VALUE STREAM MAPPING IN REVERSE LOGISTIC ENTERPRISES

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Abstract

This article presents the use of value stream mapping tools in an enterprise which is a reverse logistics link in the chain. Products that have completed their life cycle play an important role in the sustainable economy, where it is sought to recover value from waste. Forming a continuous flow of enterprise reverse logistics is complex, because it requires a different approach to the material and information flows. These flows are not focused on the customer and do not create value but on an attempt to recover value from waste and / or secure their development.

Keywords: Value stream, reverse logistic, lean management

1. INTRODUCTION

Returns and waste management are now rapidly developing areas of the economy. The structure of processes in this area is complex due to the presence of many sources of supply, non-uniform flow of the content, a significant number of legal conditions, a growing number of competitors and modern waste processing technologies. These changes affect the development of reverse logistics. Increased competition in the management of returns and waste resulted in a need to seek new ways of organizing logistics processes whose effective execution affects the level of customer satisfaction and reduces costs. Logistics processes occurring in manufacturing companies with a reverse supply chain are similar to the processes in traditional chains, yet they have a slightly different character. Their primary purpose is to recover the value of the products delivered, while in the traditional sense they create value. Hence the introduction of methods and techniques to improve the flow of materials and information plays an important role in improving logistics and production processes. The article raises the issue of improving the flow of material and information in manufacturing enterprises with reverse logistics. This article presents the use of lean concept tools in an enterprise with reverse logistics. The use of lean management in these companies appears to be possible and useful but may cause additional difficulties in implementation.

2. LEAN MENEAGEMENT IN A REVERSE FLOW SHAPE

Lean is a concept of improving flows, whose main aim is the continuous elimination of waste by the optimal use of resources in the embodied processes leading to the supply of a product with a desired value [1]. The added value is all the steps leading to process the raw materials into a product, in line with customer expectations. This perception of added value inclines the company to provide the customer with a product with certain characteristics and qualities, at a specified time and at a fixed cost. It is worth noting that the included added value increases with the flow direction (from the sources of raw material acquisition, through producers and distributors, to the customer). A slightly different view of the added value occurs in the case of reverse flow of products, i.e. products that have completed their life cycle. In this case, the actions are associated with recovering value inherent in the products, thus placing them on the reuse, recovery of spare parts or recovery of recyclable materials [2]. Processes occurring in reverse logistics can also include redirecting products after the end of their life for safe disposal, however, those processes do not generate added value [3]. **Fig. 1** presents the relationship between material flows in the supply chain and the formation of added value.

