MUNICIPAL WASTE MANAGEMENT ISSUES

Ligita Melece[1], Janis Brizga[2], Raimonds Ernsteins[2]
[1]Institute of Agricultural Resources and Economics, Latvia; [2]University of Latvia, Latvia
ligita.melece@arei.lv

Abstract. Reuse, recycling and recovery are becoming the key words for a new paradigm of the sustainability, innovation and competitiveness. Taking into account that waste becomes a resource, a new EU waste management framework can bring significant benefits: sustainable growth and job creation, reduced greenhouse gas emissions, direct savings linked to efficient waste management practices, including treatment, and a better environment. The EU Member States are increasingly shifting from municipal waste landfilling to waste prevention and recycling. It is recognised that landfilling is the worst waste management option for biodegradable waste, particularly at the EU level. Respectively, the European countries use a variety of policy instruments for: preventing waste generation, switching waste from landfilling and moving towards more recycling. In 2015, the European Commission (EC) proposed new targets for municipal waste – 60 % recycling and preparing for reuse by 2025 and 65 % by 2030. Waste prevention affects and depends on a very wide range of stakeholders, but it also depends on changes in the attitudes and behaviour of households. The aim of the study is twofold: 1) to evaluate the current state and trends of municipal waste management in Latvia, which are aimed to fulfil the EC recommendations and the EU legislation, as well as to reach the EU level accepted objectives and targets of waste related policies; 2) to assess Latvian households' attitudes against waste sorting. The comparison of performance in the implementation of municipal waste management policy among the EU Member States, the Baltic Sea Region EU countries and the Baltic States was performed. A combination of the Eurostat statistics, the legislation and various documents of the EU and Latvian institutions, as well as different sources of literature have been used as materials for evaluation. Besides, based on the national and municipal survey data, households' attitudes and behaviour regarding the solid waste management are assessed.

Keywords: municipal waste, landfilling, recycling, households.

Introduction

The significance of the green or resource-efficient economy is stressed out world-wide by policy-makers, experts and scholars. Resource efficient economy is linked to increased competitiveness, new sources of growth, including jobs, through cost savings from improved efficiency, commercialization of innovations and better management of resources [1-2]. The waste management is seen as the main driver of green economy. Moreover, reuse, recycling and recovery of waste are becoming the key words for a new paradigm of the sustainability, innovation and competitiveness; in which waste becomes a resource [3-4]. Turning the waste into a resource is an essential and significant part of resource efficiency and boosts a circular economy [1; 5-6]. In the circular economy action plan, a circular economy is explained by the European Commission (EC) as an economy 'where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised' [7]. Furthermore, the waste management domain, as recognised on the EU level, is the second most important contributor to employment growth in the environmental economy as shown by environmental goods and services (EGSS) accounts [8].

Sustainability of the waste management systems more or less is based on the approach or understanding that waste could be seen as part of a production system. The conventional waste management approach is that waste generation, collection and disposal systems are planned as independent stages or operations [9]. The impact generated by municipal solid waste landfills has received certain social, economic and environmental attention in recent decades [10]. Various negative impacts on life quality of the surrounding communities are caused by waste landfills [10-11].

The European Parliament in its resolution of 9 July 2015 on "Resource efficiency: moving towards a circular economy" proposes strictly limiting incineration of recyclable and biodegradable waste by 2020; and by 2030 – a ban on landfilling (except for certain hazardous waste and residual waste); and increasing targets for recycling and preparation for reuse to at least 70 % of municipal solid waste [12].

Environment quality strongly depends on human behaviour patterns [13]; and individuals' contribution is significant to achieve long-term environmental sustainability goals by adopting

pro-environmental behaviour patterns [14]. The waste prevention and management are affected and depend on a very wide range of stakeholders and their activities, including the households'. Numerous studies have shown the importance of incentives encouraging households' attitudes to environmental behaviour or pro-environment behaviour of households [15-16].

Previous studies in Latvia mainly were linked to the waste recycling technologies, i.e. anaerobic digestion. There are only few studies in Latvia devoted to the municipal waste management issues, including bio-waste management at all and food waste particularly. Therefore, the aim of the study is twofold: 1) to evaluate the current state and trends of municipal waste management in Latvia, which are aimed to fulfil the EC recommendations and EU legislation, as well as to reach the EU level accepted objectives and targets of waste related policies; 2) to assess Latvian households' attitudes and behaviours regarding to the municipal solid waste management.

