

PAPER • OPEN ACCESS

Waste sorting acceptability with information provision

To cite this article: O S Ketkina 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1045** 012029

View the [article online](#) for updates and enhancements.

You may also like

- [Values in the backyard: the relationship between people's values and their evaluations of a real, nearby energy project](#)
Goda Perlaviciute, Robert Görsch, Marieke Timmerman et al.
- [Acceptability of cookies substituted with moca flour and varied with red bean flour and herbal chicken gizzard](#)
M Agrifina, Jumirah and Z Lubis
- [Intervention levers for increasing social acceptance of conservation measures on private land: a systematic literature review and comprehensive typology](#)
Louis Tanguay, Jean-François Bissonnette, Katrine Turgeon et al.

Waste sorting acceptability with information provision

O S Ketkina

Ural Federal University, 19 Mira street, Ekaterinburg, 620002, Russia

E-mail: o.ketkina@urfu.ru

Abstract. To decrease the environmental degradation due to increasing amount of municipal solid waste the Ecology National Project was implemented in Russia. Its main goal is to increase recycling and liquidate all unauthorized landfills within the urban borders. While the key objective of the project is to ensure ecological improvement and to amend environmental situation in Russia its public acceptability and awareness is under question, especially in rural communities. The paper analyses rural waste management reform in small rural town in region (Sverdlovskaya oblast). The main focus is on peoples' knowledge, acceptability and perceptions of the reform and its components, especially separate waste collection.

1. Introduction

It is only in the last twenty – twenty five years that changes in production and distribution patterns have increased waste, mostly plastic which lead to environmental pollution of land and water. The use of plastic has increased tremendously and accounts for 40% of municipal solid waste in Russia. For rural regions this figure is even bigger since in private houses people usually do not generate food and paper waste, the first is usually used to feed animals (gooses, chickens, pigs et al) or as a compost for soil, the paper is used to stoke the fire [7]. Many studies underline that main purpose of lately implemented changes in waste management regulation in Russia is to increase recycling of the waste, that is to reuse it in some way [12], especially plastic which amount is growing faster than the economy [6].

While many of studies examine efficiency of Russian municipal solid waste management, rubbish protests [2], study ways to improve Russian MSW management system (reduce landfill, increase recycling, reduce or prevent waste) using circular economy criteria [11] none of them up to my knowledge evaluated people's knowledge, acceptance and perception of effectiveness of different ways of waste collection/submission and utilization in small rural communities in Russia.

The widespread preference for submitting waste as a whole (without sorting) most probably indicate that people do not understand that if the waste is not sorted at home then the share of waste that could be sorted and further recycled became smaller (for example, paper from the waste would be too dirty to be recycled) and it also less probable that the waste would be sorted later. Since “waste operator” prefer to work with preliminary sorted waste to resort it and deliver to recycling companies.

The idea behind research is that if people know more on waste management they will be more ready to sort the waste. This paper approach is to examine how prior knowledge and information provision about waste management organization affect acceptability of waste sorting and perception of effectiveness of different waste utilization schemas.

Research includes providing people with detailed information on waste management schemas and examining the impact of providing information on peoples' acceptability and perception of effectiveness of waste sorting.



Content from this work may be used under the terms of the [Creative Commons Attribution 3.0 licence](https://creativecommons.org/licenses/by/3.0/). Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.

For this purpose we conducted a field experiment among citizens of a small town in region (Sverdlovskaya oblast) ($N = 105$) about their perceptions of and attitudes to different types of waste collection and utilization.

2. Materials and methods

Small-scale field experiment was conducted. We performed interviews among citizens of small town in region (Sverdlovsk oblast), ($N = 105$), the participants were over 18 years old. We asked people about their knowledge on, perception and attitudes to waste management reform and to different types of waste collection and utilization. To test the effect of information provision, we split the sample for two groups control and treatment. Treatment group was given a short text explaining how the waste management is organized and what are the incentives for the waste operators for recycling, and also about harmful effect of polygons and garbage incineration factories. The quotas on age, gender, education, summer residents, permanent residents were introduced to ensure similarity among treatment and control groups. In addition, we tested that these samples do not differ on other covariates, such as mean value of self-perceived knowledge and assessed knowledge. The data was collected by the author in a small town in region (Sverdlovskaya oblast) in February 2022. To achieve a representative sample were used quotas on age and sex in the following format. Since the town contains permanent citizens and summer residents the whole sample was split into two parts according to number of houses in the town which belong to these two groups, as a result 36% of the houses were attached to summer residents and 64% to permanent citizens. The group of permanent citizens was quoted according to national statistics on shares of citizens in rural regions by sex and age. The rest 36% of respondents were collected by random draw from the houses of summer residents. Due to COVID - 19 restrictions most of the summer residents were living in the town, and majority of them use dacha as a permanent place to live due to possibility to work on-line. The final sample for summer residents is close to national statistics on shares of citizens in cities by sex and age with exception of more respondents in more mature age groups from 40 and older, and less in more young group. That could be explained by the fact that dacha is an extra house and it is usually obtained after purchase of a flat and it could be afforded by more mature people who already have a flat in a city and want some additional place for rest.

