DIGITAL MUDA - THE NEW FORM OF WASTE BY INDUSTRY 4.0.

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ABSTRACT
Lean management is an approach where value is created through the reduction of waste. Eight forms of waste were identified by the Toyota Company to be considered while managing an efficient production process: overproduction, waiting, transport, over processing, inventory, movement, defects, unused creativity. Since the start of Industry 4.0, machines and tools have become smart, collecting data about the processes and products produced at the plants, as well as products themselves becoming smart and generating their own data. Big data must be analyzed, since ignoring the data analytics or performing poor data analysis could lead to waste in the manufacturing process and loss of profit. A conceptual framework was developed to investigate if the inefficient usage of data has a negative impact on manufacturing performance through the decision-making process. Semi-structured interviews were conducted in leading manufacturing companies in Sweden that are following lean principles. A new form of waste, digital waste, was defined. This paper suggests considering digital waste as a new part of ‘muda’ (waste), which is its theoretical contribution.

Keywords: Lean management, digitalization, digital waste, muda.

1. INTRODUCTION
The importance of data in the manufacturing sector is growing. Factories are becoming smart and the tools are intelligent (Qin et al., 2016; Zhong et al., 2017). Many global manufacturers take previously isolated data sets, aggregate them, and analyze them to reveal important insights. By resetting different parameters, one chemical company was able to reduce its waste of raw materials by 20% and its energy costs by around 15%, thereby improving overall value (Auschitzky et al., 2014). On the other hand, according to the chief technology officer of the Digital Manufacturing and Design Innovation Institute (King et al., 2015), “[Manufacturers] mostly throw away the data. Where they keep it, they don’t know what to do.” Advanced analytics provide a granular approach for manufacturers to analyze historical process data, identify patterns and relationships, and optimize the factors that prove to have the greatest effect on value and profit (Auschitzky et al., 2014). Lean philosophy is aligned with manufacturing digitalization (Mrugalska and Wywicka, 2017; Rüttimann and Stöckli, 2016), but the meaning of waste has not received enough attention in the literature given the new circumstances of Industry 4.0.
The purpose of the paper is to investigate if not collected and not processed can be considered as a new form of muda, digital waste. The purpose can be specified in three research questions:

- Why partial or full ignorance of data collection at the manufacturing plant could be considered a waste?
- Why collected but not processed data at the manufacturing plant could be considered a waste?
- Why data processed with a specific purpose that did not lead to the expected results could be considered a waste?

2. LITERATURE REVIEW

2.1 Lean Manufacturing, Waste & Performance

Elimination of waste is one of the most significant parts of the lean philosophy (Slack et al., 2010). There are eight types of waste in lean production: overproduction, waiting, transport, over processing, inventory, movement, defects, and unused creativity (Liker, 2004; Oehmen and Rebentisch, 2010; Slack et al., 2010; Womack et al., 1990). Elimination of waste is a journey of learning to map the production value-adding activities as well as the elimination of non-value-adding activities (Liker, 2004). Waste reduction techniques are used to improve the performance of the waste minimization program in manufacturing, combining the interests of lean manufacturing and green management (Fercoq et al., 2016).

2.2 Human Decisions & Industry 4.0

Job profiles in the manufacturing sector will become more complex and require continuous learning and training (Bonekamp and Sure, 2015; Hecklau et al., 2016). Training will ensure the adaptation of current manufacturing employees to the changing work environment. Technological support is going to become a guarantee for the manufacturing employees to realize their full potential in the strategic decisions as well as to increase their flexibility in problem-solving (Gorecky et al., 2014). Industry 4.0 aims to support existing manufacturing jobs with new competencies and also offer new jobs for the digitized generation in the manufacturing sector (Richert et al., 2016).

2.3 Data Analysis, Decision Support & Performance

The combination of lean manufacturing focusing on value-adding activities and boosting the performance, as well as Industry 4.0 with a set of tools supporting the analysis of specific lean methods is defined as lean 4.0 (Mayr et al., 2018). There are no defined achievement criteria, nor is there a roadmap of technologies accomplishing Industry 4.0 (Qin et al., 2016). Lean 4.0 tools need to be selected carefully towards the specific process improvement, but not be considered a tool for cost reduction instead (Mayr et al., 2018). Zhong et al. (2017) discuss the intelligent manufacturing in the context of Industry 4.0, where all the resources are converted into intelligent objects with an ability to sense, act, and behave. According to Uriarte et al. (2018), Industry 4.0 will exclude the routine tasks performed by workers, which will allow them to become decision makers and flexible problem solvers in a growing intelligent manufacturing production. According to Mayr et al. (2018), data usability, selective provision of information, acceptance of users, profitability, and ethics are the key success factors in integration of Industry 4.0 technologies on the shop floor.
3. METHOD
The research is exploratory, with a company as the unit of analysis (Barratt et al., 2011). To avoid being subjective with results from one company, our research is comparative and involves two manufacturing companies to investigate any contrast in the results. The two selected companies have many similarities, such as the lean management approach, number of employees, industry, organizational culture, and dates of establishment. Semi-structured interviews were an approach of the study to collect the data and not limit responders by the boundaries of the question, to gain broader knowledge about the phenomenon (Barratt et al., 2011). The interviews were coded, with the data processed through conventional content analysis (Elo and Kyngas, 2008; Hsieh and Shannon, 2005).

