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Bülent AÇMA, Professor,
Anadolu University
Nedret Noyan ÖZYAKALI, Teaching Assistant,
Trakya University

Correlation Analysis of European Socioeconomic and Waste Management Structure Pursuant To EU-27 Waste Data - 2018

Aim of this research is to analyze European Union countries' solid waste data and to make a relation between waste management system and types of waste in terms of geographic location, socioeconomic and scientific-technologic perception for each region. According to common belief in society, the more the income the more the knowledge brings in which people should generate less domestic waste. In other words, if a country is economically developed, then its people must be taught well and know how not to generate more domestic waste. First thing to be considered in this article is to conclude that belief in any ways. Another point is by using European Union Statistics Office's data, namely EuroStat, analyzing each countries' waste source is observed in this article. That is to say, by knowing a countries' production area, energy resource types, cultural behaviour, agriculture and other socioeconomic structure, an analyze result is aimed to be provided in this research for observing produced waste and their resource. By analyzing the socioeconomic structures in numbers, one can predict the future waste data by understanding the correlation. It is becoming more important to predict waste generation nowadays because as mentioned in this article, not all the countries have enough land to apply landfilling process which is both inefficient in terms of economic reasons and disrespectful against the nature. Since waste management is a fact that needs to be handled depending on how wastes are generated; thus, socioeconomic struce, precise prediction methods are required for determining the best option. In this research European Union data is mostly considered and analyzed because Turkey is included in that data research for years. One must understand that all these data belong to 2018 because each data is collected twice a year and provided 2 years after. Thus, 2018 data is the most recent one which is released in October 2020 according to EuroStat Statistics Explained.

Keywords: 2018, economic development, European Union, socioeconomic structure, solid waste management

Problem statement Increase in population leads to an increase of all products that are consumed. Even it is inevitable for some, mistakenly used waste management systems may cause chaotic waste hills or enormous economic losses. Moreover, it goes without saying that not all the management systems applicable for all cases. Knowing which one to apply is another important fact to gain the maximum efficiency from waste. To understand the logic of gaining maximum profit from each waste, one must understand the relationship between waste production, sociocultural structure, income level and technological development of area.

Introduction and review of recent publications Although the world population has increased with each passing year, the rate of increase in population has gradually decreased and still tends to decrease, especially after reaching its peak in the 1970s (Figure 1). There are multiple reasons for this (Roser & Ortiz-Ospina, 2017);

- The perspectives of the generations developing with the developing technology
- Young people's willingness to lead a life independent of the concept of family
- Depending on the region (especially in Northern Europe) people do not want to have children, government motivations do not work to have a child
- Population growth prevention policies in countries that population is high
- Population decline caused by factors such as famine and deadly diseases, especially in underdeveloped countries

Figure 11. World population and population growth rate (Roser and Ortiz-Ospina, 2017)

Figure 2 shows the population density in the world and the regions where the population is denser are the regions where the employment area, underground wealth and the climate zone are better, and one of the main reasons for this is the migration of the region. Moreover, the high population density can be associated with the development of the region.

Figure 2: *World population density map (<http-1>)*

Where the population and population density are high, the demand for basic food, shelter and the most needed energy much higher than before. For instance, Japan is an island country with a land area of approximately 378 thousand km². Although the waste generation density is quite high (2-2.5 kg / person) due to high population, they have also shown their development in waste management (Figure 3). If we are to put it into figures, 1 GWh of power was obtained in Japan only by burning waste, and the contribution of this to the Japanese market is 183.2 million Yen. If we talk about the electricity consumption - with this amount-, the energy needs of approximately 70 thousand houses can be met for the houses that consume 200 kWh per month. In other words, investment can also be made in alternative resources that will meet the electricity needs of these houses free of charge (Yolin, 2015, p.31-37).

Figure 3. Domestic waste density map in the world (<http://2>)

The reason why Japan is associated with Europe is of course its waste management policy. Table 1 indicates that no such low amount of storage is not carried out in any country in the world (Table 1). The emphasis on storage becomes apparent in these countries, which are particularly developed in waste management, only when waste cannot be used otherwise. In countries that benefit from agriculture such as Spain and Italy, waste management is more focused on composting, and in more developed countries such as Germany and the USA, main aim is to recover energy and to do more recycling as possible (Saraç & Uludağ, 2011, p.247-250).