The survey addressed the following research questions: (1) how do knowledge and information provision about waste reform influence people's decision to participate in sorting waste at home (their acceptability of waste sorting). (2) How these information impact respondents' acceptability of different types of waste collection (a) as a whole, without sorting; (b) as a whole but submitting to a garbage their it would be sorted by a person who lives nearby; (c) sort waste at home and put it into different bins; (d) sort waste at home and deliver it to different firms which except different types of waste (plastic, paper, metal, glass, et al); (e) sort waste at home and submit it to collector who come at specified time and collect waste at the town. (4) How these knowledge influence respondents' acceptability of new tariffs on waste collection; (5) and perception of effectiveness of different types of waste utilization (storing on polygons, burning and sorting and further recycling).

The sample was divided into two equal by size subsamples, the first group was provided information explaining the functioning of waste management in the region and the key steps of the "waste reform" (project Ecology), the second group did not receive this information.

The survey includes five main sections. In the first section the respondents were asked to evaluate their self-perceived knowledge about "waste management reform", after that they were assessed their actual knowledge based on their answers to five true/false statements about "waste management reform". Since there was no scale of "waste management reform" knowledge available in the literature, five question were designed to evaluate peoples knowledge: all five were about key ideas of waste management reform. In the second section, we asked people to evaluate effectiveness to preserve the nature by the means of three different types of waste utilization (to collect separately and recycle, to burn, and to keep on polygons) and also asked how they consider it may affect them personally. The responses were very ineffective / ineffective / indifferent / effective/very effective for

the first question and I/We would be much worse off/ .. some worse off /... indifferent /...some better off / ... much better off for the second question. In the third section we asked people about acceptability of the current price for waste collection. And also on trust in politicians in implementing suitable waste utilization approaches to preserve the nature the most. In the fourth section we introduced participants with five different ways of waste collection:

- To collect waste all together and submit it as a whole in one bin;
- To collect waste in one bin and submit it to a garbage where the trash is sorted by a person who collect paper, metal and glass and submit them separately;
- To collect waste at home in separate bins and submit it in separate bins at garbage in the town;
- To collect waste at home in separate bins, and by themselves arrange submission of waste to collectors for money;
- To collect waste at home in separate bins and to submit each type of waste to a special service which come to the town at specified time at defined day.

Then we asked participants to comment on their acceptance of these five different ways of waste collection. The 5-point scale of acceptability is commonly used in the literature on people's attitudes to climate policy [5]. We believe that types of waste collection submission has significant impact on climate since it has an impact on the total volume of waste being burned, hold on polygons or recycled, which in turn have an impact on ecology and climate. Therefore, we consider 5-point scale of acceptability as appropriate instrument for our research. Some studies use a dichotomous variable mirroring a ballot decision which particularly makes sense for countries where the political system follows such a procedure. In our case, Russia, such ballots seldom take place at the national level, therefore, we chose 5-point scale.

To conclude the survey we asked respondents on their socio-demographical characteristics such as education, income level, number of family members, experience of living abroad, whether or not they have a flat in a city, et all.

Through the paper a Kruskal-Wallis rank-sum test was used to check for statistical differences of means. In our case it is more appropriate than ANOVA since it does not require the data to be normally distributed. Moreover, it is applicable for not big samples, as in our case.

In order to examine how waste sorting acceptability and effectiveness relate to knowledge, provided information, demographical characteristics of respondents, their attitudes to other ways of waste collection logit regression models were estimated

Key fact about the town. The total number of citizens according to official statistics is around 750 people, during summer period the figure rise to 1400 due to recreational attractiveness. It's located on the shore of a pond. The dwellings of the town include private houses and three two-storeyed houses.

