SYSTEM SAFETY: HUMAN - TECHNICAL FACILITY – ENVIRONMENT
7(1), 2025, pp. 598-605

IMPROVING THE PRODUCTION PROCESS ON THE EXAMPLE OF AN ENTERPRISE X

DOI: 10.2478/czoto-2025-0054
Received: 30/11/2025
Accepted: 04/01/2026

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Abstract: The primary objective of any organization is to deliver products or services of the highest possible quality, at the most competitive price, and within a specified timeframe. This statement is of particular significance in manufacturing enterprises. Achieving these goals is primarily possible through the reduction of waste. Within the production process, the identification of waste and the implementation of effective solutions to minimize losses are crucial. The Lean Management (LM) concept is a methodology that facilitates the search for, among other things, sources of waste. The identification of waste and the potential for its reduction within the operations of technology startup Kjosk Polska Sp. z o. o. became the subject of this research. Given the nature of the research problem, multiple methods were employed, including a method based on a case study.
The research revealed that waste at the company in question occurs primarily during device assembly. This is primarily due to unnecessary movement and the creation of excess inventory. The study also found that waste is generated by the inappropriate selection of SIM cards and mobile network operators. Furthermore, it was found that these aspects also impact the functional quality of the manufactured device.
Keywords: Lean Management, waste, improvement, startup

1. Introduction

In the subject literature, the term "startup" is defined in various ways. E. Riese (2012) defines such entities as organizations created and designed to develop a new product or service under conditions of extreme uncertainty. M. Nieć (2019) emphasizes that it is primarily an entity represented by an individual in the process of establishing an enterprise or operating one for up to 3.5 years, which utilizes modern technologies and innovative management methods to produce its goods or services, and has been on the market for no longer than 5 years. Consequently, one can agree with Blank and Dorf (2013) that it is an enterprise with relatively high growth potential, driven by technology based on innovative products or services resulting from the practical application of knowledge. The statement is also justified that, in the face of growing competition, the operation of contemporary enterprises is increasingly based on investing in innovations sourced from employee competencies and creativity (Łuczak, 2014). Considering that a startup is an organization working on a problem solution where the solution is not obvious and there is

no guarantee of commercial success (Baldridge, 2024), it is beneficial for its operations to leverage the Lean Management (LM) concept. This concept provides a consistent and systematic approach to eliminating waste, increasing efficiency, and creating customer value with the minimal possible consumption of tangible and intangible resources (Liker, 2005; Ingaldi & Jagusiak-Kocik, 2014; Jagusiak-Kocik, 2025; Wagner & Ingaldi, 2025; Sá et al., 2025). Crucial here is the awareness of waste in the production process, which refers to activities that do not add value (Jagusiak-Kocik, 2023). Waste classification was adopted from the creator of the Toyota Production System (TPS), T. Ohno (1988). He identified seven types of waste. These are:
Waste of overproduction: delivering useless products and unnecessary information before or after the deadline agreed upon with internal or external customers. Overproduction often occurs due to a lack of adequately defined standards, requirements, or poor production planning. According to Womack and Jones (2003), overproduction is the greatest source of loss. Excess products incur costs primarily related to storage. The authors of Lean Thinking and Liker (2020) advocate for Value Stream Mapping analysis and the implementation of a Just-In-Time (JIT) system to minimize this loss.
Waste of waiting: This refers to downtime, changeover time, stoppages, or waiting for subsequent stages of manufacturing. This waste primarily contributes to making the process less flexible, generating higher costs, and slowing down delivery times. Waiting can be caused by a lack of proper tools, knowledge, materials, skills, as well as errors in planning or work organization. George (2004) emphasized that eliminating waiting is crucial not only for the production process but also for customer satisfaction. To eliminate waiting, it is proposed to use tools such as Continuous Flow Planning (CFP), Value Stream Mapping (VSM), Overall Equipment Effectiveness (OEE) monitoring, and Production Scheduling (PS).
Waste of overprocessing: This pertains primarily to processes considered unnecessary during the entire production cycle. These could be redundant operations, excessive inspections, and controls. These are also processes that lack a specific purpose in production. These stages do not add value during process execution, thereby generating only losses. Often, this type of waste is difficult to identify because, as noted by Wurjaningrum & Shafak (2022), many processes may give the appearance of being important in the overall production process.
Waste of transportation: This mainly concerns the unnecessary movement of raw materials, semi-finished products, tools, or finished goods within a manufacturing plant, warehouses, or between locations inside or outside the entity producing the good. Excessive transportation generates additional logistical and time costs, as well as the risk of product damage or loss.
Waste of inventory: This is most often related to delays in goods receipt, order cancellations, and poorly planned production. This waste is also contributed to by goods returned by customers, which often cannot be resold at full price or require disposal. Maintaining inventory generates costs, including the need to rent storage space and increased demand for labor. Inventory can also cause logistical problems and contribute to goods being damaged. As emphasized by Pyzdek (2021), to avoid this waste, it is necessary to reduce buffers between production stages, establish a pull system, and adequately align production with customer orders.
Waste of motion: This waste is associated with broadly understood unnecessary movement. It primarily includes the unnecessary movement of employees between