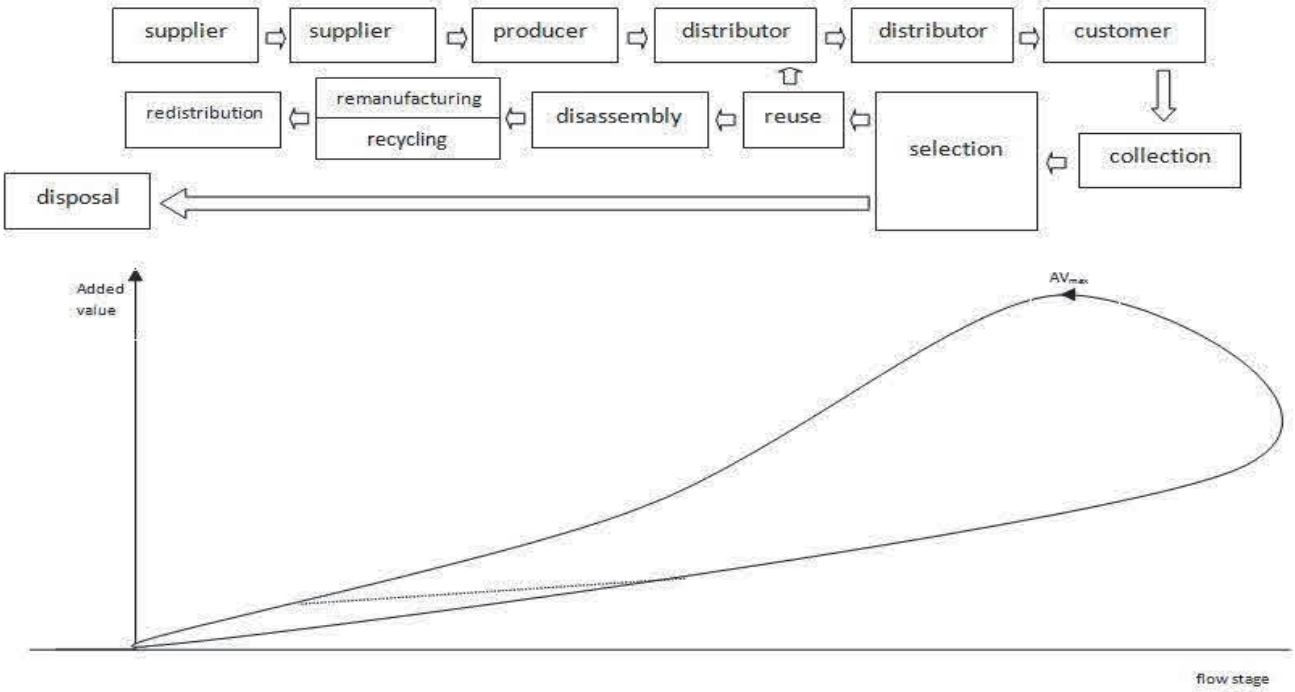

Fig. 1 Connections between flows in the supply chain within reverse logistic and added value

Regardless of the flow direction of the activities performed in individual links of a supply chain and a reverse logistics chain, they can be classified as operations which generate or do not generate value. This approach is characteristic for lean management, which identifies seven types of waste (muda) [1]:

- Overproduction - producing components or finished products for which there is no customer order generates a loss in a form of unnecessary involvement of employees, storage, transportation and excessive inventory.
- Waiting - an employee whose role is limited only to observe the operation of the machine or idling until the next stage of a process, delivery, people, parts, etc. Also if there is nothing to do because of delays, downtime, bottlenecks.
- Unnecessary transport - execution of processing in certain distances from each other generates unnecessary movement of materials, parts, finished products from the places of storage or between the stages of the process.
- Inappropriate manufacturing method - contains the necessary steps of the manufacturing process, however the process is inefficient due to the use of inappropriate tools and methods, which generates losses, also in the form of defects in the product. This includes the supply of product to the customer a higher quality produce than he would have wished.
- Unnecessary inventory - in a form of excess materials, WIP or finished goods gives rise to additional costs, the aging of the commodity, damage, additional storage and transport. Moreover, unnecessary stocks are often a symptom of a hidden problem in the process.
- Unnecessary movement - any movement of workers which is executed as part of their daily work but does not add value to the product, such as reaching, walking, looking, deposition, etc.
- Shortages, damages - production of defective parts or their fixing as all repairs, alterations or the need to launch the production of replacements.

According to the lean concept, an enterprise improves efficiency by pursuing the following basic rules, known as lean loop [4]:

- Identification of customer value, which is to define customer expectations.

- Identification of the value stream, which includes a series of actions to be completed in a correct sequence and in a correct manner, produces a product or service and an increase or recovery of added value for the customer. Identification of the value stream involves the description of activities that can:
  - Be fully or partially redundant, generating losses and therefore should be eliminated.
  - Support the main steps in the process of adding value (do not add value directly, but contribute to its formation - these activities should be limited if possible).
  - Activities directly adding value to the end customer - this type of work must be constantly improved.
- Provision of adequate flow that lean organizations should run smoothly and continuously from one activity that adds value and supports its production to the next. Even distribution of work at all levels of the process is important here.
- Use of the PULL approach, which requires that all production is carried out as a direct response to demand from customers. Customers are therefore the main initiator of cash flows. The reverse logistics customers initiate the recovery process of returning or heading to the disposal of products that have completed their life. The initiators of flows in reverse logistics are also the producers who report the demand for recycled materials or spare parts.
- Continuous improvement, which means that the organization should constantly strive to increase efficiency through continuous improvement of processes, elimination of losses.

