Municipal Waste Management in the European Union

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Abstract
From a numerical point of view, in the European Union, the population in the urban area has an increasing trend. Their desire to benefit from ever-increasing welfare has led to an increase in industrial production. Under these conditions, the quantities of waste generated also increased. The reuse and recycling of waste contributes to maintaining the quality of the environment. Technologies that allow the efficient use, in the highest possible share of raw materials, have beneficial effects on natural resources. The article presents a comparative analysis of the distribution of municipal waste generation and treatment in the Member States of the European Union. In production processes, the efficiency with which natural resources are used influences the degree to which they can be depleted. Low efficiency leads to an increase in the amount of waste that results. Environmental degradation is also influenced by climate change. From this point of view, the application of efficient waste management is becoming increasingly important. Thus, the article presents an analysis of the quantities of recycled municipal waste. The analysis presented shows that, at European level, compared to 2000, in 2020 the amount of waste generated per capita decreased and the amount of waste treated per capita increased. On the other hand, in terms of total quantities, there is an increase in both the waste generated and the waste treated. The importance of waste management has led to an increase in interest in municipal waste recycling. Thus, at the level of the member states of the European Union, there is an increase in the quantities of recycled waste.

Keywords

municipal waste, waste management, European Union.

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Introduction

Human industrial activities are gaining momentum (Balu et al., 2021). In this way, a high consumption of resources negatively influences the quality of human life and leads to the depletion of planetary resources (Sarbu et al., 2021). Climate change also has a negative influence. High amounts of waste can be prevented by sustainable flows of materials and energy, as desired in the circular economy (Radulescu et al., 2020).. The application of waste reuse measures can lead to the creation of additional value, respectively to the activation of the circular economy (Velenturf and Jopson, 2019). Through the circular economy, the European Union aims to reduce the amount of waste generated, but also to recover as much of it as possible (Magazzino et al., 2021).

In the urban environment, there is both an increase in population and a desire to increase welfare (Profiroiu et al., 2020). At the same time, urban development has led to an increase in the amount of municipal waste (Bodislav et al., 2020). Municipal solid waste management is a major challenge for human communities (Iyamu et al. 2020). Due to urban development, there is a need for proper sanitation systems in cities (Burlacu et al., 2020). Thus, the importance of waste management increases (Saxena et al., 2019). Knowledge of the factors that influence waste collection is a component of waste management (Bran et al., 2020). Not all waste can be reused. In the production process, those wastes that are unusable can be identified and it is desirable to intervene in their reduction. Improving waste recycling leads to an unpolluted environment (Otto et al., 2018). In terms of the environment, it is desirable that the benefits of

the current generation be preserved and passed on to future generations. In other words, waste management should consider the generation and treatment of as many types of waste as possible (Wisnubroto et al., 2021).

1. Review of the scientific literature

The way in which waste is collected, as well as the infrastructure for collecting it, can influence the waste management strategy (Mogos et al., 2021). There may be some shortcomings in the implementation of this strategy (Radulescu et al., 2020). Thus, certain unsustainable practices may occur that lead to high emissions and influences on sustainable development (Fuldauer et al., 2019). Food is very important for people's daily lives. But large amounts of food are thrown away. Food waste can be prevented by closely monitoring and intervening in the food production process (Bodislav et al., 2021). The reduction of food waste has beneficial effects for the economy, but also beneficial effects for people, in terms of social and environmental issues (Caldeira et al., 2021). Reducing food waste, but also the application of measures to avoid food waste, brings economic and environmental benefits (Jeswani et al., 2021). The importance of reducing food waste is also given by the fact that the production of raw materials needed for food involves the use of large areas of agricultural land (van Herpen et al., 2019). Some waste has been found to contain heavy metals. These materials increase the toxicity of the waste. An example is food waste. They contain both food waste and other associated materials. In these cases, the cost of the various treatments applied may be high (Chu et al., 2019). The location of landfills, together with local climatic conditions, can influence the efficiency of waste collection (Lee et al., 2017).

