COLLECTION - PROCESS OF REVERSE LOGISTICS AND ITS SOLUTION FOR THE SELECTED TYPE OF WASTE

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Abstract

The main goal of the paper is to present outputs of the case study realized by researchers of the Institute of Logistics, Faculty BERG, Technical University of Košice. The case study was oriented to the problem of reverse logistics and its application for wastes. The paper presents only one part of the output, namely the solution of one important process of reverse logistics, namely collection of wastes. For the solution of this problem the case study searched used tires, their production, ways of collection and processing. By the obtained results the solution was based on the creation of collecting points for used tires and their next transport to the centralized collecting point in the area of the processing enterprise.

Keywords: Logistics, reverse logistics, collection, collecting points

1. INTRODUCTION

The issue of municipal waste and its processing is very difficult mainly due to varied amount of parts, or materials which create municipal waste. Before the recycling of municipal waste it is needed to realize separated collection as the first step of the waste management. For increasing of the collection effectiveness it is possible to apply reverse material flow or reverse logistics and its processes. Reverse logistics is the process of planning, implementing, and controlling the flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal [1]. Remanufacturing and refurbishing activities also may be included in the definition of reverse logistics [2, 3]. Reverse logistics is defined as a subsystem of eco-logistics which deals with realization of reverse material flows of raw materials, materials, products, generally at the end of their lifetime at the direction from the last consumer to the processor [4]. By these facts it is possible to state [5]:

1. Reverse logistics puts the accent on the reverse material flow at the direction from customer to the producer of the original product or specialized enterprise which deals with collection/processing of the elements of reverse logistics.
2. For realization of reverse material flow are needed auxiliary operations (for example transportation, storage).
3. Accent on wastes and waste management with needed processes oriented to reduction of wastes.

For determination of reverse logistics processes it is needed to describe the basic elements of reverse logistics which create the reverse material flow. In the case of reverse logistics elements it is possible to state these categories:

1st category - production loss (faulty pieces from production).

2nd category - waste (including wrappings).

3rd category - unsold goods.

4th category - products from consumers (including products from complaints).

2. METHODOLOGICAL BASE

By the case study it was examined the reverse logistics and also processes of reverse logistics for the selected commodities of wastes. One of the important result of the case study is the solution of wastes collection by the help of decision making methods or by the help of geometric methods. By this paper it will be presented the solution by the geometric method for the collection of used tires. The main task of geometric method is to present coordinates of collecting points, distributive centres, stores or enterprise in the optimal localities for each region with minimum costs. The initial step is to create maps of the selected region with situated collecting point to the *x* and *y* coordinate. Coordinates [x_i, y_i] must be added to each locality which is under the process of assessment and it is connected with the selection of suitable locality. The next step is to present the objective function. This function must be minimized on the part of costs. The objective function is characterized as transport cost (TC). For presentation of coordinates of the searched collecting point is very important to determine the distance by the regions. The distance of distributive localities from the searched distributive centre can be determined in regard to the type of region as a distance between axes, quadratic, direct or direct corrected distance. Allocation of collecting points was primarily expressed by the method of allocation with quadratic distance. The main task of this method is allocation of new collecting points in the coordinate system [*x*; *y]* of the territory. The first step for achievement of coordinates to optimal allocation of collecting points must be last but not least achieved by minimization of the objective function TC [6]. For the coordinates of optimal allocation of collecting points it is important that the derivation of the objective function is by the *x* and it must be equal to 0. Also the derivation of the objective function by the *y* and it must be also equal 0. For the exact calculation of the collecting points it was also used method with the use of direct distance - Cooper iterative method (CIM). The results of these methods and their comparison determined the allocation of collecting points. The allocation of the collecting points was calculated by the axis X to the accuracy 0, 1 and with iteration after x_1; y_1. Also by this method it must be realized minimization of the objective function. Also it is needed that the derivation of the objective function of TC for *x* must be equal to 0 and also derivation of the objective function of TC for *y* must be equal to 0. For use of these methods it is needed and important to know these facts: quantity of produced commodity of waste in the district towns (M_i), price/t (C_i) and coordinates X_i and Y_i in the district towns of the regions of SR [6]. For allocation of the collecting points in the regions and theirs district towns was used the method of allocation with quadratic distance. The second method was the method of allocation with the use of direct distance - Cooper iterative method. By the calculation of CIM were used results of the method of quadratic distance.