3. Results

Effects of knowledge and provision of information on waste reform. First, we evaluate assessed knowledge (based on question 2 of the survey) and self-perceived knowledge (question 1) of respondents. Only correct responses were counted to get the indicator of assessed knowledge. Most of respondents, around 84% of the sample, replied correctly to statement 3 (with the waste reform introduction one of the vital element of working with waste become waste sorting) and to statement 5 (the main idea of the waste reform is to increase the share of recycling at such a level that burned will be only waste which could not be recycled). The smallest number of correct answers, 11% of the sample, were provided on statement 4 (waste management reform assume introduction of universal approaches to waste collection). The result is shown in figure 1 and figure 1a. To measure self-perceived knowledge we asked people about their knowledge on waste reform, their responses ranged from "Not at all" to "know very much" on 5-point scale. The results are present on figure 1b. Majority of respondents perceived themselves to have somewhat, little or no knowledge at all on waste reform.

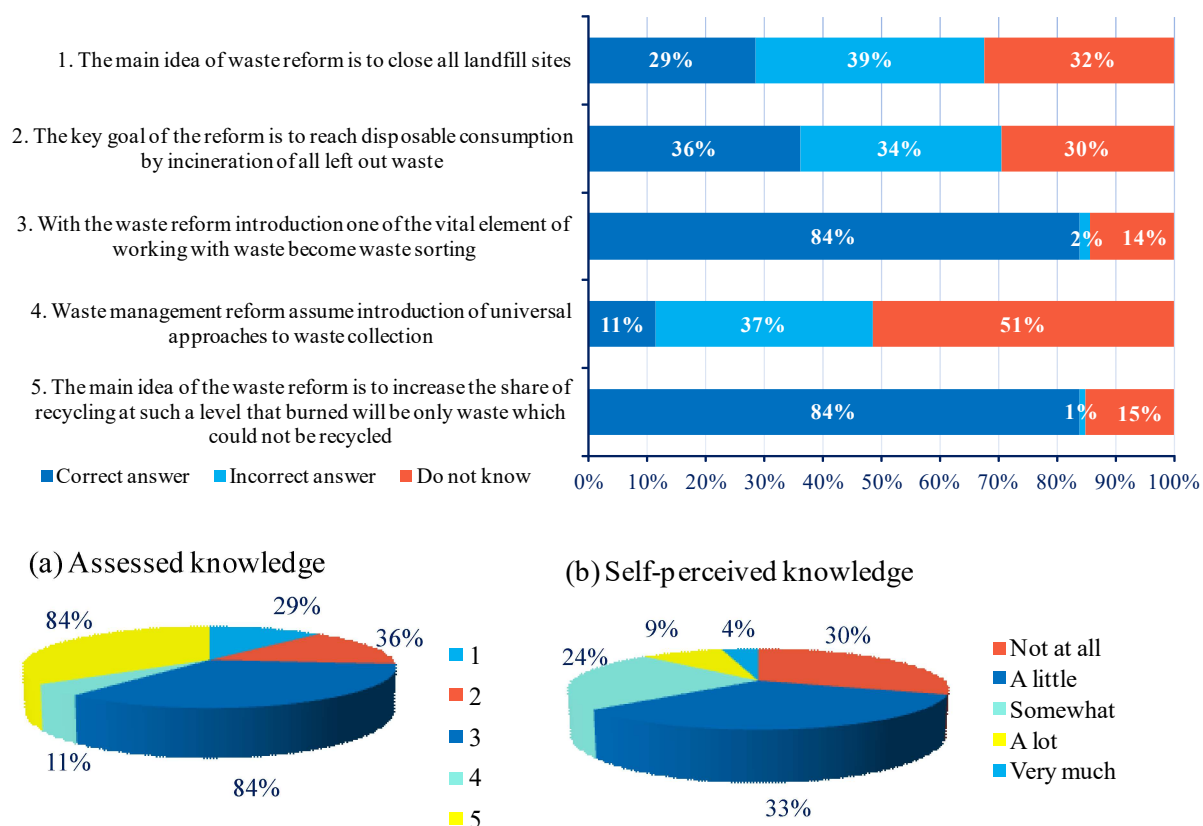


Figure 1. Assessed and self-perceived knowledge.

Further, were compared assessed knowledge and waste sorting acceptability between two subsets of respondents – those who did and who did not receive the information on waste management reform. The results are shown in figure 2. (red dots for informed respondents, blue for uninformed). On the figure are average values and error bars depicting ± 2 s.e. Acceptability take values from 1 – completely unacceptable to 5 – completely acceptable. At the bottom of each figure are p-values of Kruskal-Wallis rank-sum test for statistical differences between two subsets (informed and not informed).

