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In Search of Waste in the Supply Chain: A Value Stream Analysis in a Manufacturing Company

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Abstract:

Purpose: *The aim of the paper is to identify waste areas at the production stage in a selected company and to highlight the changes that need to be introduced in order to increase the share of value-added activities across the production process.*
Design/Methodology/Approach: *The article uses the qualitative research method of a case study. The data was collected from the following sources, MUDA walk, data provided by the audited company, and interviews with company employees. Identification of waste areas was carried out in line with the commonly adopted MUDA categories and drew on value-stream analysis.*
Findings: *The research shows numerous examples of waste mismanagement upon mapping out the value stream for one of the company's products. In order to increase the value of the chain in which it participates, the company must take relevant corrective actions.*
Practical Implications: *Regardless of business nature and company size, a value-stream map enables the identification of waste areas, which may help reduce or eliminate waste.*
Originality/Value: *The value of this article lies in its universality and applicability. The explored topic remains very current and fits into the market trend of supply-chain improvement.*

Keywords: *Value Stream Mapping, Lean Manufacturing, MUDA.*

JEL classification: *M21, L99, L83, C38.*

Paper Type: *Research article.*

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1. Introduction

Manufacturing companies operating in a turbulent and competitive environment must constantly improve the efficiency and effectiveness of their processes. The challenges they face increasingly often necessitate the search for more streamlined production methods and techniques, as well as the overall improvement of work organization and information flow. In addition, the scarcity and sometimes poor accessibility of raw materials further push companies to explore new ways of countering wastefulness. Put differently, companies must actively work towards eliminating all waste from their processes and one way to do that is through Lean Management or, to a lesser extent, Lean Manufacturing.

These two concepts fit into the broader context of Lean Supply Chain Management which aims to forge efficient and effective supply chains by limiting non-value added activities, that is, by reducing waste. Let us note that the problem of waste, or wastefulness as it is sometimes called, can often be skillfully remedied, but for that to happen, waste areas must first be thoroughly determined. The purpose of this paper was therefore to identify waste areas at the production stage in a selected company and to highlight the changes that need to be introduced in order to boost the share of value-added activities across the production process.

2. Lean Supply Chain Management

The management philosophy referred to in the literature and professional practice as "lean" consists in avoiding or reducing any activities or operations that do not directly add value to the final product. At its core lies the elimination of every possible loss occurring at different links of the supply chain, including production and distribution. The lean concept has become widely embraced in supply chain management and its origins can be traced back to Womack and Jones, themselves researchers and avid supporters of lean production, who in 1994 came up with the concept of a "lean enterprise" (Womack and Jones, 1994).

However, only recently have lean theories and principles - and with them lean tools, techniques, practices, and procedures which can be extended to the entire supply chain - been properly tackled in the literature and professional practice (Anand and Kodali, 2008; Norena-Chavez and Thalassinos, 2021).

The "lean" concept associated with supply chain management is a strategy aimed at improving efficiency by reducing costs and time, e.g., by optimizing a process across the supply chain, seeking opportunities to simplify processes, reduce waste and limit non-value added activities (Duarte *et al.*, 2011). The Lean Supply Chain (LSC) model removes redundant processes from the equation in favor of streamlining key processes to enable unhindered efficiency and agility. As such, it provides added value for the entire network of cooperating companies, helping them to offer products and services tailored to customer needs in a cost-effective manner (McKee and Ross, 2009).

In addition to improving profitability and accelerating the process of order fulfillment, Lean Supply Chain Management (LSCM) can also be beneficial for the company in its CSR efforts by eliminating the waste of resources and human labor. The underlying assumption of the LSCM concept concerns getting rid of the so-called ‘3Ms’: waste (MUDA), overburden (MURI), and unevenness (MURA) (Chaudhari & Raut, 2017). The search for the 3M elements can be carried out at every link and process in the supply chain, although production is the one that stands out significantly.

2.1 Lean Manufacturing

The concept of "lean" has gained much popularity in optimizing the production process owing to the fact that this is where significant improvements can be made in various areas. One of the key concepts of the Lean Manufacturing (LM) philosophy is waste, i.e. everything that, instead of adding value, generates losses, consumes resources or wastes time. In this concept, waste is referred to as “MUDA”, which is the Japanese term meaning something redundant and unnecessary in production processes (Alieva and Haartman, 2020) The literature in its majority tends to distinguish seven types of waste, which are: overproduction, delay and wait time, transportation, overprocessing and complexity, excess inventory, unnecessary movements, errors and defects (Arunagiri and Gnanavelbabu, 2014).