Example of calculation for the Bratislava district - Coordinates of district towns were expressed by internet application Google maps. The price of used tires [€] was expressed as average value (by the enterprise V.O.D.S. in Kechnec) - 12 EUR per t. Quantity of used tires in the district towns and regions were expressed on the base of statistics of Program of waste management of SR [7]. The result of calculation by these methods of allocation were coordinates [*x*; *y*] = 48.1708443; 17.1624706. These coordinates belongs to the territory on the west part of SR, district town Bratislava II (Na Úvrati).

3. RESULTS AND DISCUSSION

Table 1 presents coordinates [*x*; *y*] and allocation of collecting points for each region which were calculated by the method of allocation with use of quadratic distance and allocation with use of direct distance - Cooper iterative method (CIM).

The result of the calculation is allocation of new collecting points, seven collecting points for each region. These collecting points will be systematically allocated throughout the territory of SR by the regions and their district towns. Collecting points will realize collection of used tires from surrounding towns and villages. These points will also realize crushing and the next transport of this commodity of waste to the central collecting and processing centre in Kechnec. Figure 1 presents allocation of these collecting points in SR.

Table 1 Allocation of collecting points

Region	Coordinates [*x*; *y*]	Collecting point
Bratislava	48.1708443 17.1624706	Na Úvrati, Bratislava II.
Trnava	48.3375729 17.6132261	Modranka, Trnava
Trenčín	48.87369168 18.23293505	Krásna Ves, Bánovce nad Bebravou
Nitra	48.06459114 18.13277871	Šurany, Nové Zámky
Banská Bystrica	48.5451184 19.4095789	Dolinky
Žilina	49.20231973 19.01253533	Terchová, Žilina
Prešov	49.07286197 21.0298917	Hermanovce, Prešov