Materials and methods

The principal materials used for the studies are as follows: the legislation and documents of institutions (mainly the EU); different publications and papers, e.g. scholars' articles, research articles and reports; the data from the Eurostat online database [17]. For evaluation and comparison the state and trends regarding to the waste management among countries, the data of the EU Member States and eight EU countries of the Baltic Sea Region: Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden, as well as the Baltic States were evaluated. The Baltic Sea Region countries, which are the Member States of the EU, further are indicated as the Baltic Sea Region countries. The suitable qualitative and quantitative research methods have been used for various solutions in the process of study: analysis and synthesis, data grouping, correlation-regression, logical and abstractive constructional etc.

For evaluation of Latvian households' attitudes and behaviour regarding environment, including the waste handling and treatment, especially of bio-waste, the survey was conducted in March 2016. The respondents ($n = 1009$) were selected using a random, multi-stage sample design. Face to face interviews were performed in the respondents' homes. In order to in-depth assessment of Latvian households' attitudes and behaviour regarding to the environment, *inter alia*, waste sorting or separating, a survey in two cities: Liepaja ($n = 361$) and Valmiera ($n = 373$) with the confidence interval – 5 %, was conducted in September and October 2016. The questionnaire structure was similar to the national questionnaire, but questions about societal values were replaced with questions about the residents' satisfaction with environmental services provided by municipalities. The obtained data have provided useful information about drivers that influence households' (residents) attitudes and behaviour with respect to the environment (environment friendly behaviour), including waste management at household level. The frequency distributions of the questionnaire data (respondents' answers in survey) were performed with SPSS software.

Results and discussion

Circular economy, as mentioned above, is oriented to the waste reduction, reuse and recycling, in other words, to zero waste. The zero waste concept includes the "3R rule" – "Reduce, Reuse, Recycling", which has been considered to be a base of circular economy, as well as resource effective or green economy, promoting ecological balance and benefit to environment [18].

Sustainable and efficient resource consumption is one of the preconditions towards the zero waste goals, minimizing waste and environmental damage. In a zero waste system, material flow is circular, which means the same materials are used again and again until the optimum level of consumption. No materials are wasted or underused in this system [18-19]. Therefore, at the end of their life products are reused, repaired, sold or redistributed within the system. If reuse or repairs are not possible, they can be recycled or recovered from the waste stream and used as inputs, substituting the demand for natural resources [5-6; 19]. Zero waste represents a shift from the traditional industrial or linear model, in which wastes are recognised as the norm, to an integrated or circular model, in which everything has its use [19-20]. Figure 1 shows the material flow of both the circular economy waste system, where the end-of-life product or output waste are treated as resources and used as inputs, and the linear economy waste system [19].

Directive 2008/98/EC requires the Member States to adopt waste management plans and prevention programs, and that by 2020 each country must recycle 50 % of their municipal waste [21]. In July 2014 this target and deadline were updated by the EC, which proposes legislation for increasing the amount to 70 % by 2030.
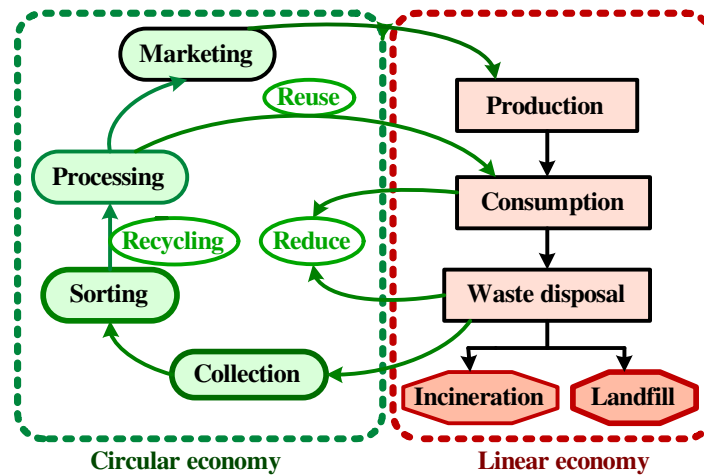
Fig. 1. **Comparison between circular economy and linear economy**

In 2011, the EC [22] worked out the recommendations for some EU Member States that had main problems with waste management. Main recommendations for Latvia are summarized in Table 1.

