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Impact of Industry 4.0 on the Lean Manufacturing concept: A systematic literature review

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Abstract The industrial world is experiencing the wave of industry 4.0, incorporating new technologies capable of ensuring new forms of competitiveness in a globalized market. However, we must understand how the integration with the Lean Manufacturing concept will be, widely disseminated and incorporated by organizations. Through a systematic bibliographic review, the objective of this article is to investigate the impacts of Industry 4.0 on the Lean concept, in order to diagnose possible gaps, visualize research opportunities and understand how these domains can interact. The results show that there are conceptual divergences of integration between researched models, as well as the need for practical validations.

Keywords: Industry 4.0; Lean Manufacturing; Systematic Literature Review.

1 Introduction

The global market drives each company to improve its process to reach a higher quality of products and services (De Felice et al. 2019). More offers without the counterpart of demands, generate the importance of products renewal to attract consumers and keep competitors away. This is the challenge for organizations, to be increasingly prepared to compete in this new scenario. The academic contribution of this paper is to fill a possible gap identified when researching the interaction between the concepts of production management, specifically Lean Manufacturing (LM) and Industry 4.0 (I4). For that, systematic reviews and meta-analyses (PRISMA) guidelines were carried out (Moher et al., 2015).

Since LM was invented, this methodology does take into account the possibilities of current information and communication technologies (Kolberg and Zühlke, 2015). To deal with growing challenges it was created I4 that can connect people and things anytime, anywhere, with anything and anyone in an ideal way using CPS systems (Wagner et al., 2017). CPS combine the physical world with cyber world through cycles controlled by embedded computers. The main role of the CPS is to achieve agility and dynamic production requirements that allow the creation of intelligent factories (Prinz et al., 2018).

There are several unexplored dimensions, such as the impacts of the LM concept with I4 (Kolberg and Zühlke, 2015; Leyh et al., 2017). Both production paradigms remain promising to solve future manufacturing challenges, the question is how they can relate (Mayr et al., 2018). Based on the research

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carried out, different perspectives of interaction will be presented that could be used to fill this gap identified by the impacts of I4 on LM.

2 Research method–Systematic literature review design

To guarantee transparency and clarity, it was used the systematic reviews and meta-analyses (PRISMA) guidelines (Moher et al., 2015). The research points out that there are divergences when investigating the interaction between the lean concept and I4.The impacts of I4 solutions on the LM concept are not clearly specified and conclusive methods of evaluation are still lacking (Wagner et al., 2017). However, there is a link between I4 and the LM concept (Mrugalska and Wyrwicka, 2017) and it is possible to create interaction models between the concepts (Sony, 2018).

3 Results and discussions

The four maturity models were identified and grouped by line of thought of the researched authors, as shown in Table 1 and can be defined based on the following perspectives:

Table 1 Maturity models by authors surveyed

Perspectives	References
LM as I4 facilitator	Buer et al. (2018), Davies et al. (2017), Enke et al. (2018), Kolberg and Zühlke (2015), Leyh et al. (2017), Prinz et al. (2018)
I4 as LM facilitator	Dombrowski et al. (2017), Enke et al. (2018), Fettermann et al. (20118), Kolberg and Zühlke (2015), Ma et al. (2017), Mayr et al. (2018), Wagner et al. (2017), Wang et al. (2016), Yin et al. (2018)
Correlation between LM and I4	Buer et al. (2018), Kolberg and Zühlke (2015), Mrugalska and Wyrwicka (2017), Sanders et al. (2016), Sony (2018), Whichmann et al. (2019)
Barriers and difficulties in integration	Kolberg and Zühlke (2015), Ma et al. (2017), Yin et al. (2018)

Lean Manufacturing as I4 facilitator: Demonstrate the need for LM as a requirement for I4 (Prinz et al. 2018). A lean industrial environment is a facilitator for the implementation of I4, as LM creates the culture of continuous improvement (Dombrowski et al., 2017).

I4 as LM facilitator: Presents I4 as a possible evolution of LM. The processes can be stabilized and refined by applying the concepts of I4, as it contributes to address the limitations of LM (Wagner et al., 2017).

Correlation between LM and I4: Affirm the idea that I4 and LM can coexist and support each other, in order to similarities in relation to goals such as reducing complexity, pillars and lean principles (Mrugalska and Wyrwicka, 2017).

Barriers and difficulties in integration: LM methods have reached their limits in complex manufacturing environments, as is the case with I4 (Kolberg and Zulke, 2015). There are limitations of interaction between concepts, stating that mass customization will be a competitive advantage and although LM is flexible and efficient, it is not able to meet this requirement, unlike I4.

4 Final considerations

The academic contribution through bibliographic research of scientific works in industrial management is necessary to diagnose possible gaps and to see opportunities for further study on the subject. One of the points identified is that there is little practical evidence of the interactions between LM and I4. And the

possible interactions between LM and I4 are still immature and there is a need to understand how these domains interact.

The conclusions of this study illustrate that there is still much to be researched under the possible interactions of the concepts, but in any case, the theme is relevant and can be used for future work in order to broaden the theme of this research. One can also relate the company´s maturity level with the results obtained through the implementation of new management models, which as stated, are vital to maintain the competitiveness of industries in an extremely challenging environment.

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