The information on waste reform explains that waste sorting is the best alternative among three ways to work out the waste namely keeping waste on polygons, waste burning and waste sorting. The results signify that respondents receiving information on waste reform tend to have a high probability (if compared with not informed) to accept separate waste collection, especially those who originally have relatively low assessed knowledge, i.e. with levels 1 and 2. There is a significant difference at 5% significance level between subsets of informed and uninformed people according to Kruskal-Wallis rank-sum test [6] (p-values are stated at the bottom in Fig. 2). Providing information does not influence respondents with relatively high assessed knowledge, levels 3 and 4, possibly because with this level of knowledge respondents already accept the idea to sort the waste at home before submission and additional information could not make better off (could not increase their accessibility of the idea to sort waste at home). For two groups of respondents – informed and not informed the average level of waste sorting accessibility is equal to 4,86 and 4,75 for level 3 and 4,93 and 4,63 for level 4. For very low (with number right answers equal to 0) and very high (all 5 right answers) assessed knowledge there are only few observations which is not enough to assess any significant difference.

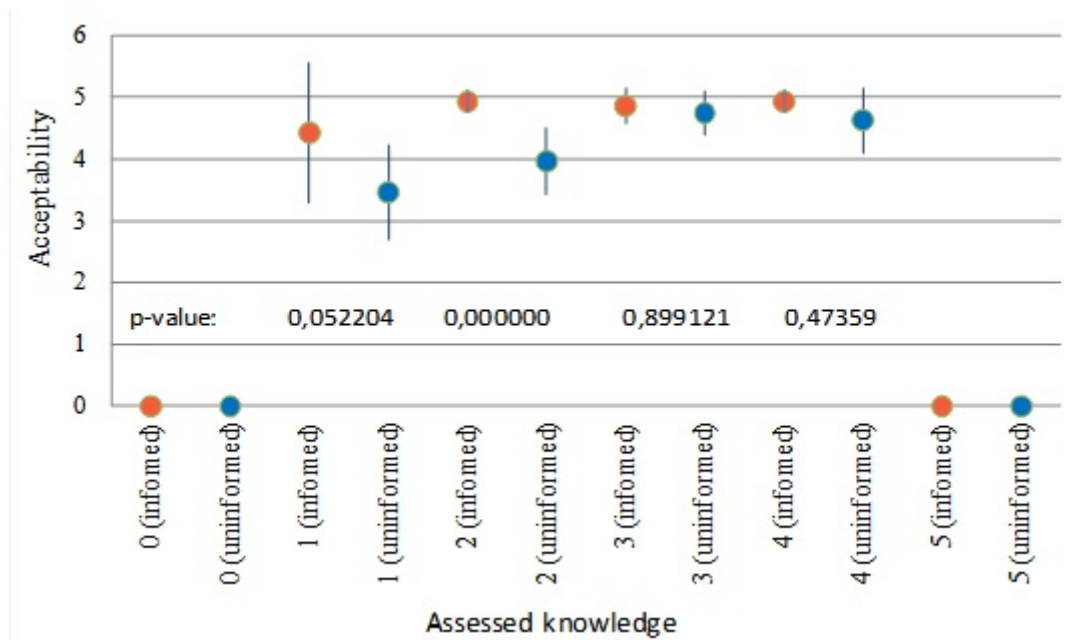


Figure 2. Relation between assessed knowledge and acceptability of waste sorting for two groups of respondents: provided and not provided with information on waste reform.

Next were tested different ways of waste collection to define which of them is the most acceptable and how it depends on whether or not respondents perceived information. The results are presented on figure 3. Average values are stated as dots and error bars depicting ± 2 s.e, in blue color are results for uninformed respondents and in red for informed. Acceptability takes values from 1 – completely unacceptable to 5 – completely acceptable. At the bottom of each figure are p-values of Kruskal-Wallis rank-sum test for statistical differences between two subsets (informed and not informed respondents).