Table 1

Main horizontal measures recommended by EC in Action plan of Roadmap for Latvia to help fulfil waste legislation and its implementation

Measure (M) and description [22]	Expected result [22]	Implemented
M 1: Increase progressively the current landfill tax (in combination with awareness raising) Increase progressively and differentiate the current landfill tax to higher total costs for landfilling than for alternative treatment.	Reduced untreated landfilled waste; improved collection and treatment of biodegradable waste, etc.	No
M2: Introduce tax on MBT* Introduce tax on MBT (analogue to landfill tax but at a lower rate).	Prevent negative incentives for recycling.	No
M 3: Restrictions/ban on landfilling municipal waste Impose a ban on landfilling biodegradable waste (in case sufficient collection and alternative treatment capacity available).	Nearly zero landfilled biodegradable waste; increase in bio-waste composting or anaerobic digestion.	No
M 4: PAYT** scheme Implement PAYT. Develop proper compensation mechanisms (e.g., rich urban would pay for less developed rural areas).	Significant increase in recycling.	No
M 5: EPR*** schemes Improve the performance of EPR schemes for the main waste flows (i.e. glass, plastics, paper and metal) to achieve higher re-use and recycling rates. Establish a deposit refund systems for packaging (plastic, metal, glass).	Improved performance of EPR for main waste flows, and deposit refund systems.	In preparation

*– mechanical-biological treatment; ** – ; pay-as-you-throw; *** – extended producer responsibility (EPR)*

To help ensure full implementation of the EU waste legislation and the waste hierarchy, the EC has identified the main problems and their reasons relevant to the management of municipal waste in

Latvia, e.g. high share of bio-degradable waste going to landfills; limited bio-waste collection and treatment infrastructure; insufficient statistics' on national and local level; limited measures for encouraging separate collection of bio-waste; limited number of scientific studies on national/regional level, i.e. bio-waste management [2; 23].

Municipal waste management

The EU waste management policies aim to reduce the environmental and health impacts of waste and improve Europe's resource efficiency [24]. The long-term goal is to turn Europe into a recycling society, avoiding waste and using unavoidable waste as a resource wherever possible. The EU aim is to achieve much higher levels of recycling and to minimise the extraction of additional natural resources. Proper waste management is a key element in ensuring resource efficiency and the sustainable growth of the EU countries' economies.

The summarized amount of municipal waste (kg per capita) generated in the Baltic Sea Region countries and EU-28 (average) in 2005 and 2016, and changes between 2005 and 2016 are presented in Table 2. The results demonstrate that only in three countries (Estonia, Poland and Sweden) less municipal waste was generated in 2016 than in 2005. Although other countries also show the increasing tendency, Latvia shows the highest raise – by 28 %.

Table 2

Municipal waste generated (kg per capita) in the Baltic Sea Region countries and EU-28 in 2005 and 2016, and changes between 2005 and 2016

Country	2005	2016	Changes, 2016/2005	
Denmark	736	777	6 %	↑
Germany	565	626	11 %	↑
Finland	478	504	5 %	↑
EU-28	515	480	-7 %	↓
Lithuania	387	444	15 %	↑
Sweden	477	443	-7 %	↓
Latvia	320	410	28 %	↑
Estonia	433	376	-13 %	↓
Poland	319	307	-4 %	↓

As shown in Table 3, except the Baltic States, in all the Baltic Sea Region countries all or 100 % of generated municipal waste has been treated. Latvia has the lowest rate of treated waste, as well as recycled waste among other countries. At the same time Latvia has the highest rate of landfilled waste – 72 %, which is the highest share among the Baltic Sea Region countries, as well as among the Baltic States.

