MANAGEMENT OF SEPARATED MUNICIPAL WASTE FLOW IN KAUNAS CITY

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Individual municipal waste streams of Kaunas (Lithuania) in the period 2012-2015 period was found that mixed municipal waste collected in the city of Kaunas municipality, prefabricated containers, compared to the 2012 decreases. 2015. Collect points mixed municipal waste are reduced from 118,065.56 tons to 100,470.6 tons, accounting for 15%. Biodegradable (green waste) quantities of green waste collection a site does not increase compared in 2012 and 2015. (in 2014 these waste was not collected). The decrease may be affected by that green waste is used boiler house that green waste for energy recovery. The recyclable waste separate secondary maximum (4.5 times) Increased quantities of collected waste paper, plastic positive capture an increase of 1.5 times. Glass collection containers steadily decreasing (from 2.46 tons 2012 to 1094 tons 2015). The trend to rise only noticeable only after complementary systems and DGASA (deposit system). In particular increased textile waste collection (up to 10 times). Toxic waste collection Kaunas City Municipality is constantly increasing tire (up to 2 times); waste containing mercury and packages containing hazardous substances (up to 3 times.). Electrical and electronic waste collection throughout the 2012 -2015 year. Period effective complementary systems (collected 99 % of such waste), but the amounts vary from year to year, and substantial growth was observed. Population change shows that especially affect the population of secondary separate paper (r= 0.994, p = 0.04), plastic (r=0.923, p =0, 0.047), tires (r=0.960, p =0, 0.040), and toxic waste (lamps, and hazardous materials) collection. According to the results it can be said that some of the waste (green, glass, electrical equipment) gathers a group of people decided to lead.

Keywords: municipal waste; mixed municipal waste; biodegradable - green waste

INTRODUCTION

Today's rapidly developing and civilized world gives special attention to the strengthening of environmental protection. The progress of science, industrial development and economic growth should be directed towards improving the state of the environment, preserving the countryside, and rational use of natural resources. Taking this into regard, the European Union strictly regulates and supervises the status of the environment. Waste management is one of the significant fields of the environmental sector. Seven billion people on the planet and their constantly growing demands result in growing amount of resources used in the production process and higher production volume; therefore, the issue of waste is becoming more and more important – it has become a national concern and also a global phenomenon. These factors have made waste management one of the most significant and urgent issues of the 21st century, which has a negative impact not only on the environment but also on the public health and welfare. Population growth and rapid urban development has led to urbanization processes which enabled to identify the issue of municipal waste. According to data of various sources, more than 240–250 million tons of municipal waste is collected in Europe annually and more than half of this amount is municipal biodegradable waste that can be processed into valuable compost (Eurostat, 2015). The biggest amount of this waste is still disposed of in landfills, which are anticipated to be completely filled in the nearest future. Such a tendency requires a new outlook as well as systematic and targeted activities to solve the problem of the growing amount of municipal waste. These factors encourage the implementation of modern municipal waste management systems that would facilitate the reduction of waste amounts disposed of in landfills, expand sorting, processing, utilization and other kinds of handling. Taking into account the fact that the tasks of municipal waste management systems, i.e. the planning, organization and

control, are attributed to local authorities with limited budgets, it is aimed to implement effective municipal waste management systems that would enable to achieve the maximal benefit with minimal expenditure.

There are many environmental issues that depend on anthropogenic activities. One of the most significant issues is the growing amount of municipal waste (Stradere, 2012; Allesch and Brunner, 2014). Waste management is one of the biggest and most important challenges of the 21st century humanity, which has received great public attention over the last two decades (Ailenei and Tartiu, 2008). Municipal waste plays a special role in the context of the waste management issue as the amount of such waste is constantly growing due to the prevailing urban lifestyle and growing consumerism. The term "municipal waste" is used to define everyday waste forming in daily life due to human activities and encompass a very wide range of specific waste: paper and cardboard, plastic, metal, wood, textile, biodegradable waste, medical, kitchen and other types of waste that have been defined in various sources. In total 26 types of municipal waste are distinguished that differ by their composition and different processing (Khan. D., Samadder, 2014; Ludwig et al, 2003). Today waste formation and processing is one of the most urgent environmental issues in Lithuania and globally that poses a threat to the environment and human health. Waste is inevitable in our life and economic activity. Waste management depends on the legal framework and waste management infrastructure in every country (Taiwo, 2011; Teirumnieka et al., 2013). On our way to the container with a waste bag, we do not usually think about the further road of waste.

