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

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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
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) (BESSERT 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
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.
<table>
<thead>
<tr>
<th>Contextualization Level</th>
<th>Group of People Management Practices by Author</th>
<th>Best People Management Practices Consolidation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Payment linked to</td>
<td>Recognition according to performance</td>
<td>1. Formal recognition system</td>
</tr>
<tr>
<td>performance status</td>
<td>Income and benefits according to function</td>
<td></td>
</tr>
<tr>
<td>&quot;Open book&quot; management style</td>
<td>Work design focused on flexibility, commitment and motivation, including steps that allow employees</td>
<td>2. Clear task and function definition</td>
</tr>
<tr>
<td>Employee involvement</td>
<td>Hierarchical levels reduction</td>
<td>3. Participative Activities</td>
</tr>
<tr>
<td>360° feedback system</td>
<td>Two-way communication</td>
<td></td>
</tr>
<tr>
<td>Coaching</td>
<td>Training</td>
<td>4. Feedback</td>
</tr>
<tr>
<td>Team</td>
<td>Positive results celebration</td>
<td>5. Coaching</td>
</tr>
<tr>
<td>Recognition</td>
<td>Carefull utilization of evaluation tasks to identify employees with potential contribution</td>
<td></td>
</tr>
<tr>
<td>Employee evaluation</td>
<td>Coherent evaluation systems</td>
<td></td>
</tr>
<tr>
<td>system</td>
<td>Incentives that recognize individuals and teams with performance above expectation</td>
<td></td>
</tr>
<tr>
<td>Information sharing</td>
<td>Communication</td>
<td>7. Performance evaluation system</td>
</tr>
<tr>
<td>Continuous training</td>
<td>Provide skills and knowledge to teams</td>
<td>8. Small group activities</td>
</tr>
<tr>
<td>Organization</td>
<td>Motivational incentives</td>
<td>9. Communication and information sharing</td>
</tr>
<tr>
<td>Formal recognition</td>
<td>Recognition and incentives utilization</td>
<td>10. Career and competence planning</td>
</tr>
<tr>
<td>system</td>
<td>Formal performance evaluation system</td>
<td></td>
</tr>
<tr>
<td>Formal mechanisms for</td>
<td>Teamwork promotion</td>
<td>11. Formal recognition system</td>
</tr>
<tr>
<td>teamwork incentive</td>
<td>Programs that raise employee ownership in order to correlate his action to business performance</td>
<td></td>
</tr>
<tr>
<td>Alignment to company’s</td>
<td>Long term employment expectation</td>
<td>12. Performance measurement system</td>
</tr>
<tr>
<td>guidelines management</td>
<td>Sophisticated training processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Career planning processes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Employees skills development policy</td>
<td></td>
</tr>
</tbody>
</table>
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).

<table>
<thead>
<tr>
<th>Phases</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 0 - Adoption of lean paradigm</td>
<td>Decide to transform the company</td>
<td>Decide to change operating philosophy into lean paradigm</td>
</tr>
<tr>
<td>Phase 1 - Prepare implementation</td>
<td>Leadership commitment to lean transformation</td>
<td>Strategic plan to lean implementation that guides leadership and organizational support, the human and cultural issues, targets and training.</td>
</tr>
<tr>
<td>Phase 2 - Define value</td>
<td>Strategy defined on phase 1, which establishes where to start lean implementation</td>
<td>Product, customer and value definition to lead distinction between operations that value added and non-value added operations.</td>
</tr>
<tr>
<td>Phase 3 - Identify flow of value</td>
<td>Value definition according to lean perspective</td>
<td>Value stream map that shows production process and information flow, identifying the amount of value added and waste activities.</td>
</tr>
<tr>
<td>Phase 4 - Design production system</td>
<td>The current value stream</td>
<td>The production system design ready to start implementing.</td>
</tr>
<tr>
<td>Phase 5 - Implement flow</td>
<td>Th LPS design and its implementation plan</td>
<td>Lean projects implemented on system that guarantee lean flow trough waste reduction.</td>
</tr>
<tr>
<td>Phase 6 - Implement pull system</td>
<td>A production system with operation flow implemented</td>
<td>A production system that responds to customer demands with appropriate mix and quantity.</td>
</tr>
<tr>
<td>Phase 7 - Look for perfection</td>
<td>Leadership commitment to lean transformation</td>
<td>Improvement on lean transition processes to any other phases.</td>
</tr>
</tbody>
</table>

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).
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:

\[
h_j = 1 - f_j, \quad j = 1, ..., 43
\]  

(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:

\[
ip_j = \sum_{i=1}^{n} r_{ij}, \quad j = 1, ..., 43
\]  

(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:

\[
kr_j = ip_j \times h_j, \quad j = 1, ..., 43
\]  

(3)

The \( kr_j \) 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 \( g_{jk} \),
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:

$$q_k = 1 - n_k, k = 1, ..., 15$$  \hspace{1cm} (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:

$$pr_k = \sum_{j=1}^{43} g_{jk} \times cr_j, k = 1, ..., 15$$  \hspace{1cm} (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 $n_k$:

$$cp_k = pr_k \times q_k, k = 1, ..., 15$$  \hspace{1cm} (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 $k$
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:

$$z_k = \sum_{n=1}^{N} \left( pd_{nk} \times pa_n \right) \times cp_k, \quad k = 1, \ldots, 15$$  \hspace{1cm} (7)

The relationship between the importance of the attributes $pa_n$ 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.
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.

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.
On the next step, the improvement opportunities are consolidated and the ones that present $c_{pk}$ 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 $c_{pk}$ values. The practice of "participative activities" and "coaching" stood out, at the individual level, as the most critical ones.

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
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.
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


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


