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LEAN & INDUSTRY 4.0 INTEGRATION: PROPOSED ROADMAP TO ASSESS MATURITY AND SELECT NEW TECHNOLOGIES

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Abstract
In the face of the global competitive scenario, the adoption of solid strategies capable of following the trends and technological innovations has become a necessity. In this environment, practices arising from productive systems, such as Lean Manufacturing and, more recently, from Industry 4.0 (I4.0), have provided an important contribution to the increase in productivity and efficiency, especially when adopted simultaneously. Some authors study the relationship between these two concepts, however, few process models approach their joint application in the organization in a practical way. To fill this gap, the present study aims to remodel the maturity assessment process and selection of new technologies by a large oil and gas company to propose a joint assessment of the domains of I4.0 and Lean Manufacturing, and assist in prioritizing new technologies for the production environment. The roadmap entitled Lean I4.0 Maturity & Technology Assessment (LI4MTA) was guided by the concepts of Business Process Management (BPM), consisting of 5 macro-steps (0 to 4): Model, Evaluation, Results, Action Planning and Maintenance (Support). The model was applied to the organization in its maturity assessment phase. As a global result related to the I4.0 domain, the assessed entity obtained "grade 1.8 (0-3)", which places it at the "survivor" level.

Keywords
Lean Manufacturing, Industry 4.0, BPMN, Evaluation Roadmap.

Introduction
Over the years, many systems, concepts and practices have been developed, replaced or improved in the quest to optimize production processes. In this sense, two milestones stand out: the birth of the Toyota Production System or "Lean Manufacturing" and the emergence of the Fourth Industrial Revolution based on "Cyberphysical Systems" and the "Internet of Things" (Ramos, Loures, Deschamps et al, 2019).

Although different in conceptual terms, both Lean Manufacturing and Industry 4.0 have principles that complement each other. Roy et al. (2015) comment that technologies in the productive environment can offer the organization the opportunity to reach higher levels of maturity in relation to lean principles.

Despite the potential benefits, there are still challenges to be overcome for a complete consolidation of both concepts. Regarding Lean Manufacturing, they are related to financial metrics, tool implementation, project prioritization and time for knowledge diffusion (Kilpatrick, 2003). When dealing with Industry 4.0, the key challenges are related to "scientific, technological, social and mainly technical issues related to technology, security and privacy, and standardization" (Xu, Xu and Li, 2018).

The lack of a standard process that guides the gradual and assertive implementation of new resources constitutes a barrier still present in organizations. In this environment, business process management (BPM) can support the alignment of strategies and operations for a process-based and value-oriented organization (Margherita, 2014), contributing to the standardization of maturity assessment and decision-making processes for new employees and investments.

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 an orientation roadmap. A case study was developed in a large industrial company to illustrate and offer a significant contribution in this context.