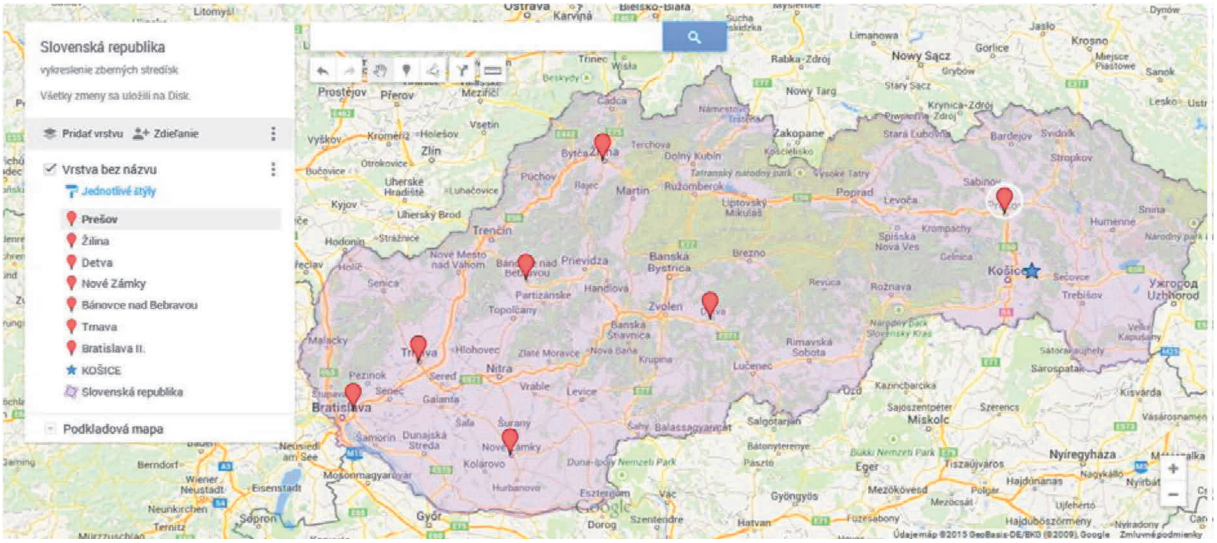

Fig. 1 Illustration of collecting points in SR

The haulage of used tires will be realized locally, the next direction will be from the regions to the new collecting points and finally to the centralized collecting point in Kechnec in Kosice region. Transport of used tires will be realized by two routes “top” and “bottom”. The top route will collect and transport used tires from the collecting point in Bratislava regions (Bratislava II), collecting point in Trnava (Trnava region), collecting point in Bánovce nad Bebravou (Trenčín region) and collecting point in Žilina (Žilina region). The schematic presentation of allocation of collecting points and realization of used tires transport by the top route is presented by the **Fig. 2**.

By the “bottom” route the collection will be realized for Nitra region with the collecting point in the district town Nové Zámky, in Banská Bystrica region in the collecting point Detva, in Prešov region in the collecting point in Prešov. **Fig. 3** presents allocation of collecting points and realization of used tires transport to the centralized collecting point.

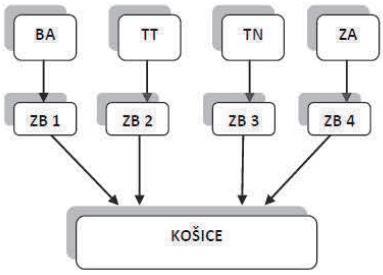

Fig. 2 Schematic presentation of collecting point and realization of transport process by the top route to the centralized collecting point

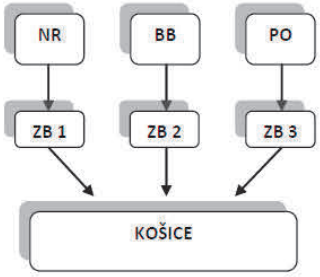

Fig. 3 Schematic presentation of collecting points and realization of transport process by the bottom route to the centralized collecting point