workstations and the superfluous movement of any vehicles and machinery. Eliminating this waste involves identifying activities such as lifting, squatting, running, and shifting during employee work. Unnecessary activities can be reduced through properly organized workstations, appropriately arranged tools, properly configured machinery, and an efficient layout of communication routes.

Waste of defects: This is mainly associated with producing defective products, i.e., those that do not meet manufacturing standards and specifications. This necessitates their correction (rework), scrapping (scrap), or redoing (redo). This generates additional labor engagement and loss of time, materials, and tangible/intangible resources, consequently leading to customer dissatisfaction.

Moreover, the literature on the subject, and particularly in management sciences, points to an eighth type of waste, namely, Waste of unutilized skills. It is identified, as indicated by Bhamu & Sangwan (2014) and Womack & Jones (1996), it is identified with the failure to adequately utilize human potential, which includes their knowledge, skills, predispositions, creativity, and experience. When improperly utilized or ignored in the work process, employees, instead of engaging in improvement or decision-making activities, limit themselves to performing routine tasks.

Reducing the types of waste characterized above primarily involves process mapping and its visualization from the moment raw materials are received until the finished product is delivered to the customer. This tool allows for the straightforward identification of points in the production process where waste occurs. Their identification and analysis serve to improve processes and reduce costs.

2. RESEARCH METHODOLOGY

As previously mentioned, Lean Management (LM) is an integrated management system based on the flexible application of principles, tools, and techniques, focused on reducing identified waste in the production process. Its integration enables the enhancement of the entire organization's operational efficiency. Many business entities, including startups, widely implement LM solutions as extensively described in the literature. Under these circumstances, and considering the LM concept, the main objective of this study is to identify the wastes present in the production process of the examined startup X.

The aim of this study was achieved using various research methods. First, a literature review was conducted, drawing on bibliographic resources from the Scopus, Web of Science, and Google Scholar databases. This process involved a critical interpretation of scientific reports on waste in business operations. Particular attention was paid to research relating to the organizational, process, and resource conditions in which startups operate. The literature review identified a significant research gap. In the literature, waste is considered primarily in relation to manufacturing companies, while this issue is marginalized or overlooked in the context of specific entities such as startups. There is a lack of in-depth analyses that consider the diversity of their business models and the resource constraints that can generate specific forms of waste.

Furthermore, given that the case study is not based solely on a single method but represents a flexible research approach, the focus was on observing the production process. Collecting data on the actual production process, including the duration of individual operations and work station organization, allowed for the assessment of compliance with technological procedures and the identification of error and downtime locations. Additionally, laboratory experiments were conducted to assess the range and strength of the telecommunications signal. Company documentation was also analyzed. The core research was conducted in July 2024. Based on the findings, recommendations were formulated to improve the production processes in the examined startup.

3. RESULTS

The mission of the examined startup is to make technology more accessible to society. The search for improvements in human mobility within urban spaces inspired the creation of a device for renting power banks. These are portable devices used for mobile charging of phones or other devices powered by lithium-ion batteries. In the initial investment assumption, this idea involved producing a sufficient quantity of these devices to create an integrated network within a city, meaning that the rental and return of power banks could occur at various locations throughout the city. As design work progressed, it also became apparent that the device screens were an ideal platform for potential advertisers, which became an additional source of financial benefits. This device was named the "Kjosk" (see Fig. 1).

