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Analysis and evaluation of sorting and processing logistics of used products from the consumers

There are considerably high numbers of products, transportation vehicles, packages and waste materials released in connection with the processes taking place in supply chain management. Their backflows must be provided as far as the organizational, information, communication and financial aspects are concerned, and the manipulation, storage and transportation aspects up to their dismantling, separation, reworking with the aim of resale, recycling or disposal must be secured as well [1].

The main reason is the consumers´ behaviour in the „advanced" western world – the products have shorter and shorter lifespan or the desire to be „in" will, for example in case of technical incompatibility of computers, force the consumers to put the products among useless junk.

That is why the logistics approach expanded, including the back flows, and the term reverse logistics was introduced. The collection, classification, disassembly and processing of the used products, components, side products, superfluous stock and packaging material represent the main scope of reverse logistics. The main objective of this method is to secure their new use or material appreciation in a way which would be environment friendly and interesting from the economic point of view [2].

The authors are interested in the used products (end of use returns). From the point of view of reverse logistics processes, the attention is focused on their sorting and processing, in particular, on the suggested methodology for analysis and evaluation of sorting and processing logistics of used products in case of waste processing companies.

Methodology for analysis and evaluation of sorting and processing logistics of used products

The suggested methodology objective is to analyse and evaluate the current state of sorting and processing processes with regards to used products from the point of view of logistics, to define the main problems in this area, and to suggest the basic measures leading to their elimination, i. e. leading to increased capacity of the researched processes.

The methodology can be dividend into two stages:

1. Entry analysis of the sorting and processing processes of used products.
2. Evaluation of the current status and definition of the suggestions for increase in capacity of the researched processes.

The following analytical tools can be used for the entry analysis of sorting and processing process of used products:

- Analysis of used products feed
- Analysis of space arrangement and layout of the individual work sites and sorting and storage areas
- Material flow analysis
- Sorting level analysis
- Analysis of sorting and processing of the used products capacity
- Surveys of employee's working days
- Surveys of manipulation technology working day
- Surveys of sorting and processing of the used products operations

The acquired outputs serve as information base for the realization of the evaluation of the stage current status and for defining the suggestions aimed at increasing the capacity of the sorting process and the processing of the used products. The evaluation concept results from Lean principle originating in Toyota Production System philosophy (for more information see for ex. [3]). This principle uses maximum effort to eliminate all the activities which do not add value to the processed products and, at the same time, it tries to shorten, as much as possible, the realization time of the activities adding value, thus shortening the time of the entire production process. The following procedure can be recommended for the actual evaluation of the sorting and processing of the used products process:

1. Definition of the starting position – identification of value-added activities and activities not adding value and the definition of the outputs of realized analysis which are decisive for further evaluation.
2. Definition of the potential dismantling capacity – setting the theoretic capacity for the monitored process.
3. Identification and quantification of losses – definition and analysis of the current losses and the problematic areas.
4. Suggestion for eliminating the losses – a set of preliminary recommendations for minimizing the identified losses, including the tips of the anticipated benefits and costs.
5. Suggestions for reducing the realization time of the activities adding value – in similar way as in point 4.

The suggested methodology was verified and developed by a concrete waste processing company using two processes:

1. Sorting the bulky waste.
2. Disassembling scrapped electronic equipment.

The next part includes the main application outputs of the methodology created for analysis and evaluation of disassembling the scrapped electronic equipment process.

Disassembling scrapped electronic equipment

Disassembling, as a first stage of the recycling process, takes place in specialized sites, marked as disassembling workshops. These workshops most often process the following types of electronic equipment:

- Small home appliances – vacuum cleaners, irons, fryers, scales etc.
- IT and telecommunication equipment – computers, monitors, printers, photocopying machine, faxes, telephones, etc.
- Consumer appliances – televisions, radio, camcorders, video recorders, etc.

Disassembly of scrapped electronic equipment with CRT (Cathode Ray Tube) screen, i. e. televisions and monitors, is prevailing, according to this enumeration. They make up 80 to 90% of all disassembled electronic equipment. CRT screens, plastic, wood, ferrous and non-ferrous metals in the form of sheet links, cables and coils can be retrieved by dismantling the televisions and computer monitors. CRT screens, which belong to hazardous waste, must be further processed on the screen recycling line. The outcome is clear front glass and rear cathode-ray tube funnel glass.

The disassembling process is largely a manual activity and only simple tools are used in the process – pliers, hammers, screwdrivers. The manipulation with the electronic equipment and the components can be carried out manually or by means of manipulation machinery (conveyors and fork-lift trucks).

Analysis and evaluation of scrapped electronic equipment dismantling logistics

Two dismantling workshops are currently used for the disassembly process. Employees with changed capacity of work are employed in the workshops. Both workshops are situated in two separate places. The scrapped electronic equipment feed is realized in containers. The dismantling, including the manipulation of the scrapped electronic equipment and its components, is carried out purely manually. The employees put the dismantled parts in baskets which, when they are full, are taken away by fork-lift trucks. Despite the fact that the television and computer monitors represent 90% of the disassembled electronic equipment, the workshops do not have a line for processing CRT screens. This activity is provided by external companies.

With regards to the permanent increase in volume of the processed electronic equipment, it was necessary to change the existing dismantling method, characterised by low processing efficiency, demanding manual handling and unsuitable working conditions. The following activities have been realized within the frame of the entry analysis:

- Analysis of scrapped electronic equipment feed
- Analysis of space layout and dislocation of the individual workplaces, sorting and storage areas in dismantling workshops
- Analysis of material flows of scrapped electronic equipment and its components.
- Analysis of the current capacity of dismantling workshops
- Time study of the working day of the employees dismantling the scrapped electronic equipment
- Time study of the dismantling operations of scrapped electronic equipment.