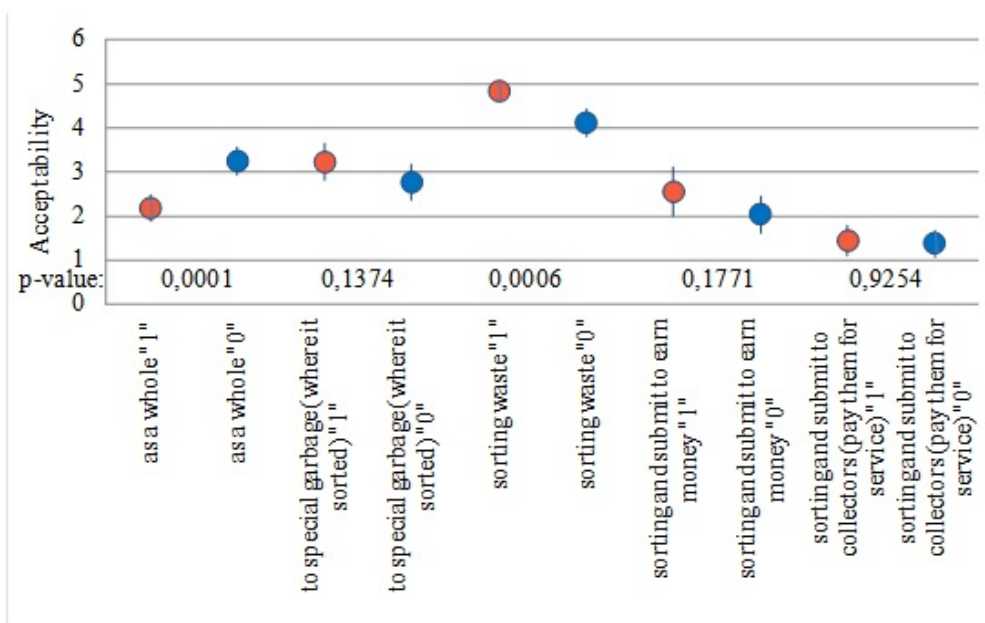


Figure 3. Effect of information provision on acceptability for different ways of

waste collection.

The most acceptable option for both groups of respondents (informed and uninformed) is “sorting waste at home and submit it into separate bins at garbage place” with significantly high acceptability of this option for informed respondents (with mean value equal to 4.85). The only option which is not attractive for both groups is to collect sorted waste at home and then to submit it to collectors at some specified time, and this service it paid by the customers. For this option there is no statistically significant difference between informed and uninformed respondents. Most of participants mentioned that it is not appropriate way of waste collection since you can't be sure that the collector will come in time and you always attached to the house and should wait for the garbage collectors to come. Moreover, in the town it is not appropriate to live the waste at the road since there are a lot of dogs and they do mess of the left garbage. The option “submit waste as a whole without sorting” is more acceptable for uninformed people, for them it is the second best choice.

Majority of summer residents (80%) and high income respondents (82%) select waste submission to a special garbage (additionally paid garbage, where waste is sorted by a person who is living nearby) as the most acceptable option. Such garbage place is located at the exit road from the town and for summer residents who often travel to city it is convenient way to submit waste, for high income respondents it also provide possibility do not sort waste at home.

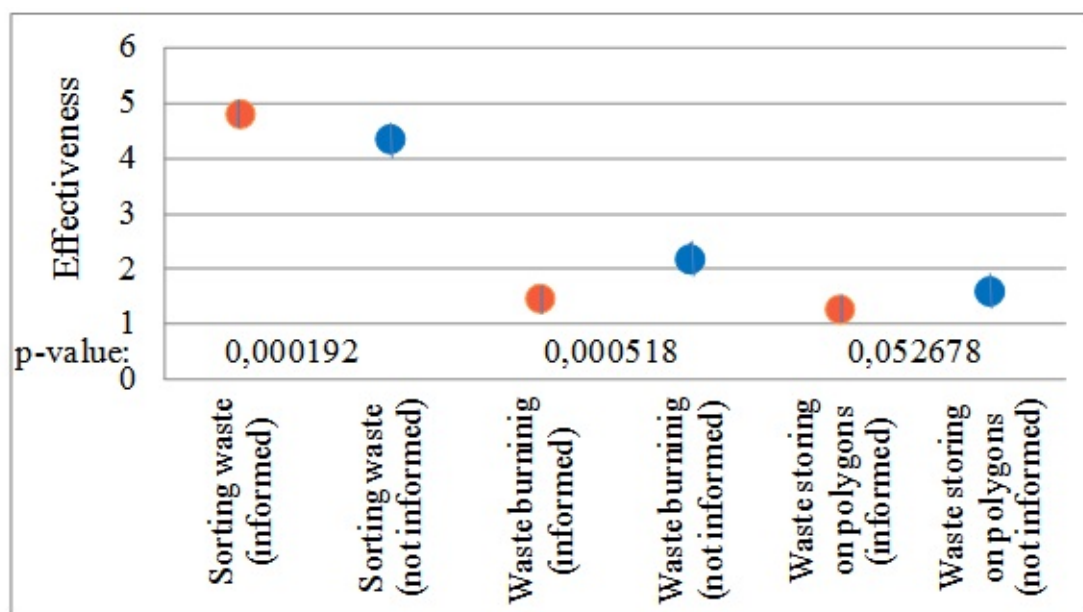


Figure 4. Effect of information on perception of effectiveness of three ways of waste utilization.