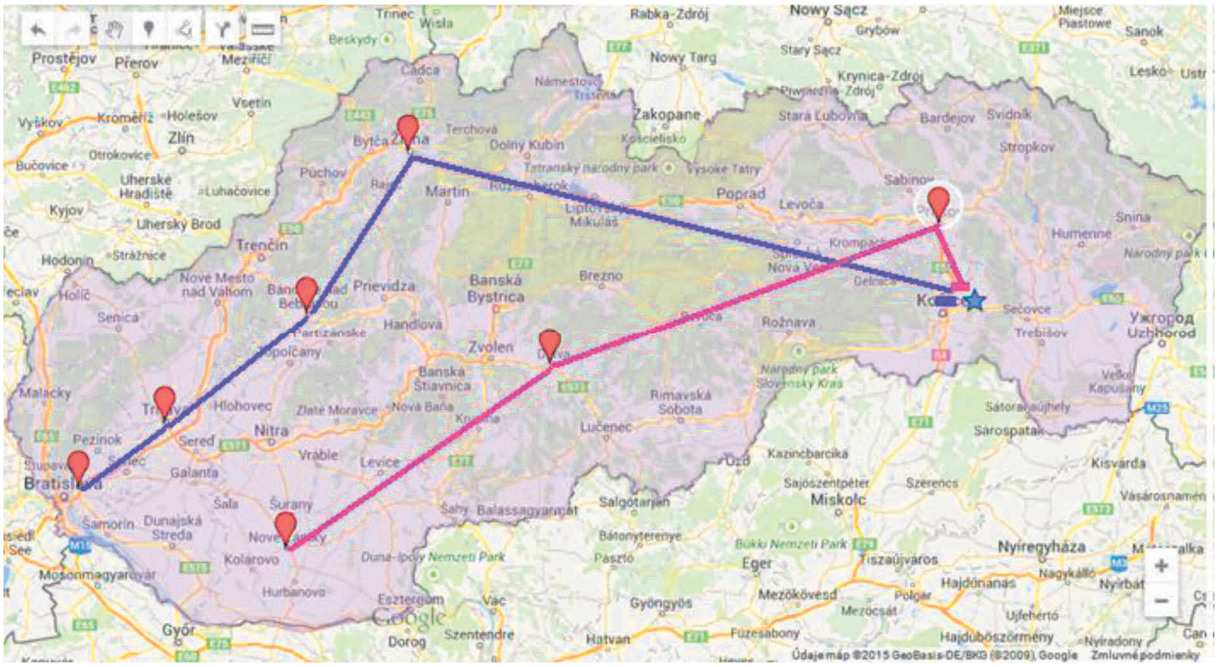

Fig. 4 Illustration of routes

Both routes of this collection will have the same target collection and processing centre in Kechnec, Košice region. **Fig. 4** presents the named routes through the collecting points to the centralized collecting centre. Collecting points could be built from the funds of Recycling fund of SR and European Union, because the economy situation in SR is very difficult. But the financial support from the side of Recycling fund of SR is hardly likely. The Government of SR endorsed the new law about wastes. The main idea of this new law is

extended responsibility of producers and importers of products from the point of production to the point of its processing in the form of waste. Therefore, the Government want to use financial reserves for elimination of illegal waste dumps.

4. CONCLUSION

Collection of wastes, their recycling and reuse achieves to improvement of environment protection, but also to decrease of costs needed for these processes. Adequate collection and right recycling of wastes can prevent or reduce negative impacts on the environment which is contaminated by wrong handling with generated wastes. The goal of the article was on the base of reverse logistics to design the way of wastes collection - collection of used tires for minimisation of waste dumping or creation of new illegal, so-called “black” dumps. By the analysis of the current state, SR has deficiency of collecting points for collection of used tires. The realized case study proposed by the method of allocation with quadratic distance and Cooper iterative method the allocation of seven new collecting points within each district of SR. The central store, for accumulating of used tires for recycling, is the store in the industrial park of the enterprise VODS dealing with recycling of tires. By this solution it is possible to reduce costs for transport, attain financial means from the new produced products (rubber granulate) and above all for disposal of used tires.

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REFERENCES

[1] KAMRAN S. MOGHADDAM. Fuzzy multi-objective model for supplier selection and order allocation in reverse logistics systems under supply and demand uncertainty. Expert Systems with Applications, Vol. 42, No. 15-16, 2015, pp. 6237-6254.

[2] FLEISCHMANN M., BLOEMHOF-RUWARRD J.M., DEKKER R., DER LANN E., NUNEN J.A.E.E., WASSENHOVE L.N. Quantitative models for reverse logistics: A review. European Journal of Operational Research, Vol. 103, 1997, pp. 1-17.

[3] HAWKS, K. What is reverse logistics? *Reverse logistics magazine*. Vol. Winter/Spring 2006 Edition.

[4] HUSÁKOVÁ N., TOMKOVÁ E. Eco-logistics - new application field of logistics. Logistický monitor. No. 7, 2015.

[5] HUSÁKOVÁ N. Reverse logistics - theoretical aspects. Logistický monitor, No. 8, 2012, pp. 1-9.

[6] STRAKA M. Distribution logistics in examples. 2nd ed. Košice: Technical University of Košice, 2012.

[7] Program of waste management of SR for years 2011-2015. Available on: http://www.minzp.sk/files/oblasti/odpady-a-obaly/poh/poh2011-2015/poh-sr-2011-2015.pdf