The main outcomes of the evaluation of the scrapped electronic equipment dismantling logistics current status can be summarized in the following manner:

DEFINITION OF THE STARTING POSITION. The identification of the activities which add value and the remaining activities which bring only losses was carried out first:

- Activities adding value – the only activity adding value is the dismantling of the scrapped electronic equipment
- Activities which do not add any value – they are mostly manipulation with electronic equipment and its components, weighting, bar code reading, unloading the electronic equipment from the container.

As a result of the first analytical stage, the following aspects were determined for the evaluation and quantification of losses:

- Employees intended for dismantling and their available labour fund
- Processed volume and disassembly capacity
- Duration of all the performed activities.

DEFINITION OF THE POTENTIAL DISMANTLING CAPACITY. The potential dismantling capacity expresses the theoretic amount of scrapped M/TV which could be processed provided that the whole available labour fund would be focused only on the disassembly (i. e. only to activity adding value).

If we compare it with reality, there is a potential dismantling capacity increase by 71 % in the monitored disassembly workshops.

IDENTIFICATION AND QUANTIFICATION OF LOSSES. The main reasons for not reaching the theoretical disassembly capacity can be seen in these areas:

- Limited output of the employees due to their reduced capacity of work – in reality, this fact is taken into account and the daily available time of the employees is lowered by approx. 2 hours, which represents 64% of total losses (provided that this time does not include activities which do not add value)
- Performing activities which do not add value – the identified activities were divided into two groups which represent 36 % of the total losses: manipulation related to each M/TV (13 %) and other activities not adding value (23 %).

SUGGESTIONS HOW TO ELIMINATE THE LOSSES. The specified losses made it possible to define the preliminary suggestions for their elimination in the following manner:

- Elimination of capacity limitations – increase of the employees" available working time by 2 hours or an adequate increase in the number of employees leads to a 33% increase in dismantling capacity. However, this measure will result in personnel cost increase
- Elimination of selected activities not adding value – merger of the existing two disassembly workshops in order to use the advantages resulting from the centralisation of the manipulation units and the machinery and elimination of demanding manual manipulation by introducing their automatization. In general, an approach based on disassembly lines, cellular disassembly or a combination of both methods can be used to serve this purpose. In case of disassembly lines, the disassembly is divided into sub-operations just like the assembly line, and it is carried out by workers in the individual workplaces dislocated around the line. The disassembled components are stored in crates located by the disassembly work areas. The disassembly of the whole electronic equipment is realized in each disassembly workplace on the disassembly lines. The disassembled components are stored in crates or on a conveyor belt and they are sorted behindhand. If we compare the disassembly lines with the cellular disassembly, the disassembly line is noted for a higher

capacity – the line enables to influence the disassembly speed by forced movement of the belt and it increases the speed of the disassembly operations thanks to their continuous repetition. On the other hand, it requires synchronisation of the employees and operations and constant presence of all disassembly workers. The regular flow of large amount of processed electronic equipment must be provided as a necessary condition. It must be possible to divide the equipment into homogenous groups and to create specialized disassembly lines. The suggested solution leads to a 25% capacity increase while keeping the available working time. This measure requires an investment in order to purchase and install the manipulation technology and the operational costs and the costs of transferring the workshops into common room and its adaptation are to be included as well.

SUGGESTIONS TO SHORTEN THE REALIZATION TIME OF ACTIVITIES ADDING VALUE. In the given case, the point is to speed up the dismantling operations:

- Dismantling standardization using „the best practices" – elimination of different methods used for the individual operations, including different order of their realization or accumulation in batches. This measure will require minimum costs, but you can expect capacity increase of only a few percent
- Machinery for grinding and separation of electronic equipment – purchase of such equipment will make it possible to eliminate the most time consuming operations of M/TV dismantling and manual dismantling of small appliances. This measure will increase the capacity by 88% when keeping the existing dismantling system. It is, again, necessary to count with the investment to purchase, install the equipment and with its operational costs.

Conclusion

The suggested methodology serves as a starting point for improvement of sorting and dismantling logistics of used products. The next step is to provide economic evaluation of the suggested solutions. In order to do so, the procedure mentioned in [4] can be recommended. It can be implemented after all the other criteria, crucial for the selection of the final solution, are taken into consideration.

Streszczenie

Artykuł przedstawia metodologię do analizy i oceny stanu bieżącego procesów sortowania i przetwarzania zużytych produktów z punktu widzenia logistyki, wyznaczenia głównych problemów w tym obszarze i zaproponowania podstawowych kierunków prowadzących do ich usunięcia, to jest do zwiększenia wydajności badanych procesów. Koncepcja proponowanej metodologii wywodzi się z zastosowania zasad Lean. Możliwości zastosowania stworzonej metodologii podane są na przykładzie analizy i oceny logistyki demontażu zużytego sprzętu elektronicznego.

Abstract

The article presents methodology for analysis and evaluation of current situation in sorting and processing of used products from the point of view of logistics, defining the main problems in this area, and suggesting basic directions leading to the eliminations of the problems, i. e. to increase in capacity of the researched processes. The suggested methodology concept results from the use of Lean principles. The possible applications of the created methodology are illustrated using the example of analysis and evaluations of scrapped electronic equipment dismantling logistics.

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