Waste management encompasses the collection of materials (waste) discarded after human economic activity, their transportation, processing, biodegradation, combustion of waste with the recovery of heat for the production of electricity and heating, or waste removal due to health, aesthetical and other reasons (Gudaityte, 2009). Although the obligation to sort waste was established by laws more than 20 years ago in Lithuania, the practice shows that this obligation is still carried out with difficulty in practice even after several decades (Šliogeris and Butėnienė, 2013). The Directive 2008/98/EC of the European Parliament and of the Council on Waste establishes that waste management shall be carried out without risk to water, air, soil, plants or animals, and without adversely affecting the countryside. After Lithuania became a member of the European Union, its waste collection and management system underwent an essential reorganization. The objective in the field of waste management shall be to reduce the generation of waste, ensure waste management that is safe for human health and the environment and the rational use of material and energy resources of waste, thereby reducing the use of natural and other resources and the disposal of waste in landfills (National environmental...,2016). Ten regional waste management centers were established for this purpose, the construction of regional non-hazardous waste landfills and other regional waste management infrastructure was started (bulky waste collection sites, green waste composting sites, reloading stations, etc., Status of Environment, 2012).

Objective of the paper: To analyze the management of separate municipal waste flows in Kaunas City in the period of 2012–2015.

MATERIALS AND METHODS

Valuation of the municipal waste management system according to the selected types of waste in Kaunas City Municipality in the period of 2012–2015. The list of waste is specified in the approved Waste Management Regulations (Order No 217 of the Minister of the Environment of 14 July 1999 on the Approval of Waste Management Regulations) and is mandatory for all municipalities. The territory of Kaunas City Municipality, mixed municipal waste is collected in ground and underground standard containers of various capacities. Municipal waste holders use individual containers or collective containers located at container sites.

The following is analyzed according to the waste list section:
•Packaging waste; otherwise undefined absorbents, wipes, filter materials and protective clothing;
•Waste undefined otherwise in the list;
•Municipal waste (domestic waste and similar business, industrial and commercial waste), including separately collected groups.

The following types of waste were analyzed among separate municipal waste flows collection means and amounts in Kaunas City Municipality selected for the analysis according to the waste list lines:
1. Paper and cardboard and paper and cardboard packaging waste;
2. Glass waste and glass packaging waste;
3. Plastic waste and plastic packaging waste;
4. Biologically degradable (green) waste;
5. Mixed municipal waste;

The correlation and regression were calculated using software STATISTICA 7 (Čekanavičius, Murauskas, 2006; Hill, Levicki, 2005). The symbols used in the work as follows: * – data significant at 95% probability level. R05 – significant difference limit at 95% probability level.

RESULTS AND DISCUSSION

Mixed municipal waste forms the biggest part of all collected waste. Mixed municipal waste is domestic waste that has remained after sorting.
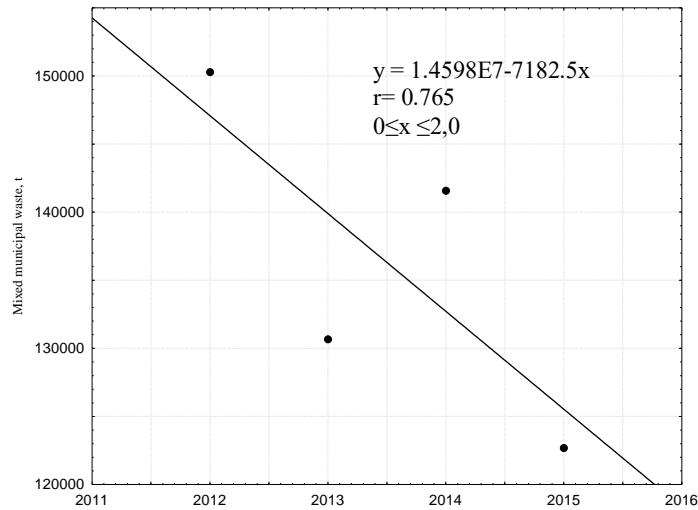