Product development is, by default, a value-added process. However, operations carried out as part of this activity are often interspersed with those that no longer bring about benefits and only generate costs. Unfortunately, as it turns out, it is precisely these non-value added activities that prove to be the most time-intensive in the production process (Rahani and Al-Ashraf, 2012).

Lean Manufacturing is therefore geared towards minimizing the resources required in production by eliminating wastefulness (where waste is understood as any non-value added activity that increases costs, lead time and inventory requirements), all while anticipating the risk of unplanned downtime, implementing quality-improvement programs, developing a pull system, and boosting production capacity (Chaudhari and Raut, 2017).

From the perspective of Lean Manufacturing, unfavorable and redundant activities should be identified and adequately remedied. Companies that waste resources and time on unprofitable operations actively trim their own profit margins and in so doing burden employees with extra work that could otherwise be spared. While it is not possible to avoid waste entirely in the process of delivering value to customers, certain solutions can indeed be prioritized to help anticipate and safeguard against such losses in the future. Such measures are collectively referred to as process rationalization, meaning the continuous improvement of processes. By reducing waste, relevant resources can be managed more effectively (Gupta and Jain, 2013). The crucial aspect of incorporating LM into the production process is thorough knowledge of the company at the micro and macro level, as it unlocks crucial information and its shuffling potential, and consequently, helps make the right decisions (Jasiulewicz - Kaczamarek *et al.*, 2021).

3. Design and Results

3.1 Research Methodology

The case study method, being one of the qualitative scientific research methods, was used. It consists in empirical inference concerning a contemporary phenomenon as it appears in its natural context, "especially when the boundaries between *phenomenon* and *context* are not clearly evident" (Yin, 2014). One of the objectives of this method is confronting the theoretical deliberations with the empirical, real-life feedback.

The source of data may include, observations, interviews, company documentation, press releases, surveys, or databases maintained by various institutions. In this article specifically, the 'MUDA walk' technique and free-form interviews with company employees were used to collect data. In addition, a current-state value stream analysis (VSA) was performed as illustrated by a corresponding current-state map. Value Stream Analysis is a tool designed to rethink the manufacturing process towards lean manufacturing (Lasa *et al.*, 2008). It is the first step and prerequisite to guide the company through the entire process, including by identifying issues and waste in a stream, by outlining the correlation between material and information flows, as well as by establishing actions to be taken as part of a rebound plan (Rother and Shook, 1998).

The map, itself developed on the basis of the analysis, shows the current state of the stream on a specific day and makes it possible to determine the time required to transform components into a finished product expressed as LT (Lead Time), meaning the period of freezing the cash spent on components. In this study, we opted to focus on the internal stream of values.

3.2 The production Process in the Case-Study Company

The case study presented in this paper concerns a company that manufactures outdoor wooden benches and tables and which sources sawmill - its base raw material - from a lumber mill. The analysis intentionally did not factor in other suppliers such as the manufacturers of mounting bolts, packaging, and assembly manuals. The materials required for the production process are procured on a per-order basis in the Just-in-Time system, meaning after the order is placed and before production begins. The exception is sawn timber, the sale of which is seasonal and takes place from October to June. There are a total of 15 employees involved in production and warehousing, 8 of whom work directly on the production line and 3 are responsible for the preparation of cardboard boxes with a complete set for the assembly of the bench. The facility operates one 8-hour shift, 5 days a week, but during the observation it was found that, excluding employee breaks and staff meetings, the actual working time is 7 hours. The production process proceeds similarly for all products, therefore a decision was made to analyze the process of manufacturing a self-assembled garden bench.

The production process of this product in particular is divided into five stages, wood cutting, milling and drilling, sanding, varnishing, and packaging. The employees at individual workstations are responsible for the transfer of semi-finished goods between individual cells. After the initial selection of the wood, the milling process begins to obtain the desired timber width and length for further processing. In this stage, two machines are used, and the following activities are performed: choosing the right material, putting leftovers aside, admeasurement and cutting, moving the machine twice, transporting the blank between stations.

