

WHAT ENCOURAGES HOUSEHOLDS TO SORT WASTE: EXTERNALLY ENABLED CONDITIONS, INTERNAL INCENTIVES OR ECONOMIC ENFORCEMENT?

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Abstract: *Municipal waste formation and management are contemporary issues in a modern world. Residents' participation is very important trying to utilize and recycle it because municipal waste is mainly generated by households'. For this reason, waste collection and sorting at home becomes crucial starting point solving problems created by waste. Aiming to examine what encourages households to sort waste we analysed following: (i) is it enough to create waste sorting system to encourage households to sort waste or (ii) waste sorting habits depend on lifestyle, environmental awareness and socio-demographic characteristics, or (iii) there is a need to introduce economic incentives to stimulate waste sorting. Theoretical analysis revealed that the main factors potentially affecting sorting habits are infrastructure at municipal level, economic instruments, socio-demographic characteristics and individual motivation. Empirical survey of Siauliai city households grounded on chi-square statistics and estimations of logistic regression showed that internal incentives and externally enabled conditions highly impact households' waste sorting behaviour. Moreover, results of the research clearly show that economic incentives embedded into existing waste management system are not strong enough to shape households' behaviour.*

Keywords: *Municipal Waste, Waste Sorting Determinants, Infrastructure, Awareness, Motivation, Logistic Regression.*

JEL Classification: *C39; Q53, Q58.*

Introduction

Waste formation and management are among the main problems in a modern world and the importance of taking appropriate care of waste has been discussed for a long time. The purposeful management of waste based on social, economic and environmental aspects is one of the main conditions of harmonious development, trying effectively and economically to use environmental resources, reducing environmental pollution, increasing the health level of a society and improving the quality of life.

There are no existing habits of waste sorting in Lithuania; however, the system allowing sorting waste has already been formally created. The European Union, Lithuanian Government and Municipalities spent a lot of money to develop waste collecting systems. The containers are built by the apartment blocks, private houses, roadsides, rest stops and elsewhere. However, the everyday waste collection and especially recycling have not been yet fully implemented, because the amount of recycled waste is extremely low.

Active residents' participation is important in waste utilizing and recycling system because its foundations are household waste collection and sorting, which are preferably carried out at the place of formation that is home. In order to implement it successfully, benevolent society's participation is a must, which depends on certain factors. And here it is important to clarify – is it enough to create waste sorting system to encourage

households to sort waste or perhaps habits depend on lifestyle, environmental awareness and socio-demographic characteristics, or maybe there is a need to introduce economic incentives to stimulate waste sorting. Generalizing the abovementioned, the paper aims to determine to what extent externally enabled conditions, internal incentives and economic enforcement influence households' decision to sort municipal waste.

The rest of the research is organised as follows: Section 2 presents theoretical background of factors determining households' waste sorting habits. The background of the methods, model and variables used in the analysis are explained in section 3. Section 4 presents the results of empirical analysis and section 5 concludes the paper.

1 Theoretical background of waste sorting determinants

Research on waste sorting determinants has been in focus for the last decades (see Tab. 1), but there is no unanimous opinion for this question. The main argument is that it is difficult to rate the actions and motives of individuals due to a variety of determinants, which usually are not related to waste or environmental protection.

Tab. 1: Summary of determinants for household waste sorting

Determinants	Indicators	Source
Infrastructure at municipal level	Average distance to collection sites	Jesson, 2009
	Type of containers	Burnley, 2007
Economic instruments	“Pay as you trough” system	Reichenbach, 2008; van Beukering et al., 2009; Huang et al. 2011; Ulfik, Nowak, 2014
Socio-demographic	Education level	Benítez et al., 2008
	Degree of urbanization	Johnstone, Labonne, 2004
	Household size	Johnstone, Labonne, 2004; Martin et al., 2006; Benítez et al., 2008; Abdoli et al., 2011
	Households income	Monavari et al., 2012
	Age	Martin et al., 2006; Vicente and Reis, 2008
Individual motivation (environmental concern / awareness)	Moral norms	Visschers et al., 2016; Kirakozian, 2016; Czajkowski et al., 2017
	Culture	Crociata et al., 2015
	Group feedback	Abrahamse et al., 2007; Carrico, Riemer, 2011

Source: Authors' analysis based on the literature listed in the table.