Figure.1. Dynamics of mixed municipal waste collected in Kaunas City

Figure 1 shows that the amount of collected mixed municipal waste was the highest in 2012. All amount of mixed municipal waste is collected from containers, and additional systems as well as bulk waste collection sites do not participate here. Comparing the period of 4 years, the amount of collected mixed municipal waste has reduced from 150,285 tons to 122,702 tons, i.e. by 18 %, in 2015. This could have been the result of 4 packaging processing organizations opened in Kaunas City by manufacturers and importers during the period, which carry out intensive educational activities and are responsible for the management of packaging and work with the public on how to sort waste and reduce the amount of mixed municipal waste. The supervision and control of various institutions also contributed to the lower amounts of waste and its suitable management.

In order to comply with the objectives of the Directive, and move towards a European recycling society with a high level of resource efficiency, member states have to take the necessary measures designed to achieve the following: by 2020, the preparing for re-use and the recycling of waste materials such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased to a minimum of overall 50% (by the amount of waste) (Directive 2008/98/EC on Waste). The received tendencies of mixed municipal waste amounts in the period of 2012–2015 show that it is possible to attain such results in Kaunas City.

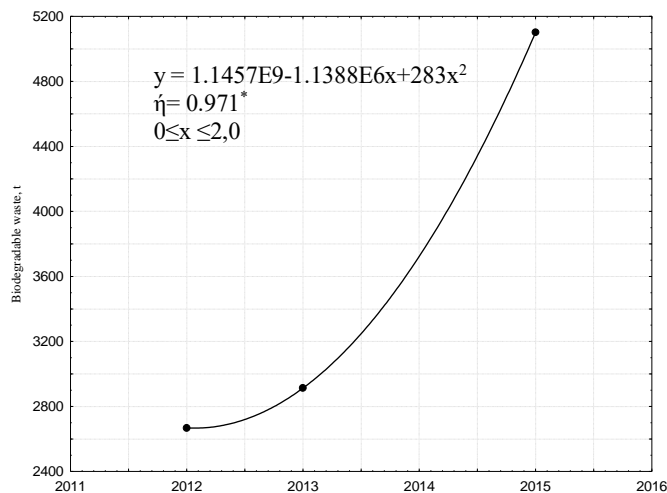The collected amounts of biodegradable waste in Kaunas City are presented in Figure 2.

Figure.2 Biodegradable waste collection in Kaunas City period 2012-2015

Municipal biodegradable waste is waste which can be processed into valuable compost thus reducing the amount of waste disposed of in landfills. Comparing the amounts of biodegradable waste collected in Kaunas City, the amount collected in 2015 (5,101 t) is almost 2 times higher than in 2012 (2,668 t), and this reduces the amount of mixed municipal waste.

Secondary raw materials are residues of paper, glass, plastic and metal used in domestic or commercial activities that are recycled for the manufacturing of new products. The amount of collected glass and glass packaging decreased during the analyzed period (Figure 3), comparing 2012 with 2013 and 2015. This could have been determined by several reasons – the lower consumption of the inhabitants, poor perception of the benefits of sorting, lack of knowledge about the correct sorting of municipal waste and/or lack of collection installations. Private households are not sufficiently provided with waste collection installations, and the present collection installations are in some places more than 200 m away and thus inconvenient to residents; as a result, they dispose of all waste into closer mixed municipal waste containers. Still, the amounts of plastic and plastic packaging as well as cardboard and cardboard packaging waste ststistically gradually growing.