Plastic waste management has an impact on soil and water quality. High concentrations of microplastics produce negative effects on agricultural land and can affect water quality. It is desirable that plastic waste management does not lead to plastic contamination (Corradini et al., 2019). Reducing the amount of plastic waste can be achieved by people manifesting a more responsible individual behavior (Kedzierski et al., 2020). The circular economy offers the possibility for natural raw materials to be replaced by certain wastes resulting from the production flow (Russo et al., 2019). Poor waste management can lead to pollution of urban areas. Thus, the pollution of green spaces is considered to influence people's lives (Elmqvist et al., 2015). Human health is affected by the effects of waste pollution (Toscano and Murena, 2021).

Reducing the amount of waste can be achieved by applying solutions related to sustainable waste management. Such applicability can be given by the circular economy. For example, the revaluation of food waste that results in the technological flow of food production. Such an approach may be the basis for circular economy strategies (Garcia-Garcia et al., 2019). The life cycle of certain products leads to their transformation into waste. Recycling efficiency can be increased by applying measures to recover certain reusable components from these products (Ardente et al., 2019). Thus, the efficiency of resource use can be increased by measures to implement a management that leads to both the improvement of natural capital and its protection (Zorpas, 2020).

2. Research methodology

The purpose of this research was to assess the evolution of the quantities of waste generated or treated in the Member States of the European Union, for the period 2000-2020. The article presents a comparative analysis of the distribution of municipal waste generation and treatment in the Member States of the European Union. Due to the interest in waste recycling, the article presents the comparative situation of the quantities of municipal waste recycled. The analyzes took into account both the quantities of waste per capita and the total quantities of waste.

3. Results and discussion

Waste generation is characteristic of all production processes that use materials. In all sectors of activity, the realization of a finished product also involves waste. Municipal waste is mainly produced by households, including similar waste from other sources, such as: offices and public institutions, trade. The table no. 1 presents the comparative situation of generation of municipal waste per capita (kilograms per capita). It is observed that, compared to 2000, in 2020, at European level, the amount of waste generated decreased by 8 kilograms per capita. Also in 12 countries the values fell, including: Belgium (-55 kilograms per capita), Bulgaria (-205 kilograms per capita), Spain (-198 kilograms per capita), Hungary (-82 kilograms per capita), Estonia (-70 kilograms per capita), Romania (-68 kilograms per capita). On the other hand, there were increases: Czech Republic (+172 kilograms per capita), Denmark (+181 kilograms per capita), Croatia (+156 kilograms per capita), Latvia (+207 kilograms per capita), Slovakia (+179 kilograms

per capita). In 2020, some countries also showed an increase compared to 2010: Czech Republic (+189 kilograms per capita), Latvia (+154 kilograms per capita), Slovakia (+114 kilograms per capita), Finland (+126 kilograms per capita). But compared to 2010, in 2020 a number of 14 countries recorded decreases in the amount of waste generated. The most significant decreases were recorded in: Bulgaria (-147 kilograms per capita), Ireland (-69 kilograms per capita), Cyprus (-86 kilograms per capita), Spain (-55 kilograms per capita), Italy (-44 kilograms per capita), Belgium (-40 kilograms per capita).

In 2020, over 600 kilograms per capita were: Denmark (845 kilograms per capita), Germany (632 kilograms per capita), Cyprus (609 kilograms per capita), Luxembourg (790 kilograms per capita), Malta (643 kilograms per capita). Also, under 400 kilograms per capita had: Estonia (383 kilograms per capita), Hungary (364 kilograms per capita), Poland (346 kilograms per capita), Romania (287 kilograms per capita).