According to research the person's choice to sort and comply with required municipal waste management rules depend on the complex of multiple social factors, but they can be divided into three main groups.

The primary and necessary condition for waste collection is sorting **infrastructure**, for which to implement the financial resources are needed. Ordonez et al. (2015) emphasize that sorting infrastructure has to be designed for the user. Following the logic “sorting by possibility”, waste sorting infrastructure becomes necessary objective

condition to execute the waste sorting (Hage et al., 2009). This is the position followed by the structural paradigm representatives (Spaargaren, 2011), who claim that infrastructure is one of the most important factors in environmental habits.

Individual motivation (environmental concern / awareness). Each technological innovation, each infrastructure operates successfully only when the majority of its participants positively appreciate it and participate in various activities organised by institutions. Only timely presented, reasoned, objective, science-based and easily accessible environmental information is an assumption which affects society's change and civil activity. Research (see Tab. 1) also show that it is important to consider which social impact approaches are appropriate to various groups of society.

According to Adomavičiūtė et al. (2012), willingness to sort can be based on motivation, which can be divided into internal and external. Internal motivation and behaviour are based on personal opinion, understanding and self-respect. Also the part of internal motivation is considered to be an approach to the environment (discussed above). External motivation is based on someone's or something's impact, for example, it could be **economic factors**, such as increased taxes.

Studies (see Tab. 1) have revealed that household's decision to sort municipal waste influenced by socio-demographic factors of household's head, such as age, education and income. The approach to waste sorting under different age groups was examined – younger people are more open-minded to ecological ideas, while older people are more oriented to the purpose, however to accept eco-friendly (sorting precisely) ideas as desirable and suitable for them, they are hesitant as easily as younger people (Martin et al., 2006). In terms of gender – women are more environmentally responsible and more inclined to sort than men. Education and workplace – people with higher education and better job position are more environmentally responsible and tend to sort more it can be said that public values are considered to be the main sorting motivation factor and the significant influence on their realization has various objective determinants, such as infrastructure, information and others.

2 Data and research methods

The research was conducted in Siauliai city and its object was households. The data was collected (from 2017 October 1 to November 15) using an online questionnaire with estimated sample size (Barlett et al. 2001):

$$ss = \frac{Z^2 \cdot p \cdot (1-p)}{c^2} \quad (1)$$

where ss – sample size; Z – Z value (we used 1.96 for 95% confidence level); p – percentage picking a choice (we used 0.5 for sample size needed); c – confidence interval, expressed as decimal (we used 0.05 = ±5%).

Because our population is finite (according to data of Statistics Lithuania, on December 31, 2016 there were 42 843 households in Siauliai city) we corrected our sample for finite population:

$$css = \frac{ss}{1 + \frac{ss-1}{pop}} \quad (2)$$

where pop – population size.

It was estimated that at least 396 heads of households have to be interviewed and 409 participated in the survey. We used non-random assignment to the sample. This way of collecting data could potentially lead to biased sample when certain groups from the population would be over-represented or under-represented. Tab. 2 provide information do the main characteristics of the sample correspond to characteristics of the population and it can be stated that sample reflects the characteristics of the total population.