On figure 4 dots indicate averages, error bars gives ± 2 s.e. For effectiveness were used 5-point scale replies from 1 – very ineffective to 5 – very effective. Total sample of 105 observations is split into 2 parts informed and uninformed respondents. Average values among informed and uninformed participants significantly different for each type of waste utilization. To test statistical difference between control and treatment group we undertook a pairwise Kuskal – Wallis rank-sum test, p-values are reported at the bottom line of fig. 4. The most effective way of waste utilization for all respondents is sorting waste (with further recycling) with average effectiveness rate 4,8 and 4,3 for informed and uninformed, respectively. Other ways of waste utilization get averages below 2,2. Waste burning and storing on polygons considered by respondents to a greater or lesser extent equally ineffective. Most of the respondent do not possess special knowledge in ecology but majority say that to burn waste is as bad as to keep it on polygons.

Relations between perceptions and acceptability of waste sorting. The relation between waste sorting acceptability and perception of its effectiveness and its impact on wellbeing of respondents were estimated. As we can see from tab. 2 acceptability of waste sorting strongly positively related to effectiveness of waste sorting and negatively related to effectiveness of waste burning and wellbeing change due to waste burning. Effectiveness has strong positive relation with perception of wellbeing change due to waste sorting and negative relation with perception of wellbeing change due to waste burning.

People with high prior knowledge (assessed knowledge) tend to show a higher acceptability of waste sorting. Perceived knowledge increase people's acceptability and perception of effectiveness. Women and families or single persons who have experience of living abroad tend to show a higher acceptability of waste sorting.

Table 1. Determinants of effectiveness and acceptability of waste sorting based on ordered logit regression.

Explanatory variables	Dependent variable	
	Acceptability	Effectiveness
Perception variables		
Effectiveness of waste sorting	1.560796 (0.0003)	—
Effectiveness of waste burning	-0.533752 (0.1140)	-0.097605 (0.7445)
Wellbeing change due to waste sorting	0.258293 (0.4872)	1.033974 (0.0008)
Wellbeing change due to waste burning	-0.638005 (0.0626)	-0.807965 (0.0033)
Control variables		
Assessed knowledge	0.727844 (0.0145)	0.057821 (0.8138)
Perceived knowledge	1.262079 (0.1054)	1.422101 (0.0181)
Trust to politicians	0.524291 (0.2313)	-0.030945 (0.9174)
Gender	1.063789 (0.0791)	-0.205776 (0.6907)
Family / respondent have experience living abroad	1.631150 (0.0672)	-0.255776 (0.7101)
Temporary living at that place*	-1.771635 (0.1245)	-0.493642 (0.6754)
Summer resident	-0.901673 (0.1775)	-0.343957 (0.5739)
Pseudo R-squared	0.408424	0.253190

Note: p-values are stated in the brackets. *This variable distinguish between respondents who are permanently living at the town or in nearby city and those who come for paid work and rent dwelling at the town. Dummy variable "summer resident" takes value 1 if a respondent is a summer resident, and 0 if a person is inhabitant of the town.

To test our models for multicollinearity we used correlation coefficients among explanatory variables and variance inflator factors (*VIF*) calculated based on R^2 . To obtain *VIF* we run auxiliary regressions (OLS, equation 1) for each explanatory variable ($x_i^1, x_i^2, x_i^3, \dots, x_i^{(k-2)}, x_i^{(k-1)}, x_i^k$) as a function of the rest explanatory variables and use obtained R^2 to calculate *VIF*.

$$x_i^1 = \alpha_1 + \alpha_2 x_i^2 + \alpha_3 x_i^3 + \dots + \alpha_{k-2} x_i^{(k-2)} + \alpha_{k-1} x_i^{(k-1)} + \alpha_k x_i^k + u_i \quad (1)$$

$$VIF = \frac{1}{1 - R^2} \quad (2)$$

According to common rule correlation coefficients bigger than 0,75 suggest a multicollinearity problem in the estimated model. For our models correlation coefficients among explanatory variables do not exceed 0,440.

Regarding *VIF* some experts believe that $VIF < 10$ do not lead to multicollinearity problem, others argue that limit value for *VIF* is 5 [4; 10; 13-15]. For our models variance inflator factors (*VIF*) varies in interval [1,054; 2,036].