These principles are reflected in one of the basic methods of the lean concept which is mapping the value stream [5, 6]. Value stream mapping is a graphical presentation of the material and information flow in the subsequent phases of the manufacturing process, from the delivery of raw materials to the delivery of the final product to the customer. The main purpose of the map is to show activities that add or do not add value to the flow. Mapping allows to identify waste in the process and disturbances in the flow [6, 7]. A mapping method used in the analysis of flows to the customer ("forward logistics") was used to analyze the feedback flows (reverse logistics), which in turn allowed for collection of data on emerging faults.

3. VALUE STREAM MAPPING IN REVERSE LOGISTICS

Value stream mapping in a reverse logistics enterprise is done with use of correct methodology for this method, and therefore a correct choice of the family of products for which a map is created, reflecting the current state [7]. Subsequently, a map for future states is made and an action plan and its implementation are designed. The action plan is designed in order to diagnose the current state and introduce changes. The general approach is shown in **Fig. 2**.

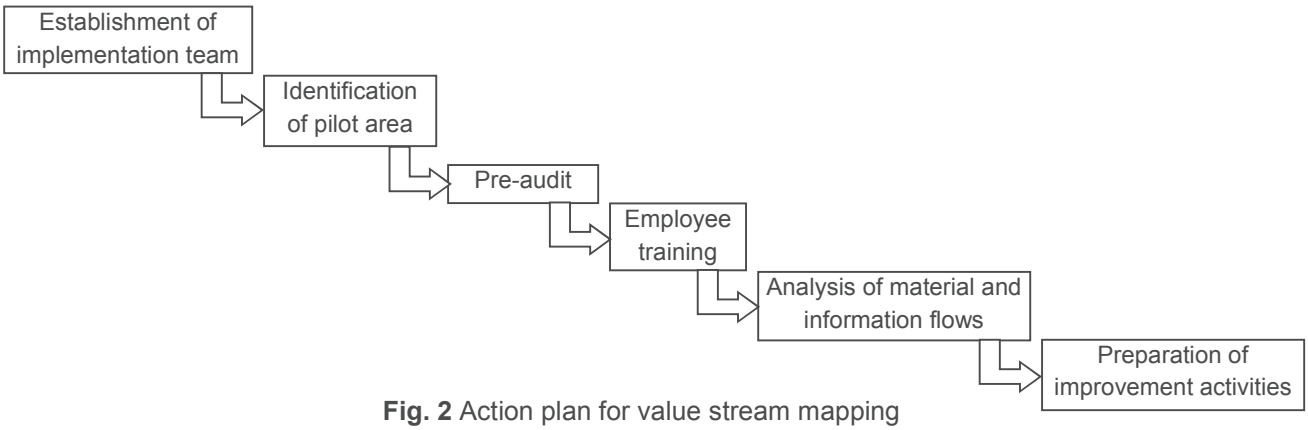

Fig. 2 Action plan for value stream mapping

Establishment of a lean implementation team was associated with the secondment of employees of several departments to work on the project undertaken by the company. Employees of the production department constituted a significant part because that is where the pilot area was established, which included setting up a

treatment plant for waste electrical and electronic equipment. The processing area comprised two production halls, a warehouse for waste electrical and electronic equipment and a store for the processed waste. Then the pre-audits were performed on the pilot area and identified the main problems that were associated with prolonged execution. An analysis of the value stream necessitated a training for employees, during which they were familiarised with the methodology and symbols used in the mapping. After that, a proper analysis was conducted. However, the specificity of the production activity precludes carrying value stream mapping from the customer perspective. It was assumed that the terms of shipments of the processed waste depend on the internal decisions. A map was designed for the selected group of waste which was computer equipment. The production process and durations of the activities include:

1. Selection, which refers to the segregation of computers and their separation from the rest of equipment. Subsequent operations include:
   - collection of waste for processing - 5 sec/piece,
   - weighing of individual containers - 10 sec/piece,
   - transport to the dismantling station - 10 sec/piece,
   - selection of waste - sorting into groups - 15 sec/piece,
   - weighing of segregated computers - 10 sec/piece,
   - transportation to the warehouse - 10 sec / piece.
2. Preliminary or complete dismantling of computer into their components. Subsequent operations include:
   - transportation to the dismantling station - 10 sec/piece,
   - preliminary dismantling - 720 sec/piece,
   - weighing of finished and semi-finished products - 5 sec/piece,
   - transportation to the warehouse - 5 sec/unit (small parts).
3. Final dismantling, that is the separation of smaller components. Subsequent operations include:
   - transportation to the final dismantling station - 5 sec/piece,
   - removal of tiles - 75 sec/piece,
   - weighing of products - 5 sec/unit (small parts),
   - transportation to the warehouse - 5 sec/piece.

