Age Structure and Municipal Waste Generation and Recycling – New Challenge for the Circular Economy

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Abstract

Municipal waste generation and treatment represent important parts in the circular economy approach, which is being more and more soundly promoted by the European Union among its members. While the issue of industrial waste stream is developing quite progressively, the issue of municipal waste remains a challenge. Compared to the industry, municipalities tend to produce a greater diversity of waste with lower overall recycling rates, and therefore the approach to deal with it has to be more complex. Municipalities play a very important role in promoting the prevention and separation of the waste produced by its citizens. But in order to that effectively, it is necessary to identify how various groups of people behave in terms of their waste generation and tendencies to separate their waste. In our study we have examined the relationships between the age structure of people in the municipalities, their municipal solid waste generation per capita, and their per capita waste separation levels. We have used data from Czech municipalities from years 2011 and 2013. Our results suggest that young people tend to performs best in both aspects, while people aged 50-79 seem to both generate most residual waste per capita and separate the least. Such findings can be used by the municipalities in order to target more precisely those age groups that have the highest potential for improvement in the context of municipal solid waste management, instead of focusing on those age groups that are performing already well.

Keywords: age structure, municipal solid waste, separation, recycling

Introduction

Municipal solid waste (MSW) generation and treatment represents an important socioeconomic issue in the European Union, and becomes even more important when the effectiveness and the efficiency of municipal solid waste management (MSWM) are considered. We point out two issues regarding waste generation today: waste treatment is becoming more expensive; and resources are becoming scarce and therefore more expensive as well. Both of these issues can be directly addressed by adopting principles of a circular economy to the municipal waste management. According to the circular economy strategy, the main task is to transform Europe into a more competitive, resource-efficient economy.

The idea of a circular economy [1-2] is becoming more and more current, as the EU is promoting strategies towards adopting circular economy in individual countries. Rapidly expanding country like China is also among those giving significant attention to this area as well [3-4]. But we see several issues with the current research regarding circular economy. Studies in this field often focus on individual waste fractions or some specific types of waste, and examine how to include them in circular patterns without some part of it being left out. Although this approach is fine, it focuses only on technical aspects of the waste management process. Next issue is that because industry and businesses are usually responsible for most of the generated waste today, the research focuses primarily on them as well. But there is another important producer of waste – the municipalities. In our opinion, much more attention should be paid to them, as they usually produce much greater diversity of waste, while most of it ends up without much further utilization

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as a mixed residual waste in a landfill or incinerator. Compared to the waste produced by industry, collection and treatment of municipal waste is significantly less expensive, and people are therefore less motivated to separate their waste. Due to this the local municipal governments play a very important role in promoting the prevention, collection, separation and treatment of municipal waste among the people. But in order to do that, municipalities need to have sufficient knowledge about who they should target with their measures and instruments in order to achieve the best results in waste management, resp. how to do it effectively.

Our paper is focused on the situation of the municipalities in the Czech Republic. Although there has been notable progress over the past years in terms of the increased availability of waste separation options in the Czech Republic (together with stable to slowly decreasing generation of mixed municipal waste per capita), there still exists large room for decreasing total generated waste while increasing the share of recycled waste, which is necessary when considering the strategy of a circular economy. This will most likely have positive impact on the municipal expenditures in this area as well, because municipalities usually pay notably less for collection and treatment of separated waste compared to mixed waste, and sometimes even profit from it.

A lot of research has been already conducted regarding socio-economic factors influencing the solid municipal waste generation and recycling in various countries like Great Britain [5], Germany [6], Italy [7], and so on [8]. However, from our experience, very little has been published on the issue of age structure and effect on municipal waste management [9-10]. If studies include age factors, they usually work with only few age groups, which could not produce very precise results. In our opinion, more detailed age structure should not be omitted when examining MSWM, as one's waste-related behavior significantly changes throughout the life. Just a few examples to illustrate; a small child practically without any budget is relying on what its parents provide, thus the generated waste depends on the parents preferences; a young students and adults already have some budget, but it is usually not very high, which also limits the consumption and subsequently waste generation, which is therefore usually little; or an adult with already established professional experience, who is at the peak of his earnings possibilities, and has the highest consumption, and subsequently produces the most waste.

