

# Lean Manufacturing and Industry 4.0: Integrated Roadmap Proposal for Process Management Maturity Assessment

Santos V A<sup>1</sup>, Loures E F R<sup>2</sup>, Ramos L F P<sup>3</sup>, Deschamps F<sup>4</sup>.

**Abstract** In view of the current strong competitiveness and accelerated technological development, the search for efficient and automated processes is becoming increasingly intense. The emergence of Lean Manufacturing and more recently of Industry 4.0 brought great advances and, despite their differences, present convergences of great potential to be explored. Despite the benefits of this joint implementation, the lack of a roadmap for the technological direction associated with Lean tools is still a challenge for most organizations. In view of this gap, the present study aims to build a roadmap with steps that aim to guide organizations on this journey, based on the concepts of the Business Process Model (BPM) and having as an application domain an Industry in the Oil and Gas. The Roadmap entitled LI4MTA has 5 macro-steps ranging from strategic alignment to the execution of action plans for improvement. The proposed steps helped the organization to diagnose current maturity, and to prioritize initiatives for digital transformation to address the current weaknesses in Lean Manufacturing. As next steps, it is proposed to detail the roadmap using Multicriteria Decision Making Methods (MCDM).

**Keywords:** Lean Manufacturing; Industry 4.0; BPMN; Evaluation Roadmap.

## 1 Introduction

Given the competitive and technological global scenario, many systems, concepts, and practices were developed or improved in the search for the optimization of production processes, among them the so-called Toyota Production System (TPS), which appeared in 1950 [2]. Another major milestone in the productive context took place in the 1990s, with the so-called Fourth Industrial Revolution, marked above all by the constant alignment between information technology with software and hardware to monitor production [4]. Although different, both the Lean system and Industry 4.0 have elements that complement each other, that is, both Lean supports the implementation of Industry 4.0, and the technologies of Industry 4.0 automate the Lean tools and help to enhance the expected results [1]. However, there are still challenges to be overcome to have a complete consolidation of both production systems. In this environment, the Business Process Management (BPM) - a management approach that refers to Business processes as assets – can increase productivity and efficiency through the standardization of corporate processes [5]. In his

---

<sup>1</sup>Vanessa Aline dos Santos (e-mail: [vanesa.aline@pucpr.edu.br](mailto:vanesa.aline@pucpr.edu.br)).

Dpto. de Pesquisa e Pós Graduação em Engenharia de Produção e Sistemas (PPGEPS). Pontifícia Universidade Católica do Paraná. Curitiba, PR, Brazil.

<sup>2</sup>Eduardo de Freitas Rocha Loures (e-mail: [eduardo.loures@pucpr.br](mailto:eduardo.loures@pucpr.br)).

Dpto. de Pesquisa e Pós Graduação em Engenharia de Produção e Sistemas (PPGEPS). Pontifícia Universidade Católica do Paraná. Curitiba, PR, Brazil.

<sup>3</sup>Luiz Felipe Pierin Ramos (e-mail: [luiz.pierin@pucpr.edu.br](mailto:luiz.pierin@pucpr.edu.br)).

Dpto. de Pesquisa e Pós Graduação em Engenharia de Produção e Sistemas (PPGEPS). Pontifícia Universidade Católica do Paraná. Curitiba, PR, Brazil.

<sup>4</sup>Fernando Deschamps (e-mail: [fernando.deschamps@pucpr.br](mailto:fernando.deschamps@pucpr.br)).

Dpto. de Pesquisa e Pós Graduação em Engenharia de Produção e Sistemas (PPGEPS). Pontifícia Universidade Católica do Paraná. Curitiba, PR, Brazil.

holistic/systemic view [3], it can contribute to the decision-making processes related to the diagnosis of maturity and decision of new technology investments.

## **2 Objectives and method**

Recognizing such gaps, the present study aims to improve the current process of evaluating maturity and selecting new resources and technologies in the productive environment through a road map. The present study was developed in a large industrial company from Oil & Gas sector aiming to illustrate and offer a contribution in this context. The company performs a process strongly guided by Lean Manufacturing, however, it still does not include the bases and resources of Industry 4.0. The execution of the project took place in 7 stages, which include from the literature review, mapping and analysis of the current process, elaboration of the road map, up to the applied case study. For the elaboration of the Road Map, the Margherita model [2] provided the basis for the construction of the stages based on the BPMS.

## **3 Results**

Based on data and bibliographic surveys about the domain of Lean Manufacturing and I4.0, as well as the investigation of models that represent it, it was possible to establish a conceptual roadmap for the elaboration of an evaluation and selection program of technologies that best meet current weaknesses based on Lean Manufacturing indicators. The model, entitled Lean I4.0 Maturity & Technology Assessment (LIMTA), is divided into 5 macro-steps (0 to 4): Model, Evaluation, Results, Action and Maintenance Plan (Support). Each stage is composed of joint actions between evaluators (specialists) and work team (members of the organization that will assist in the collection of information), which will guide the process from the strategic alignment to the execution of the action plans for improvement. The current project had its scope focused on the procedural domain of reformulation of the evaluation process. In its continuity, maturity models and correction methods between the domains of Lean and Industry 4.0 will be explored.

## **4 Conclusion**

Through the proposed model, Lean I4.0 Maturity & Technology Assessment (LI4MTA), it was possible to have a broader diagnostic view of the current state of the organization about its digital transformation initiatives (Industry 4.0) and Lean Manufacturing. Through the proposed methods, the model gained greater robustness and the graphics significantly helped in understanding the relationships between both contexts, having Industry 4.0 principles as the bridge. The application of the model in a metal-mechanic industry facilitated the understanding of the stages of the project, being possible to provide contributions to the evaluated organization. Because it is adaptable to different dimensions of Lean or Industry 4.0 according to the model adopted by the organization, the method may have its applicability in different contexts. As next steps, we can see the details of the process with the application of maturity models using multi-criteria decision-making methods (MCDM) and its execution through an electronic interface that makes it easily applicable in organizations.

## **5 References**

- [1] Buer, S. V., Strandhagen, J. O., & Chan, F. T. (2018). The link between Industry 4.0 and lean manufacturing: mapping current research and establishing a research agenda. *International Journal of Production Research*, 56(8), 2924-2940.
- [2] Cardoza, E., & Carpinetti, L. (2005). Indicadores de desempenho para o sistema de produção enxuto. *Revista Produção Online*, 5(2).
- [3] Margherita, A. (2014). Business process management system and activities. *Business Process Management Journal*.
- [4] Ramos, L., Loures, E., Deschamps, F., & Venâncio, A. (2020). Systems evaluation methodology to attend the digital projects requirements for industry 4.0. *International Journal of Computer Integrated Manufacturing*, 33(4), 398-410.
- [5] Trkman, P. (2010). The critical success factors of business process management. *International journal of information management*, 30(2), 125-134.