Value stream map for the current processes is shown in **Fig. 3**.

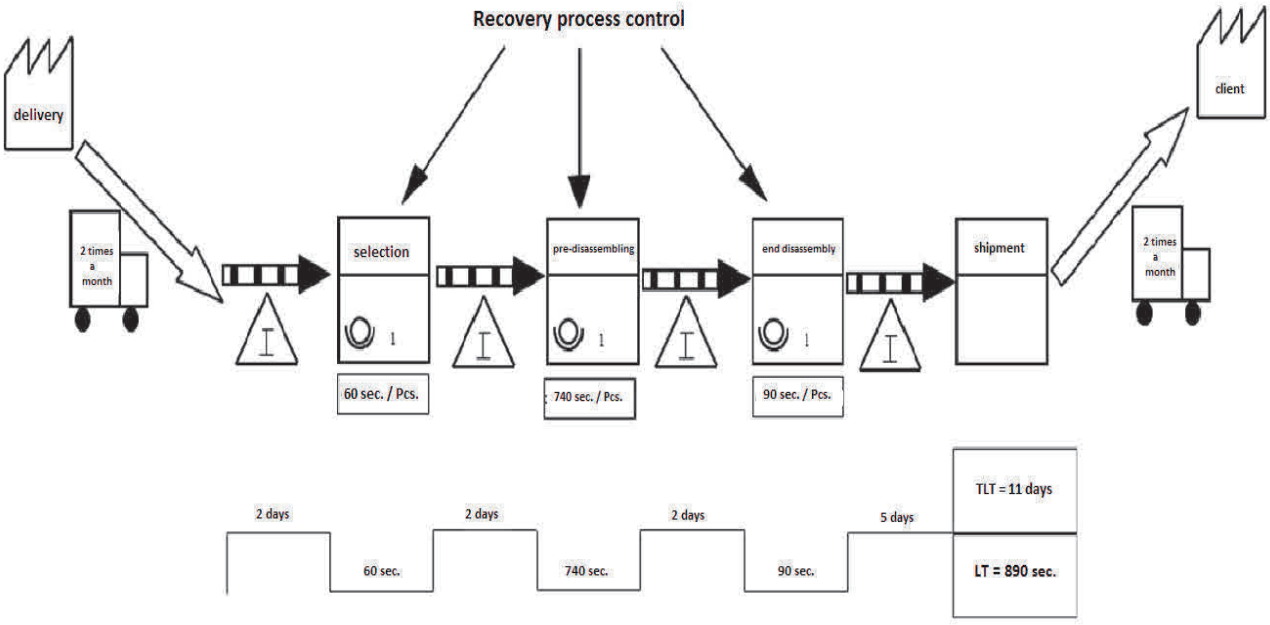

Fig. 3 Value stream map for computer waste equipment (current state)

The analysis of the developed value stream map revealed the following major sources of waste:

- Prolonged flow of disassembled parts in the process. Idling of elements for dismantling is a total of 11 days storage time prior to the dispatch of 5 days, the period of preparation depends on the client,
- The lack of continuity of the process of recovery.
- Improper organization of delivery and acceptance of waste at the warehouse. The used equipment is shipped in bulk but unloaded while packaged in containers.
- Improper placement of workstations.
- Poor organization of workplaces causing unnecessary movements of workers in search of tools and materials.

In order to eliminate reported losses in the value stream, analysis of a selected group of waste electrical and electronic equipment resulted in proposed changes in the organization of the processing. These changes were mainly based on assumptions of method 5s and were related to:

- Reduction of the total time of passage of the waste through the process by combining the steps of: receiving the waste and selection with the initial and final dismantling.
- Introduction of a new management for the supply of used equipment, which would be placed directly in dedicated containers.
- Introduction of queuing in the production process to optimize the production cycle.
- Reduction of storage space for waste recovery and boosting the flow capacity.
- Introduction of visualization of the disassembled components to ensure proper classification.

