Integrating Industry 4.0 in Lean Manufacturing: A Review

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Abstract. The convergence of Lean Manufacturing and Industry 4.0 technologies represents a major opportunity to design intelligent, sustainable, and agile production systems. This paper provides an overview of the current state of research on the integration of Lean Manufacturing and Industry 4.0, highlighting their synergies, the challenges encountered, and implementation strategies within the SGRL (Smart, Green, Resilient, Lean) paradigm. While Lean is recognized for its effectiveness in reducing waste through its tools, its limitations become apparent in an increasingly dynamic industrial environment. Industry 4.0 technologies provide greater flexibility, customization, and real-time decision-making. The integration of the two approaches is not only possible but also complementary, promoting operational gains and a cultural shift towards continuous improvement. Despite this, certain obstacles remain. This study highlights the key benefits and critical barriers and proposes avenues for future research, including human-centered integration and the design of sector-specific roadmaps. The first part of the article covers the importance of lean manufacturing and production performance, and moves on to the importance of lean smart in manufacturing production. The second part presents a review of previous research on lean smart. The third part presents the issues identified in the literature review.

Keywords: Lean Manufacturing, Industry 4.0, Smart Manufacturing, Digital Transformation, reviewer.