By this, we conclude that the models do not reveal multicollinearity problem.

Price acceptability of the town inhabitants. While in the paper we do not have an air about conduct comprehensive study of waste collection price we estimated relations between price of waste collection acceptability and perception of waste sorting and waste burning effectiveness and other variables. For this purpose we used Pearson correlation coefficients matrix. In tab. 3 we present correlation coefficients with value more than 0,1. We calculated *t*-statistics to check the correlation coefficients for significance, it is given in the brackets. As tab. 3 signifies price acceptability is positively related to acceptability of waste submitting to a special garbage where it is sorted.

Furthermore, people with higher income level, higher education, summer residents and those who have experience living abroad, respondents with better knowledge on waste reform (self-perceived and assessed) tend to show a higher acceptability of price. People with trust to politicians and elderly tend to have low price acceptability.

Table 2. Determinants of price of waste collection acceptability based on Pearson correlation coefficients matrix.

Variables	Price Acceptability	
Perception variables		
Effectiveness of waste burning	0.13893	(1.42379)
Wellbeing change due to waste sorting	0.09829	(1.00239)
Acceptability variables		
Waste submitting to a special garbage where it is sorted	0.184799*	(1.90837)
Control variables		
Assessed knowledge	0.188913*	(1.95241)
Self-perceived knowledge	0.176745*	(1.82246)
Perceived knowledge	0.110835	(1.13183)
Trust to politicians	-0.19944**	(-2.06559)
Education	0.379389***	(4.16150)
Age	-0.16320*	(-1.67881)
Income level	0.517722***	(6.14144)
Family / respondent have experience living abroad	0.329058***	(3.53652)
Summer resident	0.315137***	(3.37001)

Note: *t*-statistics of the correlation coefficients given in the brackets, asterisks ***, ** and * denote 1%, 5% and 10% significance, respectively. Dummy variable “summer resident” takes value 1 if a respondent is a summer resident, and 0 if a person is inhabitant of the town.

4. Discussion

The study revealed that waste sorting is the most preferred and accepted way of waste collection and submission and it is strengthened by low effectiveness and negative wellbeing change due to waste burning.

People in general ready to sort waste and submit it to separate bins, they are very enthusiastic about ecologically friendly approaches to waste management. At the same time most of respondents complaining that in the town there is no infrastructure for separate waste collection and also it is not clear whether or not the sorted waste is actually recycled, some believe that it goes to the same polygons as before and that makes people frustrated. Some mentioned that in the region there is no any information on local TV or radio about good examples of waste recycling and waste sorting.

While price for waste collection at the town majority (75%) of summer residents assess as absolutely or just acceptable. During the survey collection most of them complain that they have to pay for waste collection at any dwellings they possess even if it's not occupied. As a result the total cost of waste collection grow tremendously, in some cases up to 1200 rub per month per a person, and that is value become essential, especially for pensioners. And in the region (Sverdlovskaya oblast) there is no rule to avoid double, triple or more payments for waste collection. For example, in Moscow if you spent summer at collective garden and not at a flat in the city it is enough to bring to the management company in the city a certificate from collective garden (collective sad) about your permanent stay in the garden. And this would expel you from payment for waste collection for the flat in the city for summer period. In region (Sevrdlovskaya oblast) there is no rule to be expeled from double, triple or more payments for waste collection.

Acceptance of waste sorting approach and perception of it's effectiveness does not depend on respondents age. Among each group there are active supporters of waste sorting and it's effectiveness, and in the whole sample not many who are strongly against of sorting and believe it is ineffective measure of nature saving.

Disregarding people's prior knowledge and perceived knowledge among three possible ways to deal with waste management majority of respondents report sorting as the most effective way to preserve the nature, burning as a second possibility with much low effectiveness and polygons as a least effective option. That signifies people's awareness of different ways of waste utilization and that they have overall understanding which way is better and worse off. But even among very well informed respondents (with good assessed knowledge) there is no understanding would it be possible to avoid waste burning by changing packing materials or reusing it as it was during the Soviet times. Or may be it is possible to force incineration factories to use the best ever filters to decrease air pollution. Because burning is considered by respondents as a way to solve the problem in a short run. According to their believe to burn waste all the time will bring more harm than good. And burning waste should be minimized and goes to zero in the future (better in the near future).

5. Conclusion

The study revealed that majority of people perceived themselves to have somewhat, little or no knowledge at all on waste reform and indeed based on assessed knowledge we have to conclude that people are not well informed on current situation with waste management.