In our perspective each age group should be approached in a different manner that understands how the behavior of the specific age group differs from other groups. By taking this into account, local authorities can, for instance, adjust their MSWM in order to reflect better the age structure of their municipality. Also if it is possible to identify some patterns in the waste behavior of some age categories, better focused campaigns can be created and target a specifically selected age group with the relevant message, instead of creating some general message that is not well suitable for any specific group, and might end up just as a waste of money. Moreover, if some age group is already performing well, there is little need to focus further campaigns specifically on this age group, as the possible benefits from further improvement will be most likely marginal. On the other hand, if we are able to identify other group that is performing rather poorly, then we should focus more on this group, as the benefits will likely be high.

Therefore, the main goal of our study was to examine how the age structure influences municipal waste generation together with waste separation using statistical and econometric analysis. We have used available data regarding age structure and municipal waste generation from more than 5000 Czech municipalities. The results show notable differences between people of various age, and how the average waste generation of people changes throughout their life. Our findings could help municipalities to better focus their measures on the specific age groups in order to achieve better results in municipal waste management.

Methods and Material

In this study we analyze quantitative data regarding municipal waste generation in the Czech municipalities. Data used in this study come from two sources. Data on waste quantity were acquired from CENIA (Czech Environmental Information Agency under the Ministry of Environment). At the time of our research, the most recent data were provided for 2013. These data contain amounts of annual production of generated waste fraction for the Czech municipalities. Although it is natural that every single municipality produces at least some waste, these data are not available for all municipalities. This might be caused either by some technical errors, or simply because responsible local authority did not provide the data. Especially in case of very small municipalities with no professional staff the local authority might simply prefer to invest time in other more important duties than reporting such data.

For clarification we note that by MSW we consider mixed residual municipal waste fraction – unsorted waste that practically ends up in a landfill or in an incinerator, and is not utilized in any other way. As separated waste we consider a sum of any municipal waste that is separated and then somehow utilized – it consists mostly of separated paper, plastics, glass, biodegradable municipal waste, metal, or other relevant waste fractions. Depending on the separation options in individual municipalities, some of these fractions might not be separately collected, and therefore end as mixed residual waste in examined years – but we did not examine this in more detail in this study.

Age structure data for individual municipalities were acquired from the portal of the Czech Statistics Office (CZSO). However, CZSO publishes detailed data about municipal age structure only since 2014. Until that, published municipal age structure data consisted of only 3 groups – children aged 0-14, adults aged 15-64, and elderly aged 65+. In our perspective such differentiation is far from sufficient, as especially the middle age group contains very large variety of people ranging from teenagers to practically retired. If we were to get some more exact results, we were very limited in the choice of the years to analyze. As the most recent waste data were available for 2013, we decided to use the age structure data from 2014 together with the waste generation data from 2013. We assume that the changes in the age structure between the two consecutive years are marginal, and therefore would not create any significant distortion in the results. Additionally, it was possible to include year 2011, when the national census that collected also age structure data occurred, and the data regarding waste generation were also available. One drawback is that age structure data from the census are mostly for 10-year age cohorts, while CZSO now publishes data for 5-year age cohorts. Therefore we have merged relevant age groups in order to make a consistent dataset with the census data structure. By doing this we got 10 age groups, compared to only 3 age groups available in the previous years and in many foreign studies.