Table no. 1. Comparative situation for generation of municipal waste per capita (kilograms per capita)

Countries	2000	2010	2020	Countries	2000	2010	2020
European Union	513	503	505	Latvia	271	324	478
Belgium	471	456	416	Lithuania	365	404	483
Bulgaria	612	554	:	Luxembourg	654	679	790
Czechia	335	318	507	Hungary	446	403	364
Denmark	664	:	845	Malta	533	623	643
Germany	642	602	632	Netherlands	598	571	534
Estonia	453	305	383	Austria	580	562	:
Ireland	599	624	555	Poland	320	316	346
Greece	412	532	:	Portugal	457	516	513
Spain	653	510	455	Romania	355	313	287
France	514	534	537	Slovenia	513	490	487
Croatia	262	379	418	Slovakia	254	319	433
Italy	509	547	:	Finland	502	470	596
Cyprus	628	695	609	Sweden	425	441	431

Source: own processing according to data published by Eurostat (2022)

The evolution of waste generated in the European Union is shown in figure no. 2. From the data presented in figure 2, there is a decrease in values for the period 2010-2014. In the next period (2014-2020), the values increase from 478 kilograms per capita to 505 kilograms per capita, a value almost identical to that recorded in 2010 (503 kilograms per capita).

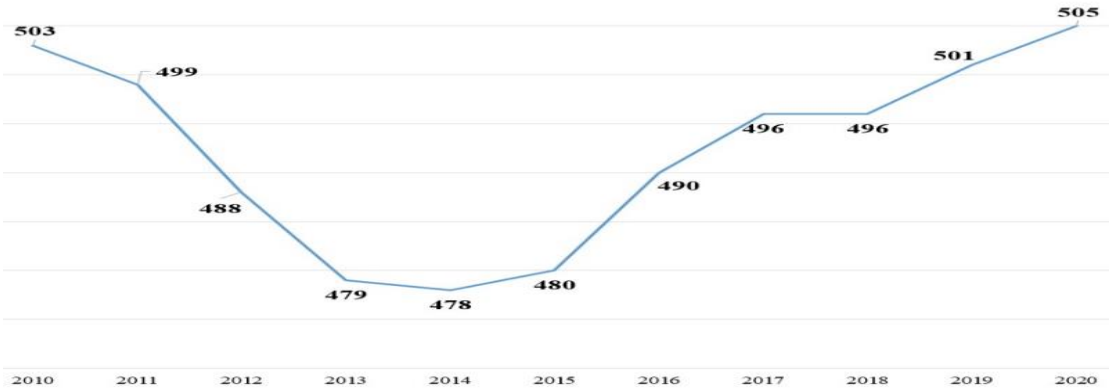

Figure no. 2. Evolution of waste generated in the European Union
Source: own processing according to data published by Eurostat (2022)

The table no. 2 shows the comparative situation for waste treatment (kilograms per capita).

Table no. 2. Comparative situation for waste treatment (kilograms per capita)

Countries	2000	2010	2020	Countries	2000	2010	2020
European Union	486	490	495	Latvia	252	324	455
Belgium	484	436	416	Lithuania	346	369	428
Bulgaria	495	547	:	Luxembourg	654	679	790
Czechia	317	304	493	Hungary	407	403	364
Denmark	664	:	845	Malta	533	600	599
Germany	642	602	632	Netherlands	510	571	534
Estonia	441	256	331	Austria	633	548	:
Ireland	621	575	546	Poland	320	264	346
Greece	412	532	:	Portugal	457	516	473
Spain	491	510	455	Romania	295	279	269
France	514	534	531	Slovenia	433	393	385
Croatia	:	373	376	Slovakia	249	309	433
Italy	497	515	:	Finland	526	470	596
Cyprus	628	676	518	Sweden	425	441	427

Source: own processing according to data published by Eurostat (2022)

It is observed that, compared to 2000, in 2020, at European level, the amount of treated waste increased by 9 kilograms per capita. Also in 12 countries the values fell, including: Belgium (-68 kilograms per capita), Bulgaria (-88 kilograms per capita), Estonia (-110 kilograms per capita), Ireland (-75 kilograms per capita), Cyprus (-110 kilograms per capita). On the other hand, there were increases: Czech Republic (+176 kilograms per capita), Denmark (+181 kilograms per capita), Greece (+112 kilograms per capita), Latvia (+203 kilograms per capita), Slovakia (+184 kilograms per capita). In 2020, some countries also showed an increase compared to 2010: Czech Republic (+189 kilograms per capita), Latvia (+131 kilograms per capita), Slovakia (+124 kilograms per capita), Finland (+126 kilograms per capita). But compared to 2010, in 2020 a number of 16 countries recorded decreases in the amount of waste treated. The most significant decreases were recorded in: Bulgaria (-140 kilograms per capita), Ireland (-29 kilograms per capita), Cyprus (-158 kilograms per capita), Spain (-55 kilograms per capita), Italy (-53 kilograms per capita).