On the basis of the proposed solutions and improvements, a future state map was developed (see **Fig. 4**). The developed flow map is a proposal for improvements to the process and allows to estimate new times for the process of dismantling of waste computer equipment. The implementation of the proposed solutions will review the proposed plan of action and will allow to make the time of computer equipment recycling more real.

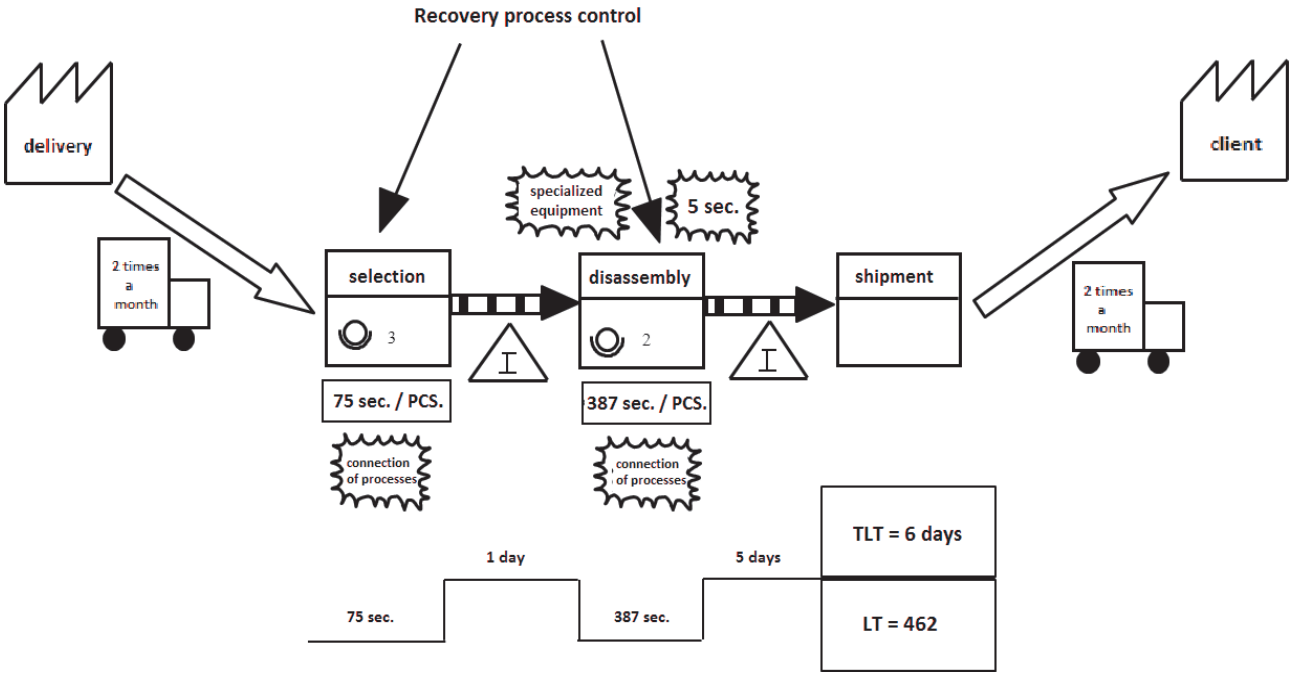

Fig. 4 Value stream map for computer waste equipment (future state)

4. CONCLUSION

In companies that operate in reverse logistics chains, the concept of lean management can improve organizational performance and make the recovery process of value-added products that have completed their

life cycle more real. It should be remembered that the purpose of the analysis changes in reverse logistics chains. The streams of materials and information are determined by other activities than in case of the supply chain and are aimed at the recovery of value of exploited products or at redirecting them to harmless disposal. The analysis of recovery of waste electrical and electronic equipment carried out in this article led to identification of the main problems in the flow. This allowed for planning of measures to streamline the company under lean concepts.

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