Reverse Logistics Problems of Worn Tires

Ślusarczyk Beata and Kot Sebastian

***Abstract*—Rapid development of the automotive market, apart from indisputable advantages, brings about a range of problems. One of them is an increase in the amount of worn tires which must be disposed of since they pose a significant threat to the natural environment. Therefore, in every country, there ought to operate an efficient system of reverse logistics which will allow to collect all worn tires and subject them to appropriate recovery operations. However, in practice, it turns out that the efficiency of such actions is far from ideal and the system itself copes with many problems. The present study is to signal these problems and attempt to propose their solutions.**

***Index Terms*—Worn tires, reserve logistics, waste disposal.**

I. Introduction

An increase in consumption and widely understood improvement in quality of life, being the result of strong economic development of the last decades bring about a range of problems. One of them is constantly growing amount of waste, particularly such waste whose decomposition process takes hundreds of years or which is not subjected to such a process at all. An example of such waste is waste tires whose storage is so dangerous for the natural environment that, in the countries of the European Union, such an activity has been banned [1]. This prohibition enforces searching for alternative ways of disposal of rubber waste, mainly through material recycling and energy recovery. However, irrespective of the selected method, the efficiency of its application depends on the efficiency and appropriate design of the system of reverse logistics since worn tires must be efficiently collected from the market and provided to the entities dealing with their disposal.

In the subject literature, one may come across numerous studies concerning individual methods of disposal and recovery of worn tires such as: pyrolysis [2], [3], use of tires as one of alternative fuels in cement works [4]-[7], or their use (after being subjected to appropriate treatment) to neutralize oil spills and other pollutions [8]. A willingly discussed subject matter is also the lifecycle of tires along with their impact on the natural environment [9], [10]. The issues associated with reverse logistics of worn tires are subjected to the analysis much less frequently and have not seen due interest and broader considerations so far. Few authors concentrating on this issue make an effort to bring forward the organization of the management system of waste which worn tires are [11], [12], or they attempt to create the models of the reverse logistics system of worn tires [13], [14], and also to select the most optimal option [15]-[17]. However, there are no studies concerning the conditions of the operation of the reverse logistics system of worn tires and the analysis of the reasons for imperfections occurring there. Therefore, the aim of the paper is to indicate the problems and barriers occurring in the system of reverse logistics of worn tires operating in Poland and to propose the ways of their overcoming.

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II. Reverse Logistics of Worn Tires

The possibilities of disposal and management of worn tires are determined by the existence of an effective and efficiently operating reverse logistics system. Rogers and Tibben-Lembke believe that reverse logistics "is concerned with efficient reverse flows of raw materials, in-process inventories, and finished goods, from the point of consumption to the point of origin for recapturing/creating value or disposal, and as such is a subset of the broader category of recycling collection logistics" [18]. The essence of reverse logistics is therefore the flows implemented in the opposite direction than in the case of traditional logistics. At the same time, one of its main tasks is to recover value from returned products and simultaneously minimize the costs of the whole process of the flow of these products from customers to manufacturers or the entities appointed for this purpose [19]. In the case of worn tires, the main factor turns out to be just legal requirements that force manufacturers of tires to behave responsibly in the field of their collection and disposal. In here, the reverse logistics system may be organized on the basis of one of the three models of proceedings: extended responsibility of the manufacturer (management of worn tires is the responsibility of manufacturers or importers, however, in practice, most frequently they transfer the task of waste collection to the specialized recycling organizations), tax system (manufacturers or sellers pay specific charges to the state budget, associated with the manufacture of tires, and management of worn tires is commissioned to the recovery organization financed from the state budget) or free market (worn tires are a valuable secondary raw material there) [20].

III. Problems of the Operation of the Reverse Logistics System of Worn Tires

In Poland, the system of reverse logistics of worn tires has been built on the basis of the model of extended responsibility of the manufacturer. It is definitely the most popular option in the countries of the European Union, although it does not provide full efficiency of disposal of this waste (however, the same may apply to other models). Growing year by year the number of tires introduced to the market brings about that the effective operation of the system

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of reverse logistics is increasingly difficult and yet it is becoming increasingly important. In Table I, there are presented the data concerning the size of the tire market in Poland in years 2003-2015.

TABLE I: THE TIRE MARKET IN POLAND IN YEARS 2003-2015

	[thousand ton]					[%]	
	The amount of tires introduced to the market			Tires subjected to		The achieved level of	
	Total	Subjected to the obligation of					
		recovery	recycling	recovery	recycling	recovery	recycling
2003	136,0	129,9	-	56,5	-	43,5	-
2004	151,4	150,7	150,7	88,7	17,3	58,9	11,5
2005	147,8	146,0	145,1	120,3	23,6	82,4	16,2
2006	185,7	185,7	185,7	167,5	36,0	91,3	19,7
2007	195,5	195,5	195,5	178,3	46,3	91,2	23,7
2008	188,5	188,5	188,5	151,6	42,4	82,2	22,0
2009	165,8	165,8	165,8	122,7	32,9	74,0	19,8
2010	195,1	195,1	195,1	160,3	71,3	82,1	36,6
2011	222,9	222,9	222,9	213,2	67,9	96,0	30,5
2012	218,9	218,9	218,9	184,2	51,9	84,2	23,7
2013	222,0	222,0	222,0	122,7	35,4	55,3	16,0
2014	234,3	234,3	234,3	178,5	57,7	81,6	26,4
2015	222,2	217,5	217,5	175,3	47,9	80,6	22,0

In the analyzed period, the amount of tires introduced annually into use in Poland increased by more than 85 thousand tons. At the same time, there was an increase in the number of tires which will be disposed of after use. Since 2006 there has been in force an absolute prohibition on accepting tires at landfills, therefore all of them are subjected to the obligation of broadly understood recovery or, more precisely – recycling. Along with an increase in the amount of tires introduced to the market there is also an increase in the number of tires which, in a specific year, are subjected to the processes of recovery – this value, comparing the years of 2003 and 2015, increased by nearly 120 thousand tons. In total, in the analyzed period, nearly 1 920 thousand tons of tires were subjected to recovery in Poland whereas, in the same period, there were introduced more than 2 485 thousand tons of tires to the market (of which 2473 thousand tons were subjected to the obligation of recovery). Therefore, the average rate of the level of recovery amounted to 78%.

The achieved levels of recovery are far from 100% - the exception in here is the year of 2011 when this rate was at the level of 96%. Therefore, a significant amount of worn tires is still not subjected to recovery. This may be due to several reasons. The first of them is the fact that the legislator requires manufacturers to recover only 75% of the tonnage of tires put into circulation in the previous year of which 15% must be recycled. This is to some extent justified by the fact that tires in use lose some of their weigh, however simultaneously this provides some room for abuse and already, at the legislation level, it is assumed that some of tires may just "vanish into thin air" in the system of reverse logistics. Since 2005 (except for the periods of 2009 and 2013) the annual levels of recovery and recycling required by the legislator have been achieved and even exceeded by a few percentage points. Therefore, it is not surprising that manufacturers do not aim at the achievement of a 100% profit since this would be related to increased costs, therefore, from the economic point of view, this would be unprofitable to them.

Another reason for incomplete recovery of worn tires and, at the same time, the problem of the system of reverse logistics is lack of possibility to compel the society to act responsibly in the area of environmental protection. Lack of culture or environmental awareness brings about that some people throw out old tires at illegal landfills or, even worse, burn them in household furnaces. To some extent, the requirement to return old tires when purchasing new ones would be a good concept but still this would not solve the problem completely and only be associated with additional inconveniences. Therefore, in this case, the only available activity is the education of the society although it does not provide any guarantee of success.

The problem occurring recently is the fact that recovery organizations which have been ordered by manufacturers to collect worn tires (i.e. the execution of the statutory obligation), introduced charges for the collection of tires from end users. These charges may be small but the organizations explain that they will help ensure the development of the waste collection system [21], however, they may effectively discourage from the lawful disposal of worn tires. These organizations receive funds from manufacturers that make them collect worn tires as well as the entities purchasing tires for energy (mainly cement works for which it is an alternative fuel), therefore, it seems that, additionally, the introduction of charges for acceptance of waste is inadequate to the situation and inconsistent with the assumptions of the system.

Certainly, one of the most effective solutions improving the operation of the system of reverse logistics of worn tires would be the application of RFID technology and placing the RFID label in each manufactured tire. This would allow the tracking of a tire at every stage of its use, also after withdrawing from use, which would significantly increase

the efficiency of collection. However, such a solution seems to be impossible to apply at present, most of all, due to the costs of its implementation.

IV. Summary

An efficient collection and disposal of worn tires is a serious problem in today's world. The amount of tires introduced to the market year by year brings about that an efficient and properly arranged reverse logistics system of this type of waste gains particular importance. However, it turns out that in spite of many legal restrictions obliging entrepreneurs to environmentally responsible activities there still can be identified many problems and barriers in the process of recovery of tires. The first one is the tendency of manufacturers to achieve only the required statutory level of recovery. As far as it is understandable from the economic point of view, it has definitely the negative impact on the environment and hinders the operation of the system of reverse logistics. Another problem is too large independence of recovery organizations concerning the issue of setting charges for waste collection – the collection should be free not to discourage users to return worn tires to such places. Also, lack of environmental awareness of the society impedes an effective operation of the system of reverse logistics. For many people, only economic benefits (e.g. financial benefits for returning old tires to the entities dealing with their collection) would be encouragement to more responsible behavior in the field of disposal of worn tires. All of this contributes to the fact that the design and maintenance of an efficiently operating system of reverse logistics is a very difficult task and requires interest both on the side of professionals in the theoretical field and practitioners in the field of the environmental protection.