Table 3

Rate of municipal waste by waste operations in the Baltic Sea region countries and EU-28 in 2016

Country	Treatment	Landfilled	Incineration	Recycling	Composting[*]
EU-28	98 %	25 %	28 %	30 %	17 %
Denmark	100 %	1 %	51 %	29 %	19 %
Germany	100 %	1 %	31 %	48 %	18 %
Estonia	91 %	11 %	53 %	28 %	3 %
Latvia	**89 %**	**72 %**	0 %	**17 %**	11 %
Lithuania	95 %	31 %	18 %	26 %	25 %
Poland	100 %	36 %	20 %	28 %	16 %
Finland	100 %	3 %	55 %	29 %	13 %
Sweden	100 %	1 %	50 %	33 %	16 %

– i.e. digestion

Moreover, Latvia with 72 % of the landfilled municipal waste occupies the sixth higher position among the EU Member States. This rate is almost three times higher than the EU average, 6.5 times higher than in Estonia, and 2.3 times higher than in Lithuania (Fig. 2). The findings of comparison the

implementation of the EC recommendations and the EU targets regarding to the municipal waste landfilling in the Baltic States and the EU (average) show that success of EU-28, Estonia and Lithuania is significantly higher than in Latvia. The trends confirm the significant reduction of landfilled waste in the EU and above mentioned countries (significance level accordingly is $\alpha < 0.01$; $\alpha < 0.05$; $\alpha < 0.01$) has been achieved in the period 2011-2016 (Fig. 3). Latvia's progress is lagging considerably, comparing with others.
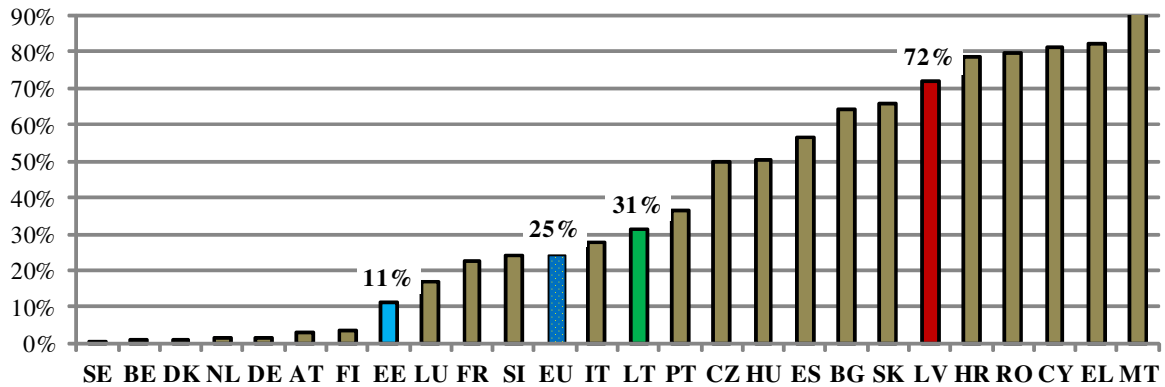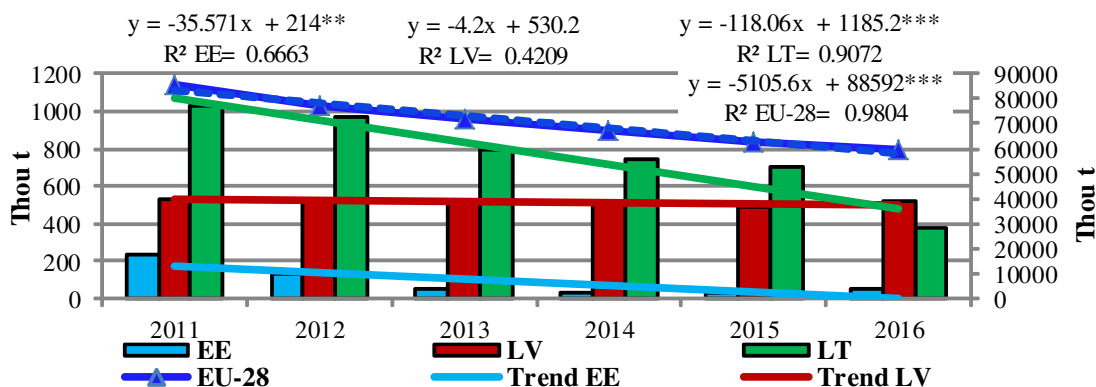

Fig. 2. **Rate of landfilled municipal waste in the EU Member States, 2016**

$y = -35.571x + 214**$
R^2 EE= 0.6663

$y = -4.2x + 530.2$
R^2 LV= 0.4209

$y = -118.06x + 1185.2***$
R^2 LT= 0.9072

$y = -5105.6x + 88592***$
R^2 EU-28= 0.9804

$** - \alpha < 0.05; *** - \alpha < 0.001$

Fig. 3. **Trends of landfilled municipal waste in the Baltic States and EU-28, 2011-2016**

