

Summary - Abstract

Today's global market is becoming more competitive and challenging, especially after recent events such as the Covid -19 pandemic. Companies seek opportunities for improving their production processes, supply chain networks, and also cultural approaches to quickly adapt their operations to changing customer needs. In such a context, supply chains play an important role in enhancing the overall business performance. Within them, warehouses represent a crucial part of logistics networks as a function of temporary storage of goods and components before dispatching to their customers. For that reason, warehouse processes should be improved to operate smoothly, productively, and adaptively, and this enhances their responsiveness and flexibility to meet today's market changes. In this regard, Lean Manufacturing (LM) provides an adequate approach to support process improvements and deliver more value to customers. In fact, it is aimed at either reducing or eliminating the non-value-added activities not only in production but also in warehouse and logistics operations. Also, automation technologies have been widely applied to warehouse activities for increasing productivity and enlarging their capacity. To achieve a higher degree of automation, Lean practices should be adopted. However, automation can also assist in implementing high levels of Lean.

This study aims at investigating Lean practices and automation as a way to improve warehouse processes with focus on developing countries. A maturity framework is developed to assess the current implementation level of Lean and automation to evaluate the readiness of warehouses in developing countries for their adoption.

The applied research methodology is inspired by Design Science Research (DSR), particularly its two first steps, namely Solution Incubation and Refinement. It consists of four phases. First, a literature review is conducted by focusing on three streams: Lean tools applied to warehouses, automation technologies applied to warehouses, and existing maturity frameworks addressing the application of Lean practices and automation. A research gap emerges related to the lack of appropriate maturity frameworks considering both the Lean approach and automation, especially in developing countries. Second, field observations and a questionnaire survey are conducted to define the current application of Lean and automation in warehouses in developing countries and the associated needs. Uzbekistan is considered as case country since it has been recently quickly developing in Central Asia. The survey involves around 570 professionals working in different industrial sectors. The questionnaire responses were analyzed via the Kruskal Wallis statistical test. According to the DSR approach, the results obtained through field observations and survey allowed the author to define the practical problem to which finding a solution. This is namely the need for having an effective tool to evaluate the readiness to apply Lean and automation to warehouses. As the third step, based on the field observations and survey outcomes, the author developed a new maturity framework. It is structured according to four assessment dimensions: physical flow, information flow and data flow automation as well as Lean logistics. Five maturity levels are defined for each assessment dimension together with a short

description. In the fourth phase, the proposed maturity framework is validated according to the multiple case study approach involving eight companies. These companies operate in two Uzbek industry sectors, having a high market share, namely the Automotive and Home Appliance Products ones. After some field tours, the author carried out interviews with company representatives to apply the framework and assessing the current maturity levels about Lean and automation in their warehouses.

As a result, the maturity level of Lean logistics is higher in automotive companies than home appliances ones because Lean was born in this industry. However, the automation maturity level varies according to physical flow, information flow, and data flow contexts. In the physical flow the maturity degree of automation application is ranked quite low in both industries because they still use more manual work and mechanized tools rather than advanced technologies. Instead, the automation levels in information and data flows in automotive companies are higher than for the physical flow and are ranked in the medium level according to the framework. The analyzed companies adopted some digital tools to handle warehouse data collection and elaboration. About the Home Appliance Products industry, the degree of application of automation to information and data flows, it is slightly higher for final product warehouses than in raw material warehouses because they have implemented more automation tools to track the movements of items to support integration with customers' ERP systems. Lean logistics is currently starting to become popular in this industry area and only very basics tools are applied by the warehouses of the case companies.

The potential future extension of this research work might involve more companies in the case studies, coming from different developing countries and industries. This will improve the validity of the proposed maturity framework. Finally, the application of DSR approach can be completed to increase the theoretical relevance and the significance of the developed maturity framework.