Fig. 1. Device for renting powerbanks (own study)

Fig. 1 shows a power bank rental device, a self-service station designed for the temporary provision of portable power sources. The device is equipped with a set of compartments containing power banks for rent. Each compartment also serves as a charger, ensuring the devices are always ready for use. A key element of the station is the control panel in the form of a screen. It also serves an informational and promotional function, displaying advertisements, system messages, and user manuals. The entire structure is designed to ensure intuitive operation and easy access to power banks in public spaces.
Taking into account the objective of this research, a block diagram illustrating the "Kjosk" manufacturing process was created (see Fig. 2). Individual stages were analyzed in terms of waste, with a number placed in the lower right corner corresponding to their detailed description. For example, (1) is a stage of the production process defined as *projecting cabinet* (see Fig. 2) etc. The focus was on those stages that generate significant losses and can be reduced using simple LM tools that do not require substantial financial investment.

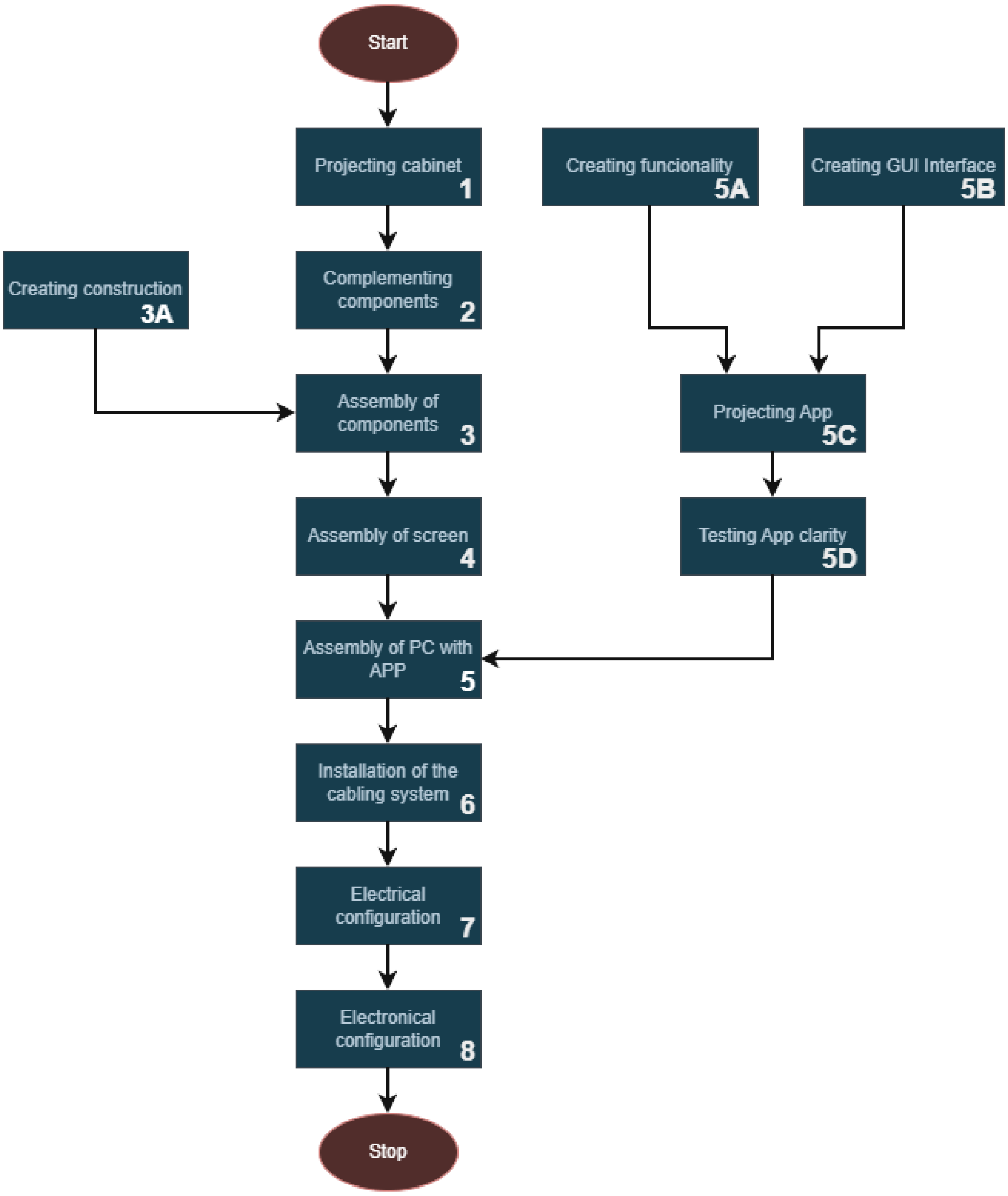

Fig. 2. Device production block diagram (Own study)