$y_{(Paper)} = -1.1838E6 + 588.6x$
$r = 0.975*$

$y_{(Plastic)} = 1.6645E8 + 1.6522E5x - 41x$
$\acute{\eta} = 0.997*$
$0 \leq x \leq 2{,}0$

● Paper and carboard and packaging waste, t
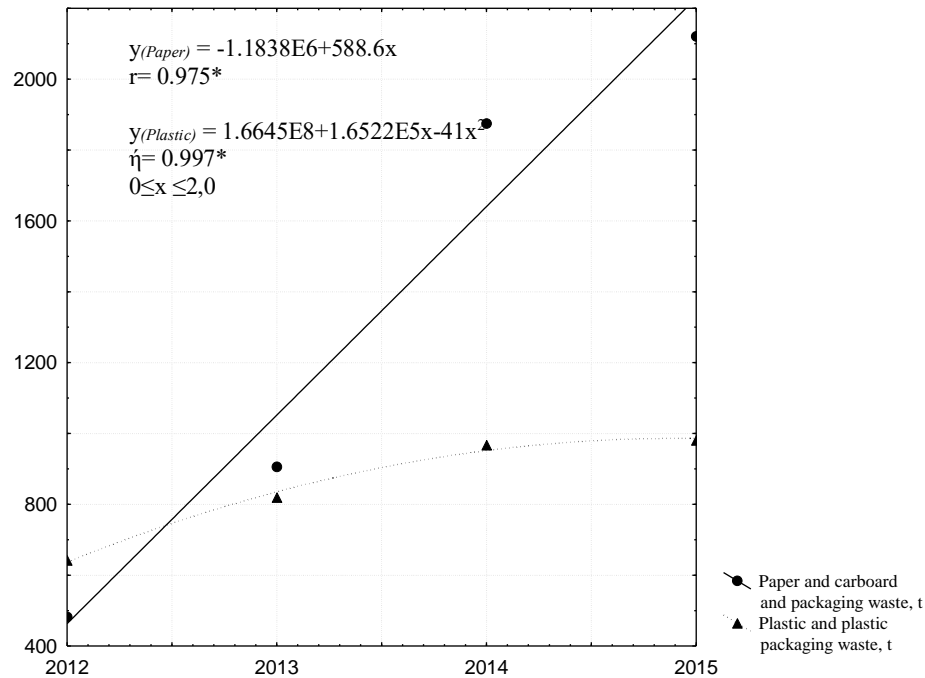▲ Plastic and plastic packaging waste, t

Figure 3. Collection of secondary sorted raw materials (glass, paper and cardboard, and plastic) in Kaunas City

The population fluctuation is important in Kaunas City Municipality. It occurs due to the negative natural population growth (the birth rate is lower than the death rate) as well as due to the negative net migration rate (the number of emigrants is higher than immigrants). The impact of these factors on the collected waste amounts is presented in Table 1.

Table 1. Evaluation of correlation between the population of Kaunas City and amount of collected waste

Amount of collected waste/ Population, number, unit.	
Mixed waste, t	r= 0.771; p=0.024
Green waste, t	r= 0.271; p=0. 729
Paper, t	r= 0.994; p=0.004
Glass, t	r= 0.110; p=0.890
Plastic, t	r= 0.923; p=0.047
Clothing, t	r= 0.892; p=0.023
Tires, t	r= 0.960; p=0.317
Hazardous waste, t	r= 0.927; p=0.033
Lamps, t	r= 0.905; p=0.025

The received results show that the population in particular has an impact on the collection of sorted waste, i.e. paper (r=0.994, p=0.04), plastic (r=0.923, p=0.047), tires (r=0.960, p=0.040) and hazardous domestic waste (lamps and hazardous

materials). It may be stated on the basis of these results that some types of waste (green, glass, electrical equipment) are correctly disposed of by a group of people determined to do this.

CONCLUSIONS

The key waste management priority is to avoid waste formation and reduce the amounts of already formed waste. The amounts of collected mixed municipal waste decreased by almost one fifth (18%) in Kaunas City in 2015 as compared to 2012.

The amount of biodegradable waste is growing in Kaunas City. The amount of biodegradable waste collected in 2015 (5,101 t) is almost 2 times higher as compared with 2012 (2,668 t), this is 53.43 percent, which is higher than the national average for biodegradable waste (48.04 percent).

The amount of collected glass and glass packaging differs every year, and the numbers show an essential difference. The amounts of plastic and plastic packaging as well as paper and cardboard and their packaging waste are gradually growing (R^2=0.98 and R^2=0.85).

The population fluctuation testifies that population in particular has an impact on the collection of sorted waste, i.e. paper (r=0.994, p=0.04), plastic (r=0.923, p=0.047), tires (r=0.960, p=0.040) and hazardous domestic waste (lamps and hazardous materials).

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