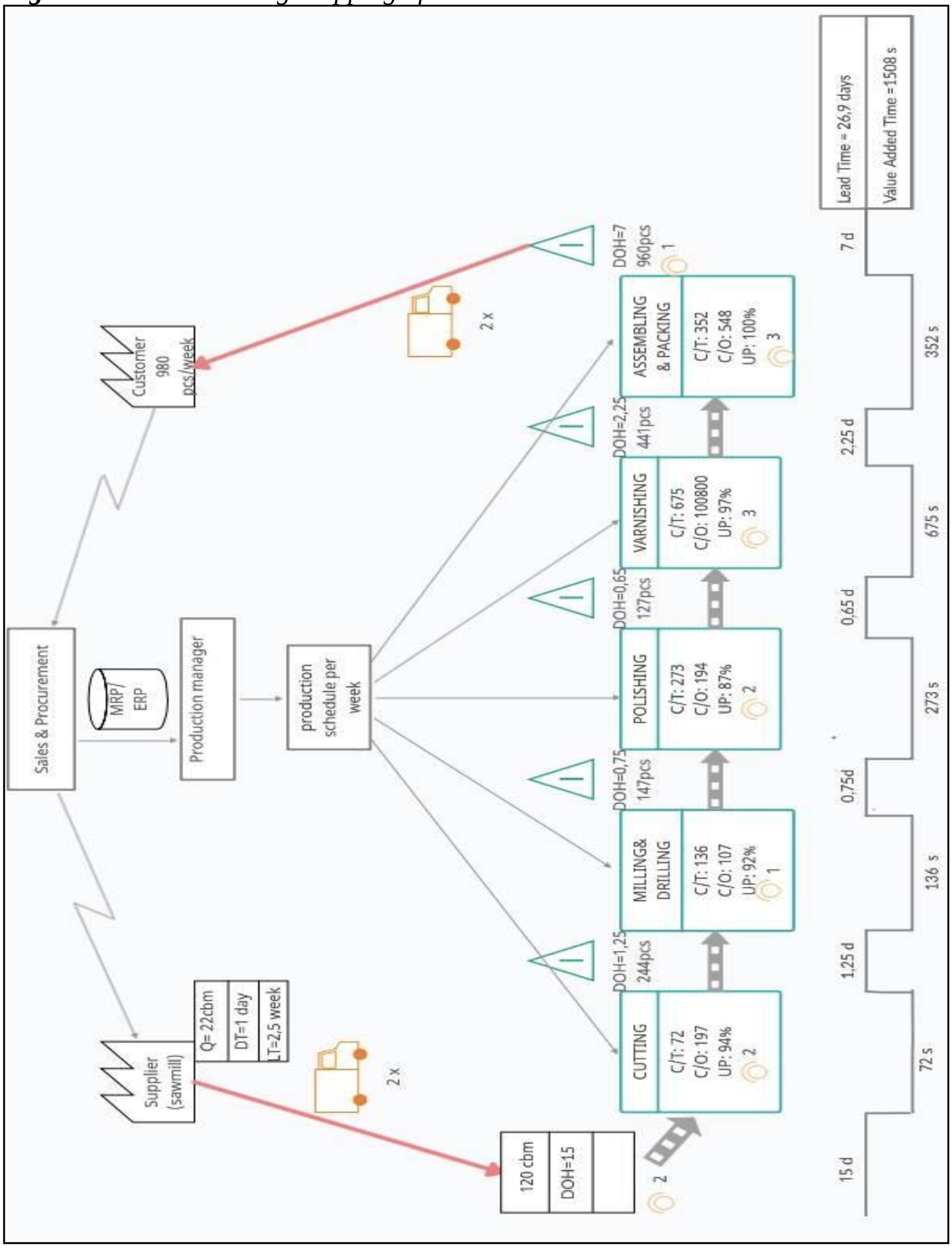
Subsequently, using specialized woodworking machinery, the elements are subjected to mechanical processing, namely milling and hole-drilling. As part of this cell, the following activities are performed: collecting square-cut timber and wood boards, measuring the length, and marking holes for drilling, setting the machines, transport between stations, and cleaning the station. These operations are aimed at obtaining components which, once processed, are subjected to grinding, during which the following pattern has been noted, receiving the blank, transport between stations, setting the machine, cleaning the station. The next stage is the varnishing of wooden elements during which the following groups of activities are performed: receiving the blank, preparing the varnish, and drying.