The analysis indicated five primary areas generating waste within the considered enterprise:

a) Waste Related to Components and Their Assembly. These wastes occur during the component kitting stage (2 see Fig. 2), mainly involving waiting and excess inventory. Additionally, this stage is one of the longest. A common waste in the structure assembly stage (3 see Fig. 2) was unnecessary motion, primarily caused by a lack of clear information on the location of specific parts. This does not affect the final product's characteristics but is inconvenient for workers and significantly slows the workflow. Occasionally, some components are also subject to excessive transportation, although as workers gain experience, this particular waste is expected to decrease.
b) Waste Related to Structure Fabrication. Considering the MUDA waste concepts, this stage (3A see Fig. 2) exhibits several deficiencies. The most significant issue at this stage is overproduction and the associated excess inventory.
c) Waste Related to Component Kitting. Common problems at this stage (2 see Fig. 2) are waiting and excessive inventory. It frequently occurs that imported inventory sits in the warehouse for many months. This also occupies additional storage space within the startup's facility. This situation incurs extra costs related to the need for additional shelving and boxes. Regarding the quality characteristics of the manufactured device, a deeper analysis revealed that the inappropriate selection of SIM cards generates waste. Due to a lack of network connection, the application malfunctions and prevents the rental of a power bank.
d) Waste Related to Application Development. The identification of this waste encompasses stages in Fig. 2 (5A), (5B), and (5C). As this is not a physical component, the primary waste at this stage is the underutilization of human potential. This mainly concerns programmers whose competencies are not fully leveraged. Furthermore, frequent changes in the application concept led to it being underdeveloped. Since several programmers with different specializations work on the application, waiting is also a problem at this stage. It happens that one programmer must wait for hours or days for another to finish their code before finalizing their own part of the application.
e) Waste Related to Quality Control. This stage is relatively optimized and is performed at the end of the manufacturing process, largely concerning the device's structural build. However, a lack of preliminary testing and network synchronization was noted, which is crucial from the device's usability perspective. This problem was signaled by employees, but their feedback was dismissed by management, which, at this stage of the production process, ignores the employees' knowledge, skills, and experience.

Based on the above waste analysis, factors determining the device's functionality were selected. The following were deemed critical:

- Application performance,
- The rental process,
- The percentage of successful interactions,
- The capability for real-time device connection,
- Fluidity in switching between application elements,
- The quality of displayed content,
- The ability to quickly update content,

- The external appearance of the device,
- Application clarity.

Out of these 9 factors influencing the device's usability quality, 7 are related to the quality of the internet connection. This is tied to the appropriate selection of SIM cards. Considering the Pareto-Lorenz method (Jagusiak-Kocik & Żywiołek, 2024; Szyszka, M., & Ulewicz, 2024), it was demonstrated how significant the impact of SIM card selection is on the remaining 78% of factors characterizing the functional quality of the manufactured device. It must be emphasized that the cost of SIM cards is marginal compared to all other device components and associated services. Therefore, the initial focus should be on minimizing waste related to the multifaceted selection of SIM cards and mobile network operators. Thus, the following aspects are crucial:

- Selection of the telecommunications operator based on the device's deployment location,
- Selection of the device's local antenna,
- Selection of an appropriate data plan,
- Analysis of data plan costs,
- Proper device network configuration,
- Quality control of the connection.

The proposed set of solutions is straightforward and can be implemented quickly, potentially yielding tangible benefits for the enterprise in a short time. Furthermore, implementing these suggestions could contribute to optimizing device operation and reducing servicing costs, while simultaneously enhancing product performance quality.

4. CONCLUSION

Waste and its reduction in production processes constitute a significant issue in production management, impacting the efficiency, profitability, and competitiveness of every enterprise. It is analyzed in the context of various aspects of the production process that do not add value to the final product yet consume resources. This is a broad issue encompassing diverse forms of loss, from excessive raw material usage and inefficient utilization of working time to unnecessary motion, downtime, and the wastage of human capital, employee competencies, and their potential.

In the present study, instances of waste were identified based on the developed block diagram of the "Kjosk" production process. Opportunities for reducing the costliest forms of waste for the enterprise were proposed. The production process of the analyzed device is complex and requires improvement at many stages, as, according to Krynke (2024), every business entity should continuously improve its production processes. Knowledge and understanding of the process flow are essential for ensuring its effective monitoring and for responding promptly to emerging waste. Crucially, it is important to recognize that the pursuit of waste elimination in the production process requires its continuous analysis.

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