Tab. 2: Socio-demographic characteristics of sample and population

Socio-demographic characteristics of household's head		In sample, %	In population, %
Gender	Male	42	44
	Female	58	56
Age	18 – 30	50	35
	31 – 40	15	20
	41 – 50	14	18
	51 – 60	13	15
	Over 60	8	12
Education	Secondary education	10	8
	Vocational school diploma	21	25
	Higher education	69	67
Family status	Single	32	35
	With family	68	65
Social status	Pupil, student	17	19
	Employed	67	60
	Unemployed	4	5
	Housekeeper	4	4
	Retired	8	12
Income per head	Up to 400 Eur	29	32
	400 – 800	56	55
	Above 800	15	13

Source: own calculations based on survey and data of Statistics Lithuania December 31, 2016

We employed cross-tabulation to show the relationship (or lack thereof) between two variables. In all cases one of the variables is households' waste sorting habits (considered as outcome variable) and other approximates externally enabled waste sorting conditions or environmental awareness of household's head, or economic incentives to sort waste (considered as cause variable). Although there could appear to be some relationship between the cause and outcome analysing cross-tabulation graphically, to have stronger evidence that the observed relationship is anything more than random variation a number of tests could be applied. One of the most commonly used tests is chi-squared. The advantage of this test is that it is appropriate for almost any kind of data. Pearson chi-squared tests null hypothesis that the variables are

independent. The lower the p-value, the less likely it is that the two variables are independent (unrelated). In case when the p-value is lower than 0.05, the two variables are related.

Abovementioned test will be applied in the first part of the research to determine how externally enabled conditions are related with households' waste sorting habits. These factors later will be used as control variables in the model to determine what socio-demographic characteristics of household's head are important while deciding to sort or not to sort waste. We will employ binary logistics regression because our outcome variable is categorical for estimating the model that links household's waste sorting habits with their head's socio-demographic characteristics (see Tab. 2) and controls externally enabled conditions.

Nevertheless logistic regression is similar to a linear regression model, but is more suitable to model where the dependent variable is binary. We also will be able to use logistic regression coefficients to estimate odds ratios for each of the independent variables in the model. Besides, logistic regression is applicable to a broader range of research situations and more flexible.

The regression model for our empirical estimations is composed as follows:

$$P(Y) = \frac{e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_6 X_6 + cC + \varepsilon)}}{1 + e^{(\beta_0 + \beta_1 X_1 + \dots + \beta_6 X_6 + cC + \varepsilon)}} \quad (3)$$

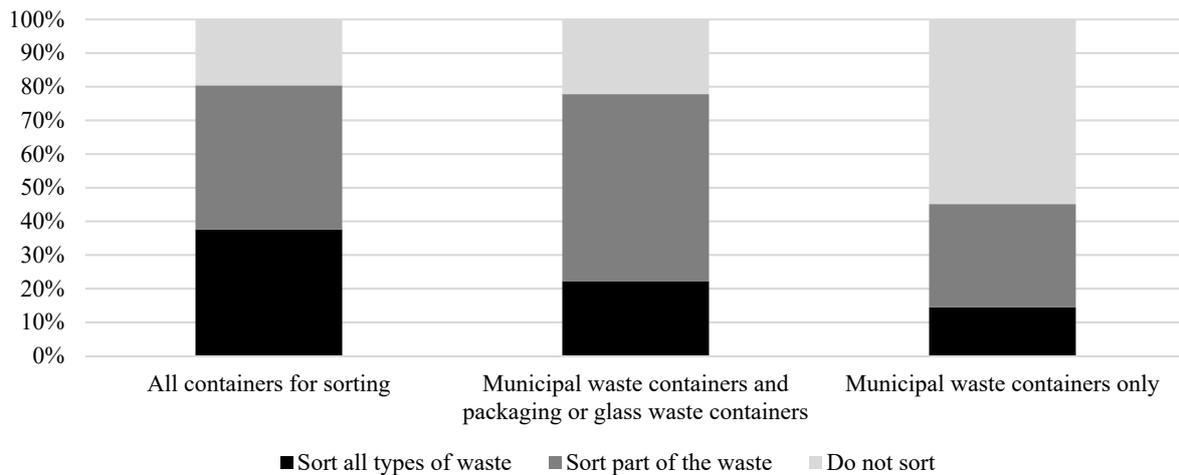
where $P(Y)$ is a probability that household will fully or partly sort waste, a situation when household does not sort waste at all in the model is considered as the benchmark value. x_1, \dots, x_6 marks all six independent variables, i.e. characteristics, starting from family status (see above). C characterises a vector of variables that we might like to control in our model. β_1, \dots, β_6 and vector c as usual marks the regression coefficients, giving information how strongly and in which direction independent variables affect the odds ratio of the dependent variable, and ε stands for error term.