Providing people with information on functioning of waste reform significantly increase their acceptability and perception of effectiveness of waste sorting as a way of waste submission. Respondents receiving information on waste reform tend to have a higher probability (if compared with not informed) to accept separate waste collection, especially those who originally have relatively low assessed knowledge.

Another finding is that disregarding a luck of information on waste management and people's distrust that waste sorted at some special places and then recycled they assess as the most appropriate way to discard rubbish is sorting waste at home and discard it into separate bins at garbage place. And the only thing which prevent them from doing so is the luck of infrastructure, while some rural citizens used to sort food, paper and metal waste and hand over it for money or use for home needs (stoke the fire, for compost or feed domestic animals).

The most effective way of waste utilization for all respondents is sorting waste (with further recycling) with average effectiveness rate 4,8 and 4,3 for informed and uninformed. Other ways of waste utilization get averages below 2,2. Waste burning and storing on polygons considered by respondents to a greater or lesser extent equally ineffective. Most of the respondent did not possess special knowledge in ecology but they believe that to burn waste is as bad as to store it on polygons.

In general, people with high prior knowledge (assessed knowledge) tend to show a higher acceptability of waste sorting. Women and families or single persons who have experience of living abroad also tend to show a higher acceptability of waste sorting.

Price for waste collection acceptability is positively related to acceptability of waste submitting to a special garbage where it is sorted.

More educated people, with higher income level, summer residents and those who have experience living abroad, respondents with better knowledge on waste reform tend to show a higher acceptability of price. People with trust to politicians and elderly tend to have low price acceptability.

References

- [1] Adeleke O, Akinlabi S, Jen T-C and Dummade I 2020 Towards sustainability in municipal solid waste management in South Africa: a survey of challenges and prospects. *Transactions of the Royal Society of South Africa* 2-14
- [2] Flikke G 2021 Dysfunctional orders: Russia's rubbish protests and Putin's limited access order. *Post-Soviet Affairs* **37(5)** 470-488
- [3] Fengshi Wu & Ellie Martus 2020 Contested environmentalism: the politics of waste in China and Russia. *Environmental Politics* **30(4)** 493-512
- [4] Hair J F Jr, Anderson R E, Tatham R L and Black W C 1995 *Multivariate Data Analysis (3rd ed)* (New York: Macmillan) 65
- [5] Kyselá E, Ščasný M and Zvěřinová I 2006 Attitudes toward climate change mitigation policies: a review of measures and a construct of policy attitudes. *Climat Policy* **19** 878-892
- [6] Larionov A and Ecorem N V 2012 *MSW management: opportunities for Russia. Summary of key findings*. Washington D.C.: IFC, World Bank Group Retrieved from: https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/publications/publications_report_russia-solidwaste
- [7] Lusk J L, Ellison B 2020 Economics of husehold food waste. *Canadian Journal of Agricultural Economics* **68** 379-386
- [8] Maphosa V 2021 Students' awareness and attitudinal dispositions to e-waste management practices at a Zimbabwean University. *Journal of Information Policy* **11** 562-581
- [9] Nkonyeasua K E, Osagli J E 2020 Beat the plastic: an approach to polyetheylene terephthalate (PET) bottle waste management in Nigeria. *Waste disposal & sustainable energy* **2** 313-320
- [10] Ringle C M, Wende S, and Becker J-M 2015 *SmartPLS 3. Bönningstedt: SmartPLS* Retrieved from <http://www.smartpls.com>
- [11] Riffenburgh R H 2011 *Statistics in Medicine. Academic Press* (Second Edition) 672
- [12] Wiesmeth H, Starodubets N V 2020 The Management of Municipal Solid Waste in Compliance with Circular Economy Criteria: the Case of Russia. *Ekonomika regiona* **16(3)** 725-738
- [13] Nosov V V, Zhichkin K A, Zhichkina L N, Novoselova S A, Fomenko N L and Bespamjatnova L P 2020 Subsidizing agricultural production of the region to achieve food security. *IOP Conference Series: Earth and Environmental Science* **548** 022077
- [14] Zhichkin K A, Nosov V V, Zhichkina L N, Ramazanov I A, Kotyazhov A V and Abdulragimov I A 2021 The food security concept as the state support basis for agriculture. *Agronomy Research* **19(2)** 629-637
- [15] Ermakova A, Oznobihina L and Avilova T 2020 Analysis of the current state and features of natural resource potential management. *E3S Web of Conferences* **157** 3005