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WHAT IS LEAN 4.0?

Azyyati Anuar

azyyati@uitm.edu.my

Faculty of Business and Management, Universiti Teknologi MARA Cawangan Kedah

Daing Maruak Sadek

daing729@uitm.edu.my

Academy of Contemporary Islamic Studies, Universiti Teknologi MARA Cawangan Kedah

INTRODUCTION

The fundamental concept of waste reduction and efficiency enhancement, which started with Japanese automobile manufacturing, has existed for an extended time. This occurred even before the term lean was introduced by John Krafcik in 1988 (Laaper & Kiefer, 2020). Currently, the manufacturing industry is undergoing a gradual transformation from craft to mass production and from mass to lean production. Lean production is an approach that continues to succeed by reducing industry complexity. However, the complexity has increased as a result of the intricacy of market demands, an unbalanced environment and excessively ambitious customers (Cifone & Staudacher, 2021). In this regard, lean applications are unlikely to be feasible in the industry as the production processes become more challenging in tandem with technological advancements. Therefore, a new research topic, Industry 4.0 (IR4.0) comes into place to deal with the increased production complexity (Mayr et al., 2018). In this sense, the introduction of Lean 4.0 and its integration with IR4.0 could be viewed as a revitalized version of lean (Raji *et al.*, 2021). Though it is believed that Lean 4.0 will contribute to robust production, by far, there is no universally accepted definition of Lean 4.0, and its components have not yet existed (Rybski & Jochem, 2021).

WHAT IS LEAN 4.0

Lean 4.0 is a combination of lean manufacturing principles and Industry 4.0 tools (Accialini Training and Consultin, 2021). Lean manufacturing is defined as a production concept created by Toyota Motor Corporation with the goal of reducing waste throughout the value chain to reduce lead times, costs and enhance quality (Shah & Ward, 2007). Toyota was one of the successful companies that implemented lean manufacturing to achieve a world-leading position in the automobile industry. Whereas Industry 4.0, colloquially known as the "fourth industrial revolution," refers to the current state of industrial operations (Raji et al., 2021). The terms "Industry 4.0" and "Industrie 4.0" were first used in 2011 at the Hannover Fair, which attracted the attention of numerous governments around the world (The Future Factory, n.d). Industry 4.0 intends to increase efficiency, transparency, and adaptability, resulting in a mass personalization scenario. Furthermore, the goal of IR 4.0 is to improve transparency by digitally connecting every component of the manufacturing process (Mayr et al., 2018). Though Vigneshvaran and Vinodh's (2021) definition of lean is based on consistency and standardization, whereas IR 4.0 is based on interconnection and adaptability.

Currently, the integration of Industry 4.0 and lean, referred to as Lean 4.0, is a sensational academic topic as everyone agrees on its enormous potential (Gillani et al., 2020; Pagliosa et al., 2019). For instance, Lean 4.0 technologies assist smoother production and product improvement by utilizing a waste detection system (Javaid et al., 2021). According to a study by Cifone and Portioli Staudacher (2021), Lean 4.0 improves company performance regardless of the production plan used; however, organizations that employ a repeated strategy see a considerably greater improvement. Indeed, when the majority of the industry embraces Lean 4.0 and digital transformation, the industry becomes more agile, flexible, and low-cost. Ghobakhloo and Fathi

(2020) mention, developing lean-digitized production systems is a realistic business strategy for corporate survival in the age of Industry 4.0. In fact, the corporate environment has evolved dramatically since lean was developed, due to factors such as the Internet, globalization, outsourcing, oversupply, "services," rapid technological change, increasingly complex products, and now, IR 4.0.

Although Lean 4.0 has helped the industry in becoming more efficient, some of the barriers of Lean 4.0 have been identified. Growing competitive pressure, an unclear long-term vision, a lack of managerial support and an insufficient capital fund are the most significant impediments to the integration of lean and IR4.0 (Vigneshvaran & Vinodh, 2021). More specifically, in an ever-changing world where demand and products are unstable, flexibility becomes critical (Raji *et al.*, 2021). Thus, one could argue that the interaction between lean and IR4.0 has not been dignified, even though discussions on this topic continue among scholars and practitioners.

CONCLUSION

To summarize, lean began as a method to eliminate waste, but has evolved into a foundation for building intelligent systems. While Lean 4.0 is a relatively new concept in several industries, it is apparent that the goal of lean is to increase firm performance by reducing waste and increasing efficiency. Additionally, Lean 4.0 also aids in the reduction of repetitive tasks, tedious work, and other non-value-added activities, especially when it comes to business decisions such as customer service. However, no link has been established between the complex IR 4.0 and the improvement of business performance. Nevertheless, industries that are unable to fully embrace Lean 4.0 will definitely face tremendous pressure in the future. Therefore, it is essential for every company to take gradual steps when deploying new technologies in order to determine what works and what does not in the implementation of Lean 4.0.

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