In 2020, over 600 kilograms per capita of treated waste had: Denmark (845 kilograms per capita), Germany (632 kilograms per capita), Luxembourg (790 kilograms per capita). Also, less than 400 kilograms per capita of treated waste had: Estonia (331 kilograms per capita), Croatia (376 kilograms per capita), Hungary (364 kilograms per capita), Poland (346 kilograms per capita), Romania (269 kilograms) per capita), Slovenia (385 kilograms per capita).

The evolution of waste treated at EU level is shown in the figure no. 3. By 2013, there will be a decrease in values from 490 kilograms per capita to 468 kilograms per capita. Starting in 2014, the amount of waste treated increases to 495 kilograms per capita (2020).

Figure no. 3. Evolution of treated waste in the European Union
Source: own processing according to data published by Eurostat (2022)

The table no. 3 shows the comparative situation of the quantities of waste generated, respectively treated, at the level of the European Union, as well as of the member countries (in thousand tons).

Table no. 3. Comparative situation of the quantities of waste generated and treated, respectively (thousand tonnes)

Countries	Waste generated			Waste treatment		
	2000	2010	2020	2000	2010	2020
European Union	220.073	222.009	225.732	208.655	216.136	221.193
Belgium	4.831	4.972	4.800	4.959	4.746	4.800
Bulgaria	4.998	4.094	:	4.046	4.044	:
Czechia	3.434	3.334	5.419	3.250	3.186	5.272
Denmark	3.546	:	4.927	3.546	:	4.926
Germany	52.810	49.237	52.567	52.810	49.236	52.567
Estonia	633	406	509	616	340	440
Ireland	2.279	2.846	2.768	2.364	2.622	2.724
Greece	4.447	5.917	:	4.447	5.917	:
Spain	26.505	23.774	21.529	19.905	23.774	21.529
France	31.232	34.609	36.154	31.232	34.609	35.745
Croatia	1.173	1.630	1.693	:	1.604	1.523
Italy	28.959	32.440	:	28.279	30.505	:
Cyprus	436	576	543	436	561	462
Latvia	642	680	909	597	680	865
Lithuania	1.276	1.253	1.350	1.209	1.143	1.197
Luxembourg	285	344	498	285	344	498
Hungary	4.552	4.033	3.545	4.157	4.033	3.546
Malta	208	258	332	208	249	309
Netherlands	9.529	9.484	9.321	8.121	9.483	9.321
Austria	4.646	4.701	:	5.069	4.582	:
Poland	12.226	12.032	13.117	12.226	10.040	13.117
Portugal	4.705	5.457	5.279	4.705	5.457	4.866
Romania	7.961	6.343	5.534	6.611	5.645	5.179
Slovenia	1.020	1.004	1.024	861	805	809
Slovakia	1.369	1.719	2.366	1.340	1.666	2.362
Finland	2.600	2.519	3.296	2.724	2.519	3.296
Sweden	3.773	4.140	4.460	3.773	4.140	4.422

Source: own processing according to data published by Eurostat (2022)

It is observed that high values of waste generated were registered in: Germany (52567 thousand tons), France (36154 thousand tons), Spain (21529 thousand tons), Poland (13117 thousand tons). Also, high values of treated waste were registered in: Germany (52567 thousand tons), France (35745 thousand tons), Spain (21529 thousand tons), Poland (13117 thousand tons). For many countries the quantities generated and treated, respectively, coincided: Belgium, Germany, Spain, Luxembourg, Netherlands, Poland, Finland.

At the level of the European Union, for the year 2020, the amount of treated waste was lower than the amount of waste generated by -4539 thousand tons. The countries where the differences were significant are: Portugal (-413 thousand tons), France (-409 thousand tons), Romania (-355 thousand tons), Slovenia (-215 thousand tons), Croatia (-170 thousand tons).

The importance of waste management has led to an increase in interest in recycling. Reanalyzing the technological flow of a product can lead to solutions such as recycling waste from intermediate processes. Thus, the intervention in each stage of making a product can lead to the conservation of natural resources.

The figure no. 4 shows the evolution of the amount of recycled waste in kilograms per capita, for the year 2020.

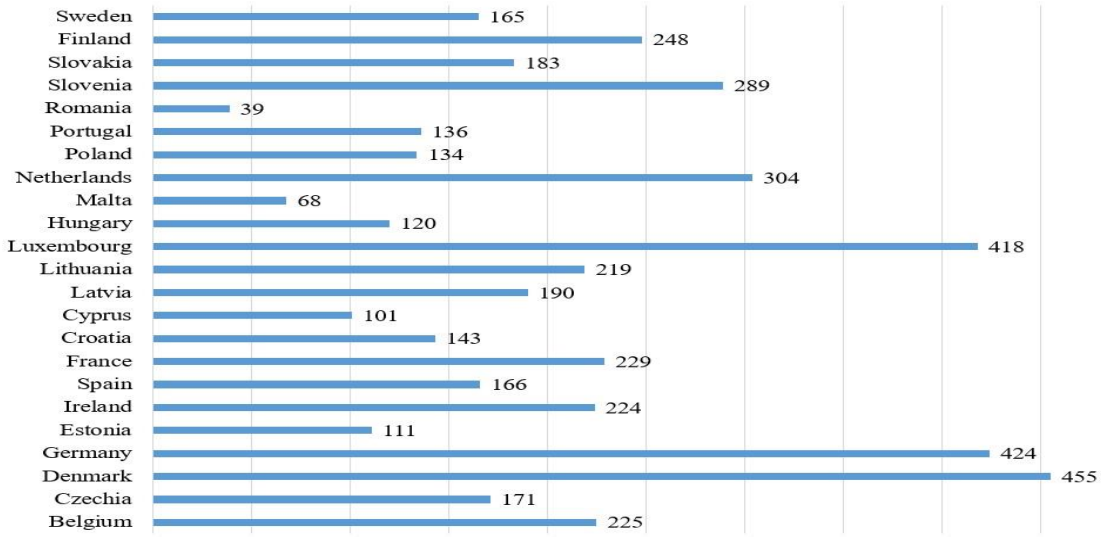

Figure no. 4. The evolution of the amount of recycled waste, 2020 (kilograms per capita)
Source: own processing according to data published by Eurostat (2022)

From figure no. 4, it is noted that Denmark (455 kilograms per capita), Germany (424 kilograms per capita), Luxembourg (418 kilograms per capita), the Netherlands (304 kilograms per capita) had the highest amounts of waste recycled in kilograms per capita. At the same time, the lowest amounts of waste recycled in kilograms per capita were recorded in: Romania (39 kilograms per capita), Malta (68 kilograms per capita), Cyprus (101 kilograms per capita), Estonia (111 kilograms per capita).

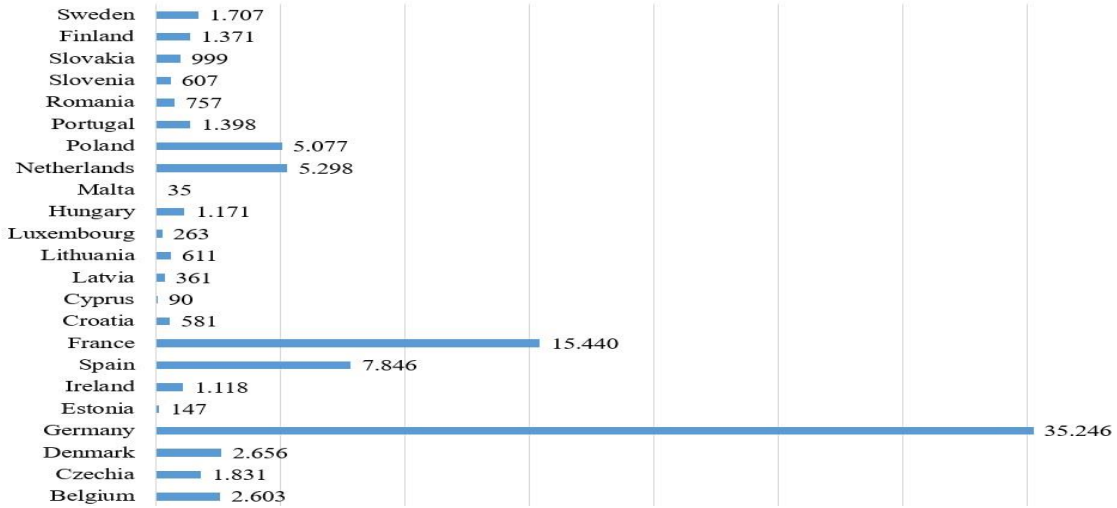

Figure no. 5. The evolution of the amount of recycled waste, 2020 (thousand tonnes)
Source: own processing according to data published by Eurostat (2022)

Also, in terms of the quantity recycled in thousand tons, from the data shown in Figure no. 5, it is observed that the highest values were recorded in: Germany (35246 thousand tons), France (15440 thousand tons), Spain (7846 thousand tons), Netherlands (5298 thousand tons), Poland (5077 thousand tons). Very small quantities were: Malta (35 thousand tons), Cyprus (90 thousand tons), Estonia (147 thousand tons).

Conclusions

From the analyzes presented, it is observed that compared to 2000, in 2020, at European level, the amount of waste generated in kilograms per capita decreased and the amount of waste treated in kilograms per capita increased. In the case of waste generated in kilograms per capita, the largest decreases were recorded in: Bulgaria and Spain. In 2020, the highest amounts of waste generated in kilograms per capita were: Denmark, Luxembourg and Malta, and the lowest: Romania and Poland. For waste treated in kilograms per capita, the largest increases were in: Latvia, Slovakia and Denmark. In terms of quantities expressed in thousand tonnes, in 2020, Germany, France, Spain and Poland had the highest values for both generated

and treated waste. Also, in 2020, Denmark and Germany recycled the largest amounts of waste in kilograms per capita, and in a thousand tons: Germany and France. It can be concluded that all countries in the European Union are concerned with waste management, but some of them are more concerned with this area, which affects our environment.

References

Ardente, F., Latunussa, C.E.L., & Blengini, G.A., 2019. Resource efficient recovery of critical and precious metals from waste silicon PV panel recycling. *Waste Management*, 91, pp. 156–167. https://doi.org/10.1016/j.wasman.2019.04.059

Balu, F. O., Radulescu, C. V., Bodislav, D. A., Gole, I., Buzoianu, O. C. A., Burlacu, S., & Balu, P. E. (2021). Cost modeling and computation in the healthcare industry. case study on a Swiss medical care organization. *Economic Computation & Economic Cybernetics Studies & Research*, *55*(1). DOI: 10.24818/18423264/55.1.21.05

Bodislav, D. A., Burlacu, S., Rădulescu, C. V., & Gombos, S. P. (2021). Using a hybid economic indicator (BADEM) to evaluate the retail sector (R5N) and consumption. In *7th BASIQ International Conference on New Trends in Sustainable Business and Consumption. Foggia, Italy* (pp. 34-42).

Bodislav, D. A., Buzoianu, O. A. C., Burlacu, S., & Rădulescu, C. V. (2020). Analysis of companies in Romania from the perspective of risk perception and the management needs thereof. *Economic Convergence in European Union*, 341.

Bodislav, D. A., Radulescu, C. V., Bran, F., & Burlacu, S. (2020, June). Public policy in the areas of environment and energy. In *6th BASIQ International Conference on New Trends in Sustainable Business and Consumption* (pp. 228-235).

Bodislav, D.A., Radulescu, C.V., Bran, F. and Burlacu, S., (2020) Public Policy in the Areas of Environment and Energy. 6th BASIQ International Conference on New Trends in Sustainable Business and Consumption. Messina, Italy, 4-6 June 2020. Bucharest: ASE, pp. 228-235

Bran, F., Rădulescu, C. V., Bodislav, D. A., & Burlacu, S. (2020). Environmental risks in the context of globalization. *Economic Convergence in European Union*, 350.

Burlacu, S., Gavrilă, A., Popescu, I. M., Gombos, S. P., & Vasilache, P. C. (2020). Theories and Models of Functional Zoning in Urban Space. *Revista de Management Comparat International*, 21(1), 44-53.

Caldeira, C., De Laurentiis, V., Ghose, A., Corrado, S., & Sala, S., 2021. Grown and thrown: Exploring approaches to estimate food waste in EU countries. *Resources, Conservation & Recycling*, 168, 105426. https://doi.org/10.1016/J.RESCONREC.2021.105426.

Chu, Z., Fan, X., Wang, W., & Huang, W., 2019. Quantitative evaluation of heavy metals' pollution hazards and estimation of heavy metals' environmental costs in leachate during food waste composting. *Waste Management*, 84, pp. 119–128. https://doi.org/10.1016/j.wasman.2018.11.031

Corradini, F., Meza, P., Eguiluz, R., Casado, F., Huerta-Lwanga, E., & Geissen, V., 2019. Evidence of microplastic accumulation in agricultural soils from sewage sludge disposal. *Science of the Total Environment*, 671, pp. 411–420. https://doi.org/10.1016/j.scitotenv.2019.03.368

Elmqvist, T., Setälä, H., Handel, S.N., van der Ploeg, S., Aronson, J., Blignaut, J.N., Gómez-Baggethun, E., Nowak, D.J., Kronenberg, J., & de Groot, R., 2015. Benefits of restoring ecosystem services in urban areas, *Current Opinion in Environmental Sustainability*, 14, pp. 101–108, http://dx.doi.org/10.1016/j.cosust.2015.05.001.

Eurostat, 2022. [online] Available at: <https://ec.europa.eu/eurostat/web/main> [Accessed 22 February 2022].

Fuldauer, L.I., Ives, M.C., Adshead, D., Thacker, S., & Hall, J.W., 2019. Participatory planning of the future of waste management in small island developing states to deliver on the Sustainable Development Goals. *Journal of Cleaner Production*, 223, pp. 147-162. https://doi.org/10.1016/j.jclepro.2019.02.269

Garcia-Garcia, G., Stone, J., & Rahimifard, S., 2019. Opportunities for waste valorisation in the food industry - A case study with four UK food manufacturers. *Journal of Cleaner Production*, 211, pp. 1339-1356. https://doi.org/10.1016/j.jclepro.2018.11.269

Iyamu, H.O., Anda, M., Ho G., 2020. A review of municipal solid waste management in the BRIC and high-income countries: A thematic framework for low-income countries, *Habitat International*, 95, 102097. https://doi.org/10.1016/j.habitatint.2019.102097

Jeswani, H.K., Figueroa-Torres, G., & Azapagic, A., 2021. The extent of food waste generation in the UK and its environmental impacts. *Sustainable Production and Consumption*, 26, pp. 532–547.

Kedzierski, M., Frère, D., Le Maguer, G., & Bruzaud, S., 2020. Why is there plastic packaging in the natural environment? Understanding the roots of our individual plastic waste management behaviours. *Science of The Total Environment*, 740, 139985. https://doi.org/10.1016/j.scitotenv.2020.139985

Lee, U., Han, J., & Wang, M., 2017. Evaluation of landfill gas emissions from municipal solid waste landfills for the life-cycle analysis of waste-to-energy pathways. *Journal of Cleaner Production*, 166, pp. 335-342.