We have examined collected data using regression analysis, specifically OLS (Ordinary Least Squares) method. This method is widely used for finding relationships in larger data sets, and results are easily interpretable. As we have two sets of cross-sectional data that are not from consecutive years, we have analyzed both datasets separately. We have used current version of econometric software gretl for performing the analyses. In order to avoid heteroscedasticity, which usually occurs in such data, we have used per capita values for waste generation and percentage of people in the individual age groups on total municipal population. By performing this, the absolute size of the municipality would not cause a bias towards large municipalities in the OLS results. Considering the normality of the data distribution, in case of the age groups we did not observe any notable irregularities. In case of waste generation per capita, the distribution was a bit between normal and a Poisson distribution, with slightly longer tail towards higher per capita values and slightly higher concentration of data points at the lowest per capita values. The longer right-tail is simply explained by the fact that the data are naturally limited on the left by the zero value, but are not limited in their maximum value – in this kind of left-bounded data it is normal. Higher concentration of the very low values is caused by the fact that many municipalities reported very low amount of total generated waste, which we assume was not always correct, but we do not have any measure how to safely identify municipalities with certainly incorrect data. In order to eliminate at least the extreme outliers, we have trimmed our sample at several levels, and provide the models for each of these trimmed subsamples in order to check, whether the calculated results are consistent.

Considering the samples, in 2011 there were 6251 municipalities in the Czech Republic, while in 2013 there were 6253 municipalities. We left out municipalities that did not report any values for generated MSW or separated waste – both cases are most likely due to some errors, as providing MSWM is compulsory for the Czech municipalities according to the law, together with providing at least some basic option for waste separation. These data are provided in the Table 1, together with the mean and median values per capita for both years and for MSW and separated waste.

From the data description we can see that MSW generation in the Czech Republic is approximately 300 kg of total municipal waste per capita per year (residual plus separated waste fractions). Compared to the EU-27 average of 500 kg per capita per year, this is a notably lower value. According to [11], the reasons for that are partly historical with the traditional thriftiness and lower standard of living in the Czech Republic compared to the western countries, both leading to a lower wastage rate, and partly due to the observed fact that in case of the Czech municipalities, reported data cover only waste produced by households, while in case of some other countries these data cover also waste from municipal sweepings and parks. This is a result of slightly different definitions of municipal waste and its fractions in various countries. Therefore the actual difference in MSW per capita generation in the Czech Republic is not that much lower compared to other EU countries, as it might seem from the data. In our case this methodological issue does not matter much, as we are dealing with the data only from the Czech Republic, which are therefore consistent.

Table 1: Sample of Czech municipalities used in the study

	2011		2013	
	Municipal solid waste	**Separated solid waste**	**Municipal solid waste**	**Separated solid waste**
Total municipalities with available data	5116	5790	5304	6030
Mean annual value per capita (kg)	231.39	69.80	219.56	66.47
Median annual value per capita (kg)	219.37	44.18	206.09	50.14

Source: own calculations based on CZSO and CENIA data

If we compare the values between years 2011 and 2013, there is not much of a difference. This was also not expected, as there is just a short time between both periods. Positive trend is that the data are available for more municipalities, and the total amount of municipalities with provided data is getting close to the total amount of municipalities in the Czech Republic. Mean value of generated MSW and separated waste per capita dropped by 5% between the periods, suggesting a small decrease in residual waste generation. In case of median values was the drop in MSW per capita value slightly larger, but in case of separated waste values this on contrary increased by more than 10%. This is most likely caused by notably fewer municipalities reporting very small amounts of total separated waste in 2013 compared to 2011.

In our calculations we used several subsamples instead of the full sample of municipalities that provided any data. The reason for that was to avoid having outliers that would cause bias in the results. First we have sorted the municipalities according to their values of per capita waste generation. Then we have trimmed the bottom and top 0.33%, resp. 0.50%, resp. 1.00% of the values in order to get three trimmed subsamples. Additionally, we made a fourth subsample in which we left out municipalities with per capita values less than 20% or more than 500% of the mean per capita value of the full sample. Details about the adjustments made in order to create the subsamples are provided in the Table 2. Besides that, no other adjustments have been made to the municipal data in the sample. Values from defined subsamples were used directly in the regressions, with regressor being either per capita value of generated MSW or value of per capita separated waste, and regressands being the percentages of people in the defined age groups for each individual municipality.