References

[1] P. Sands and P. Galizzi. (1999). Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste. [Online]. Available: http://eur-lex.europa.eu/LexUriServ/site/en/oj/1999/l 182/l 18219990716en 00010019.pdf

[2] J. D. Martinez, A. Ramos, O. Armas, R. Murillo, and T. Garcia, "Potential for using a tire pyrolysis liquid-diesel fuel blend in a light duty engine under transient operation," *Applied Energy*, vol. 130, pp. 437–446, 2014.

[3] H. Aydın and C. Ilkılıc, "Optimization of fuel production from waste vehicle tires by pyrolysis and resembling to diesel fuel by various desulfurization methods," *Fuel*, vol. 102, no. 3, pp. 605–612, 2012.

[4] P. Pipilikaki, M. Katsioti, D. Papageorgiou, D. Fragoulis, and E. Chaniotakis, "Use of tire derived fuel in clinker burning," *Cement & Concrete Composites*, vol. 27, pp. 843–847, 2005.

[5] A. Aranda Uson, A. M. Lopez-Sabiron, G. Ferreira, and E. Llera Sastresa, "Uses of alternative fuels and raw materials in the cement industry as sustainable waste management options," *Renewable and Sustainable Energy Reviews*, vol. 23, pp. 242–260, 2013.

[6] K. T. Kaddatz, M. G. Rasul, and A. Rahman, "Alternative fuels for use in cement kilns: Process impact modelling," *Procedia Engineering* vol. 56, pp. 413 – 420, 2013.

[7] B. Ślusarczyk, M. Baryń, and S. Kot, "Tire industry products as an alternative fuel," *Polish Journal of Environmental Studies*, vol. 25, no. 3, pp. 1263-1270, 2016.

[8] C. Lin, C. L. Huang, and C. C. Shern, "Recycling waste tire powder for the recovery of oil spills," *Resources, Conservation and Recycling,* vol. 52, pp. 1162–1166, 2008.

[9] A. Elkafoury and A. Negm, "Assessment approach of life cycle of vehicles tyres on Egyptian road network," *Periodica Polytechnica Transportation Engineering*, vol. 44, pp. 75-79, 2016.

[10] X. Sun, J. Liu, J. Hong, and B. Lu, "Life cycle assessment of Chinese radial passenger vehicle tire," *Int J Life Cycle Assess*, vol. 21, pp. 1749–1758, 2016.

[11] M. Sienkiewicz, J. Kucińska-Lipka, H. Janik, and A. Balas, "Progress in used tyres management in the European Union: A review," *Waste Management*, vol. 32, pp. 1742–1751, 2012.

[12] V. Torretta, E. C. Rada, M. Ragazzi, E. Trulli, I. A. Istrate, and L. I. Cioca, "Treatment and disposal of tyres: Two EU approaches. A review," *Waste Management*, vol. 45, pp. 152–160, 2015.

[13] A. Pedram, N. B. Yusoff, O. E. Udoncy, A. B. Mahat, P. Pedram, and A. Babalola, "Integrated forward and reverse supply chain: A tire case study," *Waste Management*, 2016.

[14] C. D. Ribeiro de Souza and M. de Almeida D'Agosto, "Value chain analysis applied to the scrap tire reverse logistics chain: An applied study of co-processing in the cement industry," *Resources, Conservation and Recycling*, vol. 78, pp. 15–25, 2013.

[15] J.K. Grabara, "The another point of view on sustainable management," *Quality - Access to Success*, vol. 18, pp. 344-349, 2017.

[16] P. Bajdor, "Comparison between sustainable development concept and green logistics – The Literature Review," *Polish Journal of Management Studies*, vol. 5, pp. 236-244, 2012.

[17] B. Manoj Kumar and Dr. R. Saravanan, "Network design for reverse logistics - A case of recycling used truck tires," *Applied Mechanics and Materials*, vol. 592-594, pp. 2677-2688, 2014.

[18] D. S. Rogers and R. Tibben-Lembke, "Going Backwards: Reverse Logistics Trends and Practices," *Health*, 1999.

[19] G. Kovács and S. Kot, "New logistics and production trends as the effect of global economy changes," *Polish Journal of Management Studies*, vol. 14, no. 2, pp. 115-126, 2016.

[20] S. Ramarad, M. Khalid, C.T. Rantnam, A. Luqman Chuah, and W. Rasami, "Waste tire rubber in polymer blends: A review on the evolution, properties and future," *Progress in Materials Science*, vol. 72, pp. 103-105, 2015.

[21] Information. [Online]. Available: http://utylizacjaopon.pl/News

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