3 Empirical results and discussion

3.1 The influence of externally enabled waste sorting conditions

Results of the analysis show that availability of containers for sorting is strongly associated with households' waste sorting habits. 37.6% of households sort all types of waste and just 19.6% do not sort at all if all containers for waste sorting are available. If municipal waste containers are available, just 14.5% of households are fully involved in waste sorting and 54.8% do not sort at all. Direct relationship between variety of containers available for sorting and increasing probability for a household to sort waste is uncovered in Fig. 1. Strong relationship between two cross-tabulated variables is also proved by very low p-value of chi-squared test (<0.001).

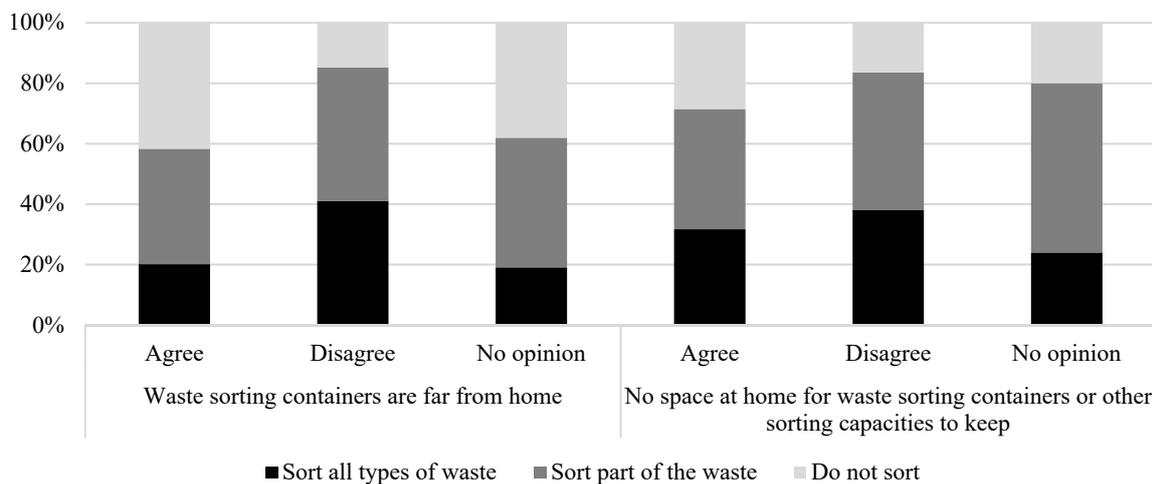
Fig. 1: Availability of containers for waste sorting and waste sorting habits



Source: own calculations based on survey

Another important factor that is related to externally enabled waste sorting conditions is location of waste sorting containers. Uncomfortable (far from home) placement of containers discourages households to sort waste. 14.9% of household does not sort waste if waste sorting containers are nearby and 41.7% if they are far away. Direct relationship between how far away from home are waste sorting containers and probability to sort waste is presented on the left side of Fig. 2. P-value of chi-squared test linking these two variables is small and indicates that they are statistically related.

Fig. 2: Agreement with the statements regarding waste sorting conditions and waste sorting habits



Source: own calculations based on survey

We could also hypothesize that conditions at household level (e.g. availability of place at home to keep separate containers for waste sorting) could be also related to their waste sorting behaviour. Nevertheless that distribution in terms of waste sorting behaviour is slightly different between households that agree and disagree with the statement “There is no space at home for waste sorting containers or other sorting capacities to keep”, they are too small to be statistically significant (p-value of chi-square test is 0.099).