A similar situation is observed for recycling of municipal waste. Latvia has the sixth worst place among the EU countries with 17 % rate of recycled waste (Fig. 4).
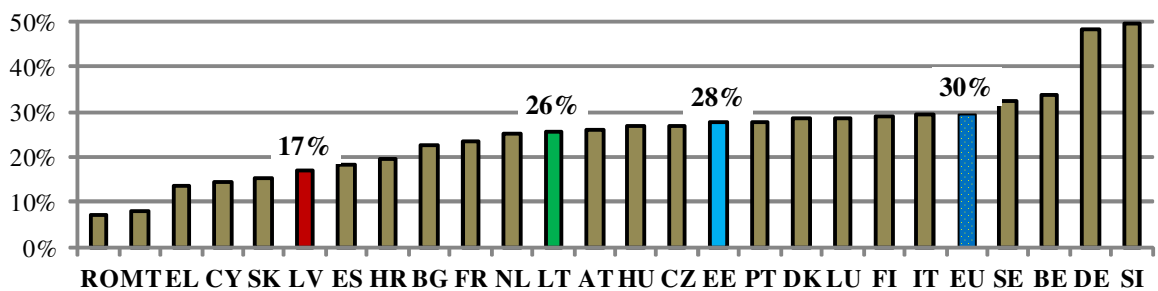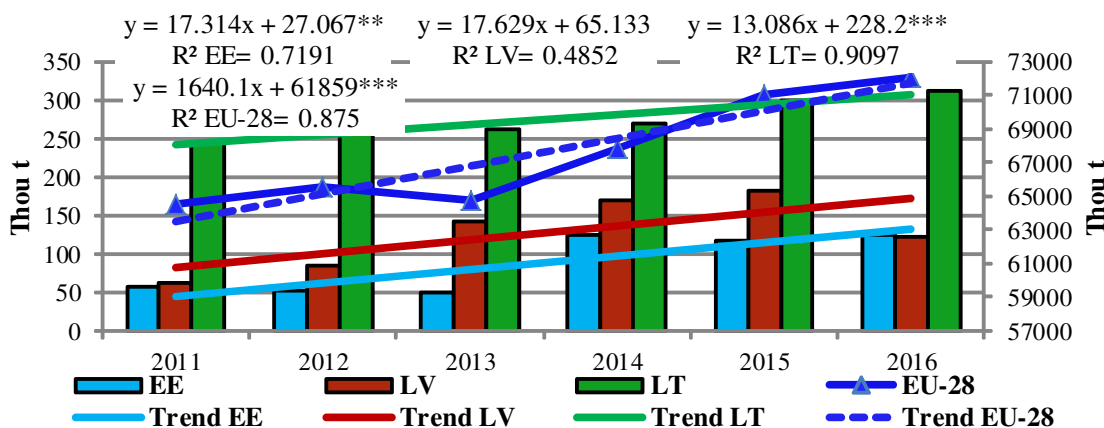

Fig. 4. **Rate of recycled municipal waste in the EU Member States, 2016**

Comparison of the trends among the Baltic States show the significantly growing trend of recycled municipal waste in Estonia and Lithuania, but lagging of Latvia (Fig. 5).

Although Latvia probably could receive the landfilled municipal waste target derogation [25], it is a huge challenge for Latvia's government and institutions to fulfil the target; at the same time strictly enforcing related regulations.

$$y = 17.314x + 27.067** \qquad y = 17.629x + 65.133 \qquad y = 13.086x + 228.2***$$
$$R^2\ EE = 0.7191 \qquad R^2\ LV = 0.4852 \qquad R^2\ LT = 0.9097$$
$$y = 1640.1x + 61859***$$
$$R^2\ EU\text{-}28 = 0.875$$

$** - \alpha < 0.05; \ *** - \alpha < 0.001$

Fig. 5. **Trends of recycled municipal waste in the Baltic States and EU-28, 2011-2016**