The paint station is located in the same room as the wood-cutting and wood-peeling facilities, separated only by a rack for storing supplies in progress. The last stage of the production process is assembling and packaging during which the material is collected, the cardboard box is assembled, the assembly components are selected for the set (bench) along with adding a bag of fixing screws, the assembly manual is attached, the cardboard box is closed, seal-secured and then moved to the warehouse. The process is considered completed when the finished product is palletized, and the properly labeled and secured pallet is in the warehouse awaiting shipment.

3.3 The Current-State Value Stream Map

According to the data outlined in the previous section and the methodology of Value-Stream Mapping (VSM), a corresponding current-state map was developed, as shown in Figure 1. Value-stream mapping makes it possible to graphically represent the value flow from the customer's perspective by means of a description. With that flow mapped out, the organization can pinpoint the areas where waste occurs and, once the analysis has been conducted, put forward a way to reduce, limit or eliminate them.

Figure 1. *Value Steaming Mapping of the current state.*



Source: *Own elaboration.*

The top part of the figure shows the flow of information (right to left), while the bottom part shows the flow of materials (left to right). The figure reveals that order fulfillment requires the former flow to be coordinated with the latter. Normally, these flows assume different variations, depending on the product groups. For our case study, the lead time is determined at 26.9 working days while the value-added time was estimated at 1508 seconds.

3.4 Results and Findings

The analysis of the production process enabled the identification of areas burdened with the most significant waste. As a next step, the corrective actions for these faulty areas should be developed, the overarching goal of which will be to reduce waste. Ideally, this is to increase the share of value-added activities across the production process, meaning that non-value added activities should be either reduced to the broadest extent possible or eliminated altogether.

In the case study under analysis, the observed examples of waste are summarized in Table 1.

Table 1. *Selected non-value added activities - MUDA.*

TYPE OF WASTE	DIAGNOSIS	AREA / PROCESS
error and defects	▪ semi-finished products do not pass quality control	▪ varnishing
excess inventory	▪ too much stock in progress	▪ admeasurement and cutting
overprocessing and complexity	▪ difficulties in operating machinery ▪ lack of order at workstations	▪ polishing ▪ cutting, milling
transportation	▪ workstations are spread too far apart	▪ milling and drilling
delay and wait time	▪ idle waiting	▪ polishing
unnecessary movements	▪ manual material lifting ▪ searching for tools,	▪ admeasurement and cutting ▪ assembling and packaging

Source: *Own elaboration.*

Having identified the main sources of waste in the workplace, several examples of solutions were proposed which can be reflected in practice upon further analysis (future-state vision). Due to the frequent movement of semi-finished products, and therefore of employees as part of internal transport, it would be necessary to observe the flow of workers using the spaghetti diagram. Quality is an important element of Lean Manufacturing, so that the absence of defects in the manufacturing process reduces waste and boosts organizational capacity.

Given that significant quality deficiencies (dirt) were noticed upon finishing the drying process of the varnished product, it would be appropriate to either use special drying equipment such as industrial varnish dryers or move the entire process to a separate zone. A better product quality will, in turn, help minimize the waste of raw materials and of human labor. Another proposed solution to reduce waste under MUDA's 'unnecessary movements' category consists in improving the process of preparing the final product for shipment to the end customer. Currently, ready-made cardboard boxes are placed on the rack and collective shipment is completed afterwards. A better solution would be for an employee - in this case, a packer - to put away the ready boxes on the Euro-pallet, which, once foil-sealed, would be forklifted to the finished goods warehouse.

4. Conclusion

The "lean" concept is often mistakenly associated with large-scale businesses and big corporations, but value-stream mapping as one of the lean tools can be beneficial to any supply-chain link where waste is detected at different stages of order fulfillment and especially in the course of adding value, that is, in the production process. This was confirmed by the research conducted as part of this case study of a small manufacturing company in which a value-stream analysis helped identify waste areas at the production stage, on the basis of which a current-state value stream map was developed. Drawing on the results obtained in the first stage of the research, a Value-Stream Design (VSD) and a Value-Stream Work Plan (VSP) will be developed in subsequent research.

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