The abovementioned findings are also confirmed by households' answers to the question "What, in your opinion, would encourage waste sorting?" An absolute majority highlighted the importance of properly installed waste sorting sites and convenient places for waste sorting containers. Household also pointed out importance to use stickers on sorting containers with the exact information about waste sorting. All those are closely related to waste management system that is organised at municipal level.

3.2 The importance of socio-demographic characteristics and environmental awareness

In this section we provide analysis results of socio-demographic characteristics' influence on decision to sort waste after controlling externally enabled conditions, which, as previous analysis already revealed, are very important. We estimated several models using different sets of household head's socio-demographic characteristics to minimize probability of collinearity, because a lot of socio-demographic characteristics potentially correlate with each other (for example, age and education level, age and social status, education and income level and etc.). We think that just gender and family status are uncorrelated. Tab. 3 presents estimation results.

Tab. 3. Estimation results

Factors in the model	Estimated β coefficient when dependent variable is probability to sort (fully or partly) waste (benchmark group – does not sort at all)			
	(I)	(II)	(III)	(IV)
Constant	-0.388	-0.613	-1.128**	-1.653*
Living with a family	0.532**	0.487*	0.454*	0.249
Female	0.313	0.316	0.458*	0.457*
Education level				
vocational school diploma	-0.755			
higher education	-0.869			
Income				
400 – 800		-0.488		
above 800		-0.452		
Business				
unemployed or housekeeper			-0.20941	
retired			2.081***	
Age				
from 31 to 40				0.280
from 41 to 50				1.536***
from 51 to 60				1.015**
61 and above				2.630***
N	409			

Factors in the model	Estimated β coefficient when dependent variable is probability to sort (fully or partly) waste (benchmark group – does not sort at all)			
	(I)	(II)	(III)	(IV)
McFadden R-squared	0.134	0.132	0.151	0.186
Likelihood ratio test: χ^2	62.006	61.058	69.529	85.698
p-value	<0.001	<0.001	<0.001	<0.001

*, ** and *** indicates significance at the 10, 5 and 1 percent level respectively.

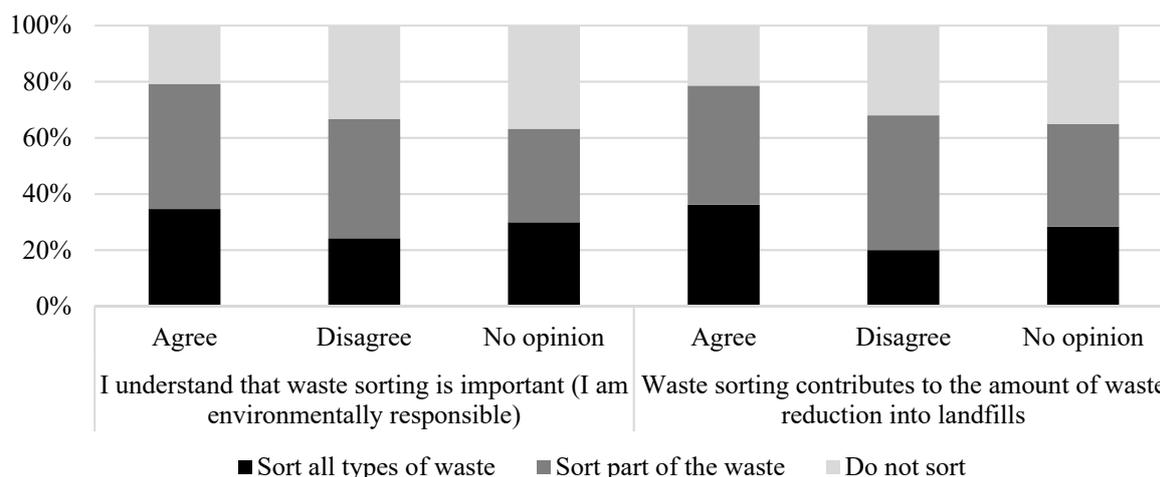
¹Benchmark group – Municipal waste containers only. ²Benchmark group – No opinion.