Households' attitudes and behaviour: results of survey

Waste sorting and separating is one of the most popular pro-environmental practices. Survey results show that the most active waste sorters are Valmiera residents – 71.9 %; in Liepaja – 59.2 %, but only 39.5 % in the national survey confirm that they sort the waste (Fig. 6).
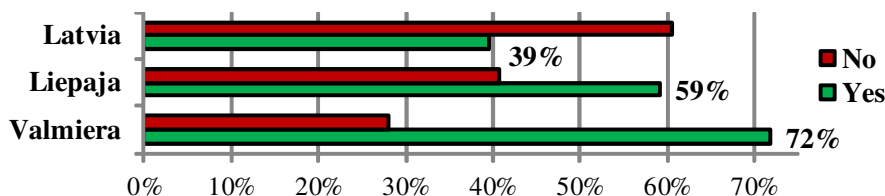

Fig. 6. **Households behaviour for sorting and separating solid waste, 2016**

The lack of appropriate infrastructure, particularly waste containers, as the main reason why the waste has not been sorted, is outlined by 55 % of national level respondents (Table 4).

Table 4

Reasons why Latvian households are not sorting waste

	Reason	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 It is not necessary	33	3.3	5.5	5.5
	2 It is cumbersome	102	10.1	17.0	22.5
	3 No containers	333	33.0	55.4	77.8
	4 Not thought about it	124	12.3	20.6	98.5
	99 Do not know	9	0.9	1.5	100.0
	Total	601	59.6	100.0	
Missing	System	408	40.4	-	-
	Total	1009	100.0		

More than 50 % of respondents, which are the residents of Liepaja and Valmiera, stress that lack of waste sorting containers is the main barrier for establishing eco-friendly behaviour – waste sorting (Table 5).

The data of the national level survey show that 17 % of households recycle (compost) bio-waste. This proportion is considerably less than other recycled non-hazardous waste types, which is separated by households. 29 % of respondents note that they separate glass, 28 % – paper, but 27 % – plastics [4]. The bio-waste composting is performed by the residents, which age is 35-64 years, mostly they are married and live in the household with more than two persons. Besides, 55 % of them live outside urban areas in single-family houses. Bio-waste composting is carried out by 37 % of the respondents, who live in single-family houses, and by 9 % – in flat buildings [4]. The respondents, which carried

out bio-waste composting, also more likely consider that their household is environmentally friendly – 65 %. Similarly, 88 % of the respondents – waste composters express a view that environment protection is very or rather important for them.

Table 5

Respondents' opinion (%) regarding necessary improvements to be made by municipalities in Liepaja and Valmiera

Necessary improvements	Liepaja	Valmiera
To provide better infrastructure, including waste sorting containers	53.4 %	50.7 %
Better arrangement of public transport	20.3 %	19.3 %
To implement sustainable consumption and to support households for it	48.6 %	20.6 %
Communication and more information how to do it	21.8 %	23.9 %
More monitored resources usage, and to stimulate households for changes	25.1 %	46.1 %

Conclusions

1. Despite some improvements, the necessary progress regarding the waste management in Latvia is not reached. The value of indicators or targets of Latvian municipal waste management – the rate of landfilled municipal waste and recycling rate of municipal waste, as well as trends of it, are still significantly below the EU average, also among the Baltic Sea region countries and other Baltic States. Besides, the bio-waste collection and treatment infrastructure is still not being developed.
2. Previous and current activities and efforts of government institutions are not effective enough for fulfilment of the EU recommendations and solving the shortcomings in the waste legislation due to the harmonisation with the EU requirements. Therefore, it is a huge challenge for Latvia for fulfilling their obligations and to achieve the targets adopted on global and EU level in the field of waste management, particularly municipal.
3. The findings of evaluation of Latvian households' attitudes and behaviour against waste management, based on the survey data, show controversial governmental and municipal environmental awareness and attitude to the waste management; households (residents) are more environmentally concerned. They have a relatively high level of pro-environmental behaviour regarding to the waste handling and sorting. Moreover, the sorting of waste is the most popular environmentally friendly household's practice. Besides, more than a half of households outlined the necessity of appropriate infrastructure – containers for separated waste disposal, which can encourage waste sorting.
4. Taking into account that the households *per se* and their awareness and attitudes are recognised as a key for the waste, particularly bio-waste (food waste), prevention and reduction, it is necessary to develop an appropriate intervention system with various programmes and measures, containing financial stimulus and educational, information and motivation programs, particularly for schoolchildren, as well as supporting the social networks, involving stakeholders, such as non-governmental institutions.

Acknowledgements

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