Table 2: Reduction of the amount of municipalities in the subsamples

		2011		2013	
	Trim level (bottom+top)	**Reduced municipalities**	**Final amount in the subsample**	**Reduced municipalities**	**Final amount in the subsample**
Residual municipal solid waste	0.33%	17+17	5082	18+18	5268
	0.50%	26+26	5064	27+27	5250
	1.00%	51+51	5014	53+53	5198
	<20% & >500%	255+6	4855	170+6	5128
Separated solid waste	0.33%	19+19	5752	20+20	5990
	0.50%	29+29	5732	30+30	5970
	1.00%	58+58	5674	60+60	5910
	<20% & >500%	592+66	5132	488+42	5500

Source: own calculations

Results and Discussion

We present results for per capita generation of MSW in the Table 3, and per capita generation of separated waste in the Table 4. In order to avoid collinearity, we had to leave out one of the age groups – in our case it is the age group 0-14. Otherwise the sum of the percentages for the age groups in each individual municipality in the model would be always the same (1.00), which becomes a problem in the regression calculation, and is typically dealt with by omitting one of the categories in the model. We left out the age group 0-14 specifically because it contains the largest age span, and the members of this group can have very different waste-generating behavior depending whether they are among the youngest or among the oldest in the group. In case of the little infants, the majority of waste they produce is in form of diapers, and they also do not affect their waste generation in any way, as they fully rely on what their parents do. On the other hand, young teenagers are already capable of affecting their waste-related behavior, and many of them can behave very pro-environmentally in the waste-related aspects, including both tendencies to minimize residual waste and separate as much waste as possible. Another thing is that little infants can produce notably more residual waste per day than average people, while teenagers are more likely to produce very little waste due to their budget constraints – they simply cannot generate that much waste if they do not consume that much. Such tendencies to behave notably different within one age group are much less likely to be present in other age categories. Therefore, as we have to leave out one of them, group 0-14 seems to be the most appropriate to do so. And final note on the models, the provided values should not be taken literally – for instance understanding the negative values as that the presence of people of this age group in the municipality actually decreases the generated MSW – but due to the nature of regression models more likely as the suggested trend of effect. The correct interpretation is that the group with lowest (even negative) coefficient values tends to contribute the lowest to MSW generation, while the group with the largest coefficient values tends to contribute the most.

Table 3: Residual municipal solid waste generation per capita for the individual age groups

	0.33% bottom+top trimmed sample		**0.50% bottom+top trimmed sample**		**1.00% bottom+top trimmed sample**		**<20% & >500% mean trimmed sample**	
	2011	**2013**	**2011**	**2013**	**2011**	**2013**	**2011**	**2013**
const	144.4**	106.5**	143.6**	85.34*	140.3***	91.24*	81.82	100.4*
	(57.92)	(51.26)	(56.42)	(50.10)	(53.67)	(47.91)	(58.18)	(52.20)
Age 15-19	-188.5	-13.52	-184.0	34.90	-162.3	-3.379	**-203.6***	-175.2
	(117.5)	(115.6)	(114.4)	(112.8)	(109.1)	(108.0)	(116.1)	(117.7)
Age 20-29	**-201.9****	**-229.8*****	**-174.6****	**-208.5*****	**-133.3***	**-165.2****	**-184.5****	**-239.4*****
	(87.29)	(79.15)	(85.08)	(77.24)	(80.94)	(73.78)	(88.10)	(80.64)
Age 30-39	-13.69	37.20	-23.46	98.46	-9.791	109.3	123.3	45.39
	(106.8)	(100.1)	(104.1)	(97.86)	(99.02)	(93.72)	(107.9)	(102.1)
Age 40-49	80.07	**169.1***	67.70	**206.1****	75.67	**205.4****	**174.9***	**189.5****
	(92.76)	(86.69)	(90.41)	(84.60)	(86.02)	(80.86)	(92.60)	(88.28)
Age 50-59	**300.9*****	**296.4*****	**294.7*****	**293.3*****	**270.3*****	**248.8*****	**431.2*****	**359.1*****
	(80.06)	(72.83)	(78.01)	(71.03)	(74.34)	(67.83)	(78.71)	(73.66)
Age 60-64	**479.8*****	**309.1*****	**478.4*****	**313.2*****	**412.8*****	**324.1*****	**552.5*****	**314.3*****
	(94.99)	(86.74)	(92.66)	(84.54)	(88.42)	(80.76)	(94.02)	(88.38)
Age 65-69	**421.1*****	**469.3*****	**415.7*****	**446.8*****	**468.6*****	**399.8*****	**618.3*****	**567.0*****
	(112.2)	(88.93)	(109.5)	(86.88)	(104.3)	(83.32)	(111.5)	(90.57)
Age 70-79	**231.7****	**266.9*****	**242.9*****	**301.0*****	**175.3****	**243.5*****	**228.0****	**297.9*****
	(93.22)	(81.89)	(90.83)	(80.09)	(87.17)	(76.64)	(92.26)	(83.91)
Age 80+	-99.67	7.751	-87.97	7.837	-13.41	17.92	45.80	55.78
	(112.3)	(99.38)	(109.9)	(96.93)	(104.6)	(92.78)	(110.9)	(99.78)
# of obs.	5082	5268	5064	5250	5014	5198	4855	5128
Adj. r^2	0.0283	0.0232	0.0292	0.0218	0.0266	0.0183	0.0409	0.0326

*, **, *** stand for statistical significance at 10%, 5%, 1%, standard errors in parentheses

Source: own calculations

Provided models show notable differences of the generation of MSWM per capita between the individual age groups. We can see that lowest values of coefficient were acquired by the youngest age groups 15-19 and 20-29, with values for the latter being consistently statistically significant regardless of year or the subsample. Such results suggest, that the people aged 20-29 contribute the lowest. From our perspective are these results in accordance with the fact that people in this age group are usually still students, or are at the beginning of their working careers, in both cases with limited budget, subsequently resulting low consumption and low waste generation.

The following age group 30-39 does not have any statistically significant results, but from the values we can expect that their waste generation per capita is increasing, which would be in accordance with that these people are usually working, and thus able to consume more, resulting in more generated waste.

Age group 40-49 has significant results in year 2013, suggesting that their contribution to the MSW generation is becoming higher than in case of the younger groups. In our opinion this is caused by their further extended budget due to their longer job experience.

Age groups spanning from 50 up to 79 have all high and significant results regardless of year and subsample. Such results suggest that people in these groups contribute the most to the overall MSW generation. The highest (peak) values can be observed among the 65-69 and in some cases also the 60-64 age groups. This suggests that throughout the lifetime, people are likely to generate the highest amount of MSW during this age. After that, the values decrease. Our interpretation of these observations, in our opinion, cannot rely solely on increasing budget, as people in the Czech Republic usually commence retirement at around the age 62 (plus minus some years, depending on the sex and both the willingness and availability to continue working), and also people at this age often prefer not to work that hard at their jobs as when they were younger. We have observed a similar thing when examining municipal expenditure related to waste management [10], and our idea is that people at around this age prepare their households for being retired, what often includes some reconstruction, refitting the household with different equipment, replacing the old, getting rid of stuff that will likely not be used anymore, and so on.

Finally, the oldest age group 80+ does not have any significant results, but from the values we can expect that these oldest people tend to produce very little amounts of waste. This is most likely the result of their decreasing budget, as they do not work anymore, and that they tend not to buy a lot of new stuff, as they most likely already have it.

If we look at the differences between the years 2011 and 2013, in general they are not that high (a constant has to be included into the consideration, as it is statistically significant in most cases). We can observe that in case of the age group 20-29 the effects on decreasing MSW generation are bit stronger, suggesting that people in this age group are continuing to produce less MSW per capita. Same positive trends can be seen in the age groups 50-69, where in all cases the contribution to MSW generation seems to be lower than in 2011. On the contrary, in case of the age group 40-49 the effects seem to be stronger, suggesting that per capita generation of MSW by this group increases – but in this case only 2013 results are statistically significant (2011 coefficient is significant only in the last subsample). In case of eldest people in the age group 70-79, the effects are approximately the same in both years.

Based on the provided results for MSW per capita generation, we suggest focusing more on the age groups 40-79, with even more emphasis on the age group 60-69. Results suggest that these groups produce largest amounts of MSW per capita, therefore they presents the greatest possibilities for campaigns and measures oriented towards waste minimizations, especially in case of people around the age when commencing retirement. On the other hand, it seems that the people in the age group 20-29 (and partially 15-19) seem to be doing already well in these aspects, without need to extend the activities focused on them much further.

In the Table 4 we provide models with similar regressors, but this time the regressand is the amount of separated municipal waste per capita.

Table 4: Separated municipal waste generation per capita for the individual age groups

	0.33% bottom+top trimmed sample		**0.50% bottom+top trimmed sample**		**1.00% bottom+top trimmed sample**		**<20% & >500% mean trimmed sample**	
	2011	**2013**	**2011**	**2013**	**2011**	**2013**	**2011**	**2013**
const	45.72	8.935	51.62*	15.24	54.26**	23.06	43.02	23.69
	(29.79)	(23.63)	(27.95)	(22.50)	(25.28)	(20.79)	(26.56)	(22.78)
Age 15-19	75.24	**170.1*** **	89.48	**166.5*** **	84.30	**145.7*** **	**104.9***	**112.8****
	(62.16)	(53.76)	(58.34)	(51.15)	(52.39)	(47.32)	(54.34)	(51.45)
Age 20-29	43.52	**113.5*** **	52.64	**100.5*** **	57.09	**60.89***	**85.33****	**68.09***
	(45.54)	(36.69)	(42.72)	(34.92)	(38.63)	(32.28)	(40.60)	(35.03)
Age 30-39	-76.50	22.19	-83.16	15.14	**-80.68***	7.200	-61.50	11.26
	(54.86)	(45.68)	(51.47)	(43.51)	(46.59)	(40.21)	(49.05)	(44.09)
Age 40-49	-3.570	-19.63	-29.84	-38.09	-13.26	-28.83	3.284	-29.71
	(47.83)	(39.47)	(44.93)	(37.58)	(40.67)	(34.70)	(42.67)	(38.26)
Age 50-59	31.29	**69.75****	16.04	**81.50****	-4.874	**88.39*** **	11.45	**83.44*** **
	(40.88)	(33.54)	(38.38)	(31.90)	(34.71)	(29.49)	(36.12)	(32.28)
Age 60-64	**141.2*** **	**111.9*** **	**133.1*** **	**97.81*** **	**86.84****	**97.27*** **	**93.51****	**97.23****
	(47.84)	(39.79)	(44.92)	(37.86)	(40.69)	(34.90)	(42.51)	(38.21)
Age 65-69	-14.97	37.30	-59.11	22.07	-59.58	0.3651	-60.11	18.81
	(57.13)	(40.85)	(53.62)	(38.98)	(48.25)	(36.00)	(49.97)	(39.48)
Age 70-79	19.03	**99.76*** **	29.83	**88.65****	33.41	**79.36****	53.10	**89.34****
	(47.88)	(37.46)	(44.93)	(35.65)	(40.34)	(32.94)	(41.70)	(36.04)
Age 80+	**99.90***	**109.9****	**106.7****	**108.8*** **	**81.67***	60.23	**143.3*** **	**147.1*** **
	(56.09)	(44.20)	(52.63)	(42.04)	(47.34)	(38.97)	(50.11)	(43.15)
# of obs.	5752	5990	5732	5970	5674	5910	5132	5500
Adj. r^2	0.0050	0.0070	0.0064	0.0083	0.0055	0.0068	0.0080	0.0097

*, **, *** stand for statistical significance at 10%, 5%, 1%, standard errors in parentheses
Source: own calculations

Compared to results of MSW per capita generation models, we get less statistically significant results. Interesting observation, when compared to the previous models, is that in case of the youngest age group the values are among the highest (however statistically significant primarily only in 2013). This suggests that the youngest people seem to separate the most, while also generating the least MSW. In our opinion this is consistent with previous note that these young people have already been affected by the waste-related campaigns at schools, and they try to behave pro-environmentally. If they have been raised with relevant information for which they as students had enough time to absorb, it often might seem natural to them to behave in this way. When we were contacting local authorities for gathering data about municipal waste management for a different research [12], many of them said that the school in their municipality plays an important role in the waste management in the way of educating young people and creating pro-environmental habits through various related activities. Once teenagers at schools were properly explained how to separate and what are the benefits, they often became actively leading the rest of the family towards higher separation (or to the separation at all). Therefore it seems logical that in municipalities with higher percentage of people in this age the separation amounts of waste would be higher. Some of this effect can be probably observable among the next age group, 20-29, but this probably needs more time, as more publicly visible campaigns towards recycling have not been introduced that long, and the people in this age group might not have been exposed to them yet.

The next two age groups, 30-49 seem to be separating the least, but the results are not significant. Based on what the values suggest, it might that part of these people try so separate, while the other part does not, and therefore the results are inconsistent. It might also be that part of the people is keeping the habits of waste separation, while for the other part it might be less convenient to do so, for example due to less available time.

Age groups 50-64 seems to be contributing to the higher separation rates, compared to the previous age group we perceive it as a positive shift. On the other hand, these positive effect might be simply a side product of the fact that

these people tend to produce the highest amounts of MSW, and therefore if separating just small part of it, it will positively influence the total separation levels.

In case of the age group 65-69, on contrary, the effects on separation are inconsistent with the values very close to zero. The interpretation might be the same as in case of the age groups 30-49, that part of the people in the group is actively separating, while the other is not. If we accept the idea of people refitting their households at around this age (due to commencing retirement), another explanation might be that people are simply getting rid of all kinds of stuff that does not fit into any separated waste fractions, and thus contributing mostly to the MSW fraction.

Finally, in case of the eldest people, we observe positive and mostly statistically significant results, suggesting that eldest people contribute to the higher separation. Especially in case of the age group 80+ the coefficients are among the highest, which is an interesting observation when considering, that this age group produces usually the lowest amounts of waste. In our opinion this might be caused by the two things – these people have time, and the positive attitude that they can be part of something, acting environmentally, sharing their experience with other peers – something they perceive as perspective to devote their time to – and therefore they might be eager to separate.

As we do not have that many statistically significant results in case of models of per capita separation levels, we do not draw any conclusions regarding the shift of the values between years 2011 and 2013.

Based on the results provided in the Table 4, we suggest that the focus of the activities promoting higher waste separation should be oriented more towards the age groups 30-49 and 65-69, who seem to produce inconsistent results regarding their separation level, possibly including also the age group between them. These age groups in general tend to produce highest levels of waste, while their separation levels do not seem to keep up with that. As was mentioned before, according to the results, these age groups can provide the largest possibilities for both reducing the amount of generated residual waste and increasing the amount of separated waste. On the other hand, the youngest people in the age groups 15-29 seem to be doing already well in this area and separating a lot, which holds also for the eldest people in the 70+ age category. Therefore it seems that there is no need to further extend the activities oriented on them.

Conclusions

Circular economy represents a current trend in the waste management and the dealing with the generated waste fractions. The technical aspects of dealing with the generated waste play an important part, but we cannot forget that it is the people that produce this waste, and that it is up to them whether they will separate and recycle their waste. In our study we did not focus on the technical aspects, but on the examination of relationships between one's age and the overall trends towards generating residual waste and towards its separation. Calculated regression models using data from the majority of Czech municipalities from years 2011 and 2013 suggest that waste-related behavior of the various age groups is notably different. We have identified that young people under 30 tend to produce lowest amounts of residual waste per capita, while also being the best in the waste separation. On the contrary, people of age 50-79 seem to be generating the most residual waste, while not separating that much. Interesting finding was also that the eldest people, while generally producing little waste overall, seem to be among the best at waste separation.

Such findings can be beneficial for the municipality when planning to improve the results of municipal waste management and planning to target information campaigns to the specific age groups, instead of using the same for everyone. Results suggest that there is no need to focus more attention to the youngest and the oldest people, as their waste-related behavior is already relatively good, and the improvement would most likely be marginal. Instead of that, the municipalities should focus more on the middle age groups, as their waste-related behavior offers the largest possibilities for improvement, both in the area of municipal solid waste generation and the separation levels.

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