Source: own calculations based on survey

All estimations (I-IV) revealed that after controlling externally enabled conditions for waste sorting (additional factor included in all estimations, but not listed in the table) household's waste sorting habits depend just on two analysed characteristics of household's head – employment status and age. It should be mentioned that both of them are closely related, because just retirement status statistically significantly increases probability to sort waste and that status is strongly linked to age. For a retired head of household there is 8 times more likely to sort waste than for pupils, students and employed. Increase in age is also linked with higher probability to sort waste – for a household with a head from 41 to 50 is 4.6, from 51 to 60 is 2.6 and from 61 and older is 13.9 times more likely to sort waste than for household with a head less than 30 years old.

Another characteristic that is strongly related to personality and potentially correlates with waste sorting habits is environmental awareness. Fig. 3 shows the results of cross-tabulation between household's head environmental awareness and waste sorting habits.

Fig. 3. Agreement with the statement regarding environmental awareness and waste sorting habits



Source: own calculations based on survey

34.6% of household with a head that treat themselves as environmentally responsible sort all types of waste and 20.8% do not sort at all. On the contrary, on third of those who state that they do not identify themselves as environmentally friendly, do not sort waste and almost one fourth sort all types of waste. Nevertheless, the differences in distribution regarding waste sorting habits between households that head identify or not themselves

as environmentally responsible are not very big (as we can see on the left side of Fig. 3), chi-square identifies them as statistically significant (p-value is equal to 0.023), i.e. environmentally responsible behaviour is inseparable from waste sorting. Similar results we also observe in case of answers provided to other question used to identify environmental awareness (see right side of Fig. 3). If we proxy environmental awareness by understanding that waste sorting contributes to the amount of waste reduction into landfills, it is directly linked to higher probability to sort waste – 36.1% of households with environmentally concerned head sort all waste, and if not – 20%. P-value of chi-square linking these variables is equal to 0.035, indicating that relationship exists.

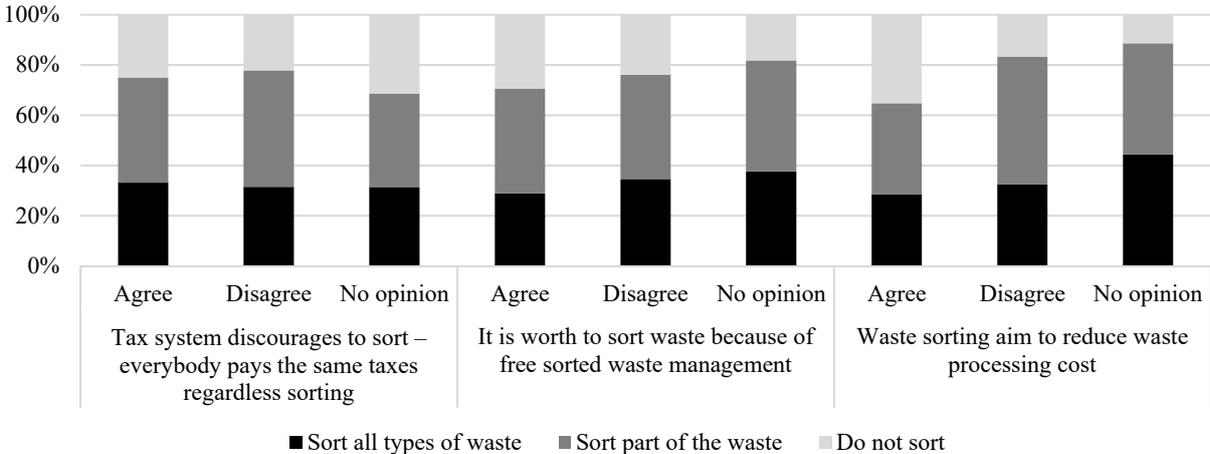
To conclude, after controlling externally enabled conditions for waste sorting, environmental concern of household’s head still remains important factor that encourages to sort waste. It could explain cases, when people sort waste even if there are no right conditions created for that. Waste sorting remains time-consuming activity – business (and that is in inverse relationship with age) decreases probability to sort waste.

