean so far off? *Works Management*, v. 55, n. 10, p. 26.

Bessant, J., Caffyn, S. and Gallagher, M. (2001). An evolutionary model of continuous improvement behavior. *Technovation*, v. 21, p. 67-77.

Biazzo, S. and Panizzolo, R. (2000). The assesment of work organization in lean production: the relevance of the worker's perspective. *Integrated Manufacturing Systems*, v. 11, n. 1, p. 6-15.

Crabill, J. *et al*. (2010). *Production operations level transition to lean roadmap*: production operations transition to lean team. Cambridge: MIT, 2000. Available in: <http://www.lean.mit.edu/index.php>.

Cristofari, C. (2008). *Proposta de método de análise de maturidade e priorização de melhorias na gestão do processo de desenvolvimento de produtos*. Dissertação (Mestrado em Engenharia de Produção) – Escola de Engenharia, Universidade Federal do Rio Grande do Sul, Porto Alegre.

Desai, V. (2011). Learning to learn from failures: the impact of operating experience on railroad accident responses. *Industrial and Corporate Change*, n. 2, v. 20, p. 1-28.

Dooley, K., Subra, A. and Anderson, J. (2001). Maturity and its impact on the new product development project performance. *Research in Engineering Design*, v. 13, p. 23-29.

Flott, L. (2002). Managing Change. *Quality Control*, v. 7, n. 6, p. 80.

Fraser, P., Moultrie, J. and Gregory, M. (2002). The use of maturity models / grids as a tool in assessing product development capability. *IEEE*.

Gilley, A., Gilley, J. and Mcmillan, H. (2009). Organizational Change: motivation, communication and leadership effectiveness. *Performance Improvement Quarterly*, v.21,4,75-94.

Guest, D. (2001). *Industrial relations and human resource management*: a critical text. London: J Storey, Thomson Learning.

Herron, C. and Braiden, P. (2006). A methodology for developing sustainable quantifiable productivity improvement in manufacturing companies. *International Journal of Production Economics*, n. 104, p. 143-153.

Hua, Y. (2007). Double-loop learning control (DLC) model for reengineering: a "yin" and "yang" balanced approach for effective organizational change. *International Journal of Production Economics*, n. 110.

Jimmieson, N., Peach, M. and White, K. (2008). Utilizing the theory of planned behavior to inform change management. *The Journal of Applied Behavioral Science*, v. 44, n. 2, p. 237-262.

Simpósio Brasileiro de Pesquisa Operacional
A Pesquisa Operacional na busca de eficiência nos
serviços públicos e/ou privados

16 a 19
Setembro de 2013
Natal/RN

Juca, A. and Amaral, D. (2005). Estudos de caso de maturidade em gestão de projetos em empresas de base tecnológica. In: XXV *Encontro Nacional de Engenharia de Produção*, Anais. Porto Alegre - RS: ABEPRO.

LEI (Lean Enterprise Institute). (2010). *Lean roadmap*. Available in: <http://www.lean.org.br/Events/LeanRoadMap.cfm>.

Marsick, V. and Watkins, K. (2003). Demonstrating the value of an organization's learning culture: the dimensions of the learning organization questionnaire. *Advances in Developing Human Resources*, v. 5, n. 2, p. 132-151.

Min, H. (1994). International Supplier Selection: a Multiattribute Utility Approach. *International Journal of Product Development and Logistics Management*, v. 24, n. 5, p. 24-33.

Ortenbiad, A. (2002). A typology of the idea of learning organization. *Management Learning*, n. 2, v. 33, p. 213-230.

Patterson, M. *et al*. (1997). *Impact of People Management Practices on Performance*. London: Institute of Personnel and Development.

Pettersen, J. (2009). Defining lean production: some conceptual and practical issues. *The Total Quality Management Journal*, v. 21, n. 2, p. 127-142.

Pfeffer, J. (2001). *Fighting the War for Talent is Hazardous for your Organization*. Stanford: University Graduate School of Business.

Pollitt, D. (2006). Culture change makes Crusader fit for the future: training in lean manufacturing helps to transform company. *Human Resource Management International Digest*, v. 14, n. 2, p. 11-14.

Productivity Inc. (2010). *Lean Production Implementation Roadmap*: a guide for the lean journey. Available in: <http://www.advancedmanufacturing.com/January00/pdf/leanroadmap>.

Sharma, G. (2011). *Top 10 Human Resources Best Practices*. Integrated Human Capital & Talent Management Suite. Available in: <http://www.empxtrack.com>.

Silva, E. (2008). *Um modelo de guia para a preparação da implementação da produção enxuta baseado na aprendizagem organizaciona*l. 309 f. Tese (Doutorado em Engenharia de Produção) – Escola de Engenharia, Universidade Federal do Rio Grande do Sul, Porto Alegre.

US Department of Labor. (1993). *High Performance Work Practices and Work Performance. US Government Printing Office*, Washington, DC.

Wong, A. and Tjosvold, D. (2006). Collectivist values for learning in organizational relationships in China: the role of trust and vertical coordination. *Asia Pacific J Manage*, v. 23, p. 299-317.