4. RESULTS, DISCUSSION AND CONCLUSIONS

Data collection
According to Slack et al. (2010), waste is anything other than the minimum amount of equipment, items, parts and workers essential to production. Elimination of all waste in a lean operation leads to faster operations, as well as higher quality products and services at low cost. Relations with a customer do not stop after the sale, and the manufacturer is responsible for quality while the product is in use. Company A stores the production data to reflect on needs, requests and complains of the customer. For example, if customers find a defect while using the product, they call back to the manufacturer and identify the reason for it. Collected (historical) data from production can prove or deny the existence of the problem and assist in improving the quality. Company B has a bottom-up approach to creating value for their customers and improving the cost through value creation. They start from the motivation or the goal, for example, to make a product more sustainable. Investigating the potential, they are looking for different possible scenarios, where product and production data play a key role in finding the solution. If data is not collected, there is no resource to meet a goal, which limits or totally excludes the possibility to improve the quality of the product. Analysis of theory and cases leads to an assumption that equipment and
items became smart, collecting and producing the data. Workers use the data to implement their jobs efficiently and eliminate eight well-known types of waste. Thus, data has become an essential part of the production. Partial or full ignorance of data collection at the manufacturing plant is a barrier for a product’s good quality potential, and can possibly be considered a waste when focusing on product quality. There is no confirmation if uncollected data is a barrier for faster operation or the potential for lower cost service.

Data processing

According to Liker (2004), waste is anything that takes time but does not add value to a customer. Company A doesn’t have a consistent method to collect data from multiple sources. Consequently, it is a challenge to process the data from all the available sources to reliable information, develop meaningful conclusions, and achieve value. Company B separates data collection into two types: product data and process data. Products have different levels of complexity, so the maturity of data collected is different and cannot be processed the same way or easily integrated with other systems such as ERP or CRM. Company B is working on the development of the central unit of data process with an understanding of what value it will create for the company. Analysis of theory and cases from the two manufacturing companies leads to the conclusion that data collection takes time, but does not create a value if the data is not processed. Consequently, unprocessed data can be considered a waste.

Data analysis

Womack et al.’s (1990) philosophy of waste elimination consists of mapping all the activities and keeping only activities that add value while eliminating those that do not add any value. Company A is dependent on data analysts, where the performance of the work can be measured over time. The analysis is associated with a defined purpose. Trial and error is a natural process of the analysis, which Company A, does not consider as a failure but rather perceives as a learning process. Company B is investing resources in developing a new generation of in-house specialists through the internship program to uplift the data analysis to a competitive level. Customer feedback and flexibility with mistakes boost for innovations. On one hand, processed data with a specific purpose that does not lead to the expected results should be considered a waste, since those activities cannot add direct value. On the other hand, the indirect impact is great and is the basis for the final results that do create a value-adding activity. If unsuccessful data analysis is a learning process and value-adding activity, then it is not a waste. But if unsuccessful data analysis cannot be mapped as a value-adding activity, it is a waste. There is no clear conclusion whether data processed with a specific purpose which did not lead to the expected results should be considered a waste. The question needs further investigation.

The two studied companies focused on both product and service sales, so from a long-term perspective the service package would play an equal or even dominating role in the performance of manufacturers. Processing data into information is the value-adding activity of lean production. There are two types of data that can potentially be a reason for waste – the data about the product and the data about the production process. Three levels of digital waste were identified during the production process. The first level of digital waste is partial or full ignorance of data collection either about the product or its production. The second level of digital waste is when data is collected, but not transformed into the information that creates value and improves process efficiency. The third level of digital waste is when data is collected, and analyzed, but the analysis does not lead to any improvements.
REFERENCES


Mayr, A. et al. (2018), Lean 4.0. A conceptual conjunction of lean management and Industry 4.0, Procedia CIRP, 72, 622-628.


new educational age, 2016 IEEE Global Engineering Education Conference (EDUCON), Abu Dhabi, UAE, 142-149.


Uriarte, A. G., Ng, A. H. and Moris, M. U. (2018), Supporting the lean journey with simulation and optimization in the context of Industry 4.0, Procedia Manufacturing, 25, 586-593.