3.3 The importance of introducing economic incentives

Previous studies (see Tab. 1) show that economic factors, such as taxation, i.e. differentiated tax for households upon waste sorting, introduce economic incentives for households to change their behaviour regarding waste sorting. To reveal whether head of household understand the economic usefulness of waste sorting, that leads to lower waste processing cost, and whether collectively funded waste sorting system encourage them to participate in this process, we aim to investigate how subjective opinion of household’s head regarding economic factors correlates with households’ behaviour.

The analysis of the results shows that economic incentives embedded into existing waste management system are not strong enough to shape households’ behaviour. Agreement with the statement that existing tax system discourages to sort because everybody pays the same taxes regardless sorting does not correlate with households’ sorting habits (see left part of Fig. 4).

Fig. 4: Agreement with the statement regarding economic factors and waste sorting habits



Source: own calculations based on survey

P-value of chi-square test that links these two variables is 0.874. Understanding that waste management system is collectively funded and it is free to join it does not encourage

household to sort waste – distribution of their waste sorting behaviour is not linked (see middle part of Fig. 4) with the agreement with the statement that “It is worth to sort waste because of free sorted waste management” (p-value of chi-square test is 0.344).

Understanding that waste sorting aims to reduce waste processing cost is linked with households’ waste sorting habits (p-value of chi-square test is <0.000), but what is surprising – agreement with this statement reduces probability to sort waste (see right part of Fig. 4). It could be explained by taking into account that households share part of waste sorting cost, i.e. it is time consuming process that needs extra space at home and households that sort waste recognise that as incensement in waste processing cost.

Answers to the question “What economic factors, in your opinion, would encourage waste sorting?” show, that households relatively disagree with the idea to fine households for not sorting – just one third of households think that such policy would be useful. What is surprising here, that households that do not sort waste are not more strict against fining compared with others. Much more acceptable policy for the households would be lower tax for people who sort waste. About two thirds of households agree with that and this part does not vary much regarding waste sorting habits, i.e. even those who do not sort waste think that such policy would be encouraging.

Conclusions

Public values are considered to be the main waste sorting determinant and various others, such as infrastructure, awareness and motivation have significant influence on their realization. The main and primary waste sorting condition is municipal waste collection and sorting infrastructure. The next necessary step is information provided to the population about the municipal waste management and collection rules. After all, the formation of the environmental regulations and motivation to manage municipal waste are important.

The survey of determinants, influencing households to sort or not to sort municipal waste, revealed that in Šiauliai city households are influenced by externally enabled waste sorting conditions, such as infrastructure and this is related to implemented waste management of municipality. This view is also supported by the researches of Jesson, 2009, Abdoli et al. (2011), Ulfik, Nowak, 2014, Ordonez et al. (2015). Analysing socio-demographic characteristics of household’s head it can be said that only two examined characteristics – employment status and age influence the sorting habits of households. Environmental awareness increases probability to sort waste, i.e. environmentally responsible behaviour is inseparable from waste sorting. The results of the research come in line with previous researches that state that recycling is the personal responsibility of each person (Vicente, Reis, 2008; Adomavičiūtė et al., 2012; Abrahamse, Steg, 2013; Crociata et al., 2015; Visschers et al., 2016; Kirakozian, 2016; Czajkowski et al., 2017).

The analysis of the results clearly shows that economic incentives embedded into existing waste management system are not strong enough to shape households’ behaviour. So it can be stated that internal incentives and externally enabled conditions, such as infrastructure of containers have higher impact on municipal waste sorting behaviour in Šiauliai city than economic enforcement.

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