Magazzino, C., Mele, M., Schneider, N., & Sarkodie, S.A., 2021. Waste generation, wealth and GHG emissions from the waste sector: Is Denmark on the path towards circular economy? *Science of The Total Environment*, 755, 1, 142510.

Mogos, R. I., Negescu–Oancea, M. D., Burlacu, S., & Troaca, V. A. (2021). Climate Change and Health Protection in European Union. *European Journal of Sustainable Development* (2021), 10, 3, 97-108 ISSN: 2239-5938 Doi: 10.14207/ejsd.2021.v10n3p97

Otto, S., Kibbe, A., Henn, L., Hentschke, L., & Kaiser, F.G, 2018. The economy of E-waste collection at the individual level: A practice oriented approach of categorizing determinants of E-waste collection into behavioral costs and motivation. *Journal of Cleaner Production*, 204, pp. 33-40. https://doi.org/10.1016/j.jclepro.2018.08.293

Profiroiu, C. M., Bodislav, D. A., Burlacu, S., & Rădulescu, C. V. (2020). Challenges of Sustainable Urban Development in the Context of Population Growth. *European Journal of Sustainable Development*, 9(3), 51-51.

Rădulescu, C. V., Bran, F., Burlacu, S., Dobrea, C. R., & Diaconu, S. (2020, December). Challenges Regarding Food Resources in the Context of Globalization and Population Growth. *In Proceedings of the International Conference on Economics and Social Sciences* (pp. 1041-1052). Sciendo.

Rădulescu, C. V., Burlacu, S., Bodislav, D. A., & Bran, F. (2020). Entrepreneurial Education in the Context of the Imperative Development of Sustainable Business. *European Journal of Sustainable Development*, 9(4), 93-93.

Russo, I., Confente, I., Scarpi, D., & Hazen, B.T., 2019. From trash to treasure: The impact of consumer perception of bio-waste products in closed-loop supply chains. *Journal of Cleaner Production*, 218, pp. 966-974. https://doi.org/10.1016/j.jclepro.2019.02.044

Sarbu, R., Alpopi, C., Burlacu, S., & Diaconu, S. (2021). Sustainable urban development in the context of globalization and the health crisis caused by the covid-19 pandemic. *Les Ulis: EDP Sciences.* doi:http://dx.doi.org/10.1051/shsconf/20219201043

Saxena, S., Ebrazibakhshayesh, B., Dentel, S.K., Cha, D.K., & Imhoff, P.T., 2019. Drying of fecal sludge in 3D laminate enclosures for urban waste management. *Science of the Total Environment*, 672, pp. 927–937.

Toscano, D. and Murena, F., 2021. The Historical Trend of Air Pollution and Its Impact on Human Health in Campania Region (Italy). *Atmosphere*, 12(5), 553. https://doi.org/10.3390/atmos12050553.

van Herpen, E., van der Lans, I.A., Holthuysen, N., Nijenhuis-de Vries, M., & Quested, T.E., 2019. Comparing wasted apples and oranges: An assessment of methods to measure household food waste. *Waste Management*, 88, pp. 71–84. https://doi.org/10.1016/j.wasman.2019.03.013

Velenturf, A.P.M., & Jopson, J.S., 2019. Making the business case for resource recovery. *Science of the Total Environment*, 648, pp. 1031–1041. https://doi.org/10.1016/j.scitotenv.2018.08.224

Wisnubroto, D.S., Zamroni, H., Sumarbagiono, R., & Nurliati, G., 2021. Challenges of implementing the policy and strategy for management of radioactive waste and nuclear spent fuel in Indonesia. *Nuclear Engineering and Technology*, 53(2), pp. 549-561. https://doi.org/10.1016/j.net.2020.07.005

Zorpas A.A., 2020. Strategy development in the framework of waste management. *Science of the Total Environment*, 716, 137088.