Table 1.

Waste management data in the world (The EU in the world, 2016, p. 157)

Country / Waste Management	Landfilling (Regular / Wild) (%)	Incineration (%)	Recycling (%)	Composting (%)
EU-28	29.9	25.5	26.9	15.4
Australia	49.0	:	45.0	:
Canada	71.0	4.0	18.0	7.0
China	80.0	18.0	0.0	2.0
Japan	1.0	78.0	20.0	0.0
Mexican	95.0	0.0	5.0	0.0
Turkey	99.0	0.0	0.0	1.0
United States of America	54.0	12.0	26.0	9.0

Research Methodology of this article can be categorized under literature review which is analyzing EuroStat Office data. The waste statistics analyzed as a result of the research were gathered from the information handled by EuroStat Office which is the statistical office of the European Union. It has been chosen as a reliable source because it is the first source accepted by the European Union. The values obtained covers 2016 and 2018 data included in the annual published by Eurostat in 2020. The report prepared for EU 27 countries covers the following countries (*Statistics Explained, 2020*);

- Germany • France • Romania • Bulgaria • Poland • Sweden • Italy • Netherlands • Finland • Spain • Greece • Belgium • Austria • Estonia • Denmark • Hungary • Portugal • Ireland • Slovakia • Luxembourg • Lithuania • Slovenia • Croatia • Latvia • Cyprus • Malta • Czech Republic

Countries that have been evaluated by Eurostat due to their non-European Union membership or their position but are not included in the EU 27 are as follows:

- United Kingdom • Serbia and Montenegro, Turkey • Liechtenstein • Norway • Bosnia and Herzegovina • Kosovo • North Macedonia

The Purpose of the Paper is to analyze waste data of European countries, understand the relation between socioeconomic structure of each country and clarify the relation between each of them.

Findings of Research. Statistical data were prepared for the countries specified by Eurostat and these data were shared in 2020 using the last 2016 and 2018 values. In order to make an accurate analysis, it is necessary to interpret the amount of waste collected first. The graph of the data obtained in this study conducted for EU 27 countries is as follows (Figure 4).

Figure 4. EU 27 waste amount chart (*Statistics Explained, 2020*)

The first issue to be deduced from here is that as of 2018, approximately 2.2 billion tons of waste was collected in EU 27 countries. The countries where the wastes are collected the most are Germany with 405 million tons, France with 342 million tons, United Kingdom with 282 million tons and Romania with 203 million tons. As can be seen in Table 2, 27,6% of the wastes generated by EU 27 countries are due to mine and quarrying, 11,1% manufacturing, 34,8% construction and demolition and only 8,3% domestic waste. In Germany, which is at the top in terms of waste amount, 55,1% of the waste produced is construction and demolition waste, 14% is production waste. Although 69,4% of construction and demolition waste is generated in France, 86,7% of the waste produced in Romania is comprised of mine waste.

Table 2.

EU 27 waste generation by economic activities and households (Statistics Explained, 2020)

	Mining and quarrying	Manufacturing	Energy	Construction and demolition	Other economic activities	Households
EU-27	27,6	11,1	3,4	34,8	14,7	8,3
Belgium	0,1	23,3	1,2	31,0	36,4	8,0
Bulgaria	81,9	2,9	7,9	1,7	3,2	2,4
Czechia	0,6	18,4	3,5	40,0	23,5	14,1
Denmark	0,1	4,8	3,9	58,3	16,3	16,6
Germany	1,8	14,0	2,5	55,1	17,2	9,4
Estonia	26,0	36,6	25,1	4,8	5,8	1,8
Ireland	15,7	34,7	2,1	10,0	27,6	9,9
Greece	78,4	6,4	3,5	0,8	4,2	6,6
Spain	15,7	11,1	3,0	27,8	25,6	16,8
France	0,7	6,8	0,4	69,4	13,6	9,0
Croatia	12,0	8,4	2,3	24,5	31,0	21,7
Italy	0,5	17,0	1,6	33,3	29,3	18,4
Cyprus	5,3	33,0	0,1	35,6	10,0	16,0
Latvia	0,0	19,4	11,4	4,4	30,4	34,4
Lithuania	0,6	41,2	2,0	7,6	31,7	16,8
Luxembourg	0,4	7,5	0,1	75,2	10,6	6,3
Hungary	0,9	16,9	16,2	22,5	25,3	18,2
Malta	7,7	1,4	0,1	68,9	13,4	8,4
Netherlands	0,0	9,8	1,5	69,9	12,8	6,1
Austria	0,1	9,2	0,8	73,4	9,5	7,0
Poland	38,8	16,5	11,3	10,4	17,8	5,2
Portugal	2,8	17,3	0,6	11,6	34,5	33,2
Romania	86,7	4,4	3,9	0,2	2,6	2,3
Slovenia	0,2	26,0	14,3	9,9	38,0	11,5
Slovakia	3,0	32,5	9,0	9,1	28,6	17,8
Finland	76,2	7,6	0,9	11,3	2,6	1,5
Sweden	77,5	4,1	1,3	6,9	7,1	3,1
United Kingdom	6,2	4,3	0,4	49,1	30,2	9,8

Iceland	0,0	24,6	0,0	4,0	31,0	40,4
Liechtenstein	3,0	2,3	0,0	87,9	1,5	5,4
Norway	3,0	14,1	1,9	27,5	31,6	22,0
Montenegro	19,2	1,9	18,1	37,4	9,9	13,5
North Macedonia	49,2	50,7	0,0	0,0	0,1	0,0
Serbia	79,0	2,6	12,2	1,1	1,9	3,2
Turkey	11,3	:	25,6	:	:	37,0
Bosnia and Herzegovina	1,6	27,2	71,1	0,0	0,0	0,0
Kosovo	13,9	20,5	39,6	5,9	9,5	10,6

If we examine it on a category basis, the highest rate in the field of energy is in Bosnia and Herzegovina, and in Iceland for domestic waste; however, these are only proportional data. Category-based wastes are given in Table 3, and the visual percentages of these wastes are given in Figure 5. Accordingly, the most common waste categories were construction and mine waste. Wastes defined as scrap were produced at the least amount in 2016 compared to other wastes or remained after recycling.

Table 3.

European waste generation overall rates (Statistics Explained, 2020)

	(thousand tonnes)	(%)
Construction	787 480	34,8%
Mining and quarrying	625 010	27,6%
Manufacturing	250 640	11,1%
Waste/water	214 020	9,5%
Households	187 400	8,3%
Services (except wholesale of waste and scrap)	88 780	3,9%
Energy	77 040	3,4%
Agriculture, forestry and fishing	20 340	0,9%
Wholesale of waste and scrap	9 820	0,4%

Figure 5. European waste generation overview (Statistics Explained,2020)

Conclusions. Considering Eurostat data, Germany with a population of 82.8 million in 2018 produces 4,85 tons of waste per capita annually, while in Romania with a population of 21.6 million, this amount is 9,01 tons and in the United Kingdom with a population of 63.5 million is 4,23 tons. It goes without saying that for Europe there is no proportion between the amount of population and the amount of waste generated. The main reason for this is that each waste must be considered as an ore and has a socioeconomic value rather than a mathematical data. In order to find out the reason for the amount of waste produced in a country, it is necessary to examine the source that the waste is occurred from. The country-based graph of the methods used in waste management in order to reconcile waste management with more than one step and the economic activities of the countries is also discussed and the values in Figure 6 are clearly shown in Table 4.

Fig 6. EU 27 waste generation resource rate chart (Statistics Explained,2020)

Table 4.

Solid waste management data (Statistics Explained, 2020)

Country/Mton waste	Recycling	Backfilling	Energy recovery	Landfill and other	Incineration w/o energy recovery
Austria	19,61	5,85	-	24,33	-
Belgium	40,60	-	6,66	3,36	2,18
Bulgaria	10,42	-	0,79	189,78	0,02
Croatia	3,40	0,29	0,07	3,45	0,00
Cyprus	0,23	0,63	0,09	1,30	-
Czechia	14,49	8,50	1,32	4,86	0,10
Denmark	6,47	-	2,45	3,67	0,00
Estonia	4,50	2,33	0,53	13,50	0,00
EU-27	824,43	227,22	130,66	1047,58	18,90
Finland	5,15	-	3,16	61,37	0,03
France	163,25	30,69	16,06	81,72	4,86
Germany	155,52	96,83	41,31	66,05	4,31
Greece	1,61	0,01	0,11	31,62	0,01
Hungary	13,35	0,90	1,82	8,44	0,14
Ireland	2,59	11,27	1,16	9,42	0,06
Italy	110,32	0,14	5,66	19,87	3,82
Latvia	0,90	0,01	0,09	0,26	0,00
Lithuania	2,34	0,29	0,40	3,97	0,00
Luxembourg	2,89	2,01	0,18	3,24	0,00
Malta	0,60	1,99	-	0,54	0,01
Netherlands	42,15	-	6,98	42,51	0,81
Poland	63,45	30,49	4,56	38,49	0,48
Portugal	12,75	2,79	3,55	10,16	0,07
Romania	14,86	1,61	5,21	347,40	0,21
Slovakia	4,27	0,50	0,75	5,10	0,05
Slovenia	3,48	1,57	0,28	0,40	0,04
Spain	59,59	9,09	5,77	86,20	0,02
Sweden	11,03	4,50	6,07	70,01	0,15
United Kingdom	145,02	23,44	10,22	112,19	7,93
Norway	3,24	0,19	2,53	1,45	0,04
Iceland	0,13	0,26	0,00	0,11	0,01
Turkey	19,42	-	0,47	-	0,12
Serbia	1,43	0,39	0,09	49,20	-
Montenegro	0,01	-	0,00	1,21	0,00
TOTAL	939,06	236,59	128,36	1295,15	25,48

As can be seen from the Table 4, the amount of waste used for direct energy recycling is approximately 128 million tons. Including direct/indirect energy recovery through incineration and recycling, a total of 964 million tons of waste is used for energy recovery. Considering that the total amount of waste for Europe is approximately 2.2 billion tons, one can conclude that 37.6% of the waste collected for Europe has a share in energy recovery.

The contribution of wastes directly involved in energy recycling is calculated as 42 TWh of electricity and 80 TWh of heat (Breeze, 2014).

The areas where a country operates economically (such as production in Germany or construction in Austria) enable to predict the types of wastes to be generated. This supports the necessity of knowing the main waste source of the country in order to choose the right waste policy. The same is true for regional waste management planning. Although the collected waste provides energy recovery, raw material recycling and energy saving, economic return should not be underestimated as well. For example, steel is an alloy that is used in almost every sector. Reasons for that are it can be easily shaped, structure is quite durable, its components are abundant in nature, its use in the food sector does not cause health problems and is cheaper compared to similar metals or metal alloys. Last but not least property of steel is it can be recycled 100%, but this recycling process also causes environmental pollution and extra cost. Just because a material is recyclable does not mean it can be used with not caution.

As for the perspective of domestic waste, the relationship between the domestic waste and the income level must be examined. The amount of waste directly depends on economic development, urbanization and income level. Higher the income level, higher the living standards, higher the consumption of products; thus, higher the amount of waste generated. It has been concluded that 1.3 billion tons of waste is generated annually in the world, but the amount of waste per person varies according to sociocultural differences. The amount of waste generated by income level is shown in Table 5. Accordingly, even in countries with high income levels, waste generation can be very low (0.7 kg), while in regions with low income levels, waste generation can be high (4.3 kg); However, if we look at the average levels, as the income level increases, the amount of waste (especially domestic waste) also increases. Sweden is the best example of this situation.

Table 5.

Domestic waste production according to income level (Hoornweg. And Bhada-Tata, 2012, p.5)

Income Level	Daily Domestic Waste Production Per Person (kg)		
	Lower Limit	Upper Limit	Average
High	0.7	14	2.1
Mid-High	0.11	5.5	1.2
Mid-Low	0.16	5.3	0.79
Low	0.09	4.3	0.6

If we compare the domestic waste generation according to the total amount and four different income levels, the amount of domestic waste generation according to the income level is shown in Figure 7. According to these results, the amount of domestic waste produced by high-income people or regions has a ratio of 46%. Although there is a belief that the level of income and cultural development is in parallel, it has been confirmed by the data that this idea has actually been debunked in terms of domestic waste generation awareness.

Figure 7. Income level domestic waste generation relationship graph (Hoornweg and Bhada-Tata, 2012, p.5)

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Бюлент АГМА, профессор
Университет Анадолу
Недрет Ноян ОЗЯКАЛИ,
Ассистент, Университет Тракая

КОРРЕЛЯЦИОННЫЙ АНАЛИЗ ЕВРОПЕЙСКОЙ СОЦИАЛЬНО-ЭКОНОМИЧЕСКОЙ СТРУКТУРЫ И СТРУКТУРЫ УПРАВЛЕНИЯ ОТХОДАМИ СОГЛАСНО ДАННЫМ ЕС-27 ПО ОТХОДАМ – 2018

Целью этого исследования является анализ данных о твердых отходах в странах Европейского Союза и установление связи между системой управления отходами и типами отходов с точки зрения географического положения, социально-экономического и научно-технологического восприятия для каждого региона. Согласно распространенному в обществе убеждению, чем больше доход, тем больше знаний приносят люди, которые должны производить меньше бытовых отходов. Другими словами, если страна экономически развита, ее люди должны хорошо обучаться и знать, как не производить больше бытовых отходов. Первое, что нужно учитывать в этой статье, - это проанализировать разные подходы к анализу данной проблемы. Другой момент заключается в использовании данных Статистического управления Европейского союза, а именно Евростата, для анализа источников отходов каждой страны, о которых говорится в этой статье, то есть путем знания производственных площадей страны, типов энергетических ресурсов, культурного поведения, сельского хозяйства и других социально-экономических факторов Структура, результат анализа должны быть предоставлены в этом исследовании для наблюдения за производимыми отходами и их ресурсами. Анализируя социально-экономические структуры в цифрах, можно предсказать будущие данные об отходах, понимая корреляцию. В настоящее время становится все более важным прогнозировать образование отходов, потому что, как упоминалось в этой статье, не все страны имеют достаточно земли для применения процесса захоронения отходов, который является неэффективным с точки зрения экономических причин и неуважительно по отношению к природе. Поскольку управление отходами - это факт, с которым необходимо обращаться в зависимости от того, как образуются отходы; таким образом, для определения наилучшего варианта требуются социально-экономическая напряженность, точные методы прогнозирования. В этом исследовании в основном рассматриваются и анализируются данные Европейского Союза, поскольку Турция уже много лет участвует в этих исследованиях. Следует отметить, что все эти данные относятся к 2018 году, потому что каждые данные собираются дважды в год и предоставляются через 2 года. Таким образом, данные за 2018 год являются самыми последними, которые были опубликованы в октябре 2020 года согласно объясненной статистике EuroStat.

Ключевые слова: 2018, экономическое развитие, Европейский Союз, социально-экономическая структура, обращение с твердыми отходами.

Бюлент АГМА, профессор
Университет Анадолу
Недрет Ноян ОЗЯКАЛИ,
Ассистент, Университет Тракая

КОРРЕЛЯЦІОННИЙ АНАЛІЗ ЄВРОПЕЙСЬКОЇ СОЦІАЛЬНО-ЕКОНОМІЧЕСЬКОЇ СТРУКТУРИ І СТРУКТУРИ УПРАВЛІННЯ ОТХОДАМИ СОГЛАСНО ДАНИХ ЕС-27 ПО ОТХОДАМ - 2018

Метою цього дослідження є аналіз даних про тверді відходи країн Європейського Союзу та встановлення взаємозв'язку між системою поводження з відходами та видами відходів з точки

зору географічного розташування, соціально-економічного та науково-технічного сприйняття для кожного регіону. Відповідно до загальноприйнятої думки в суспільстві, чим більше доходу, тим більше знань приносить людина, яка повинна створювати менше побутових відходів. Іншими словами, якщо країна економічно розвинена, то її людей потрібно добре навчити і знати, як не утворювати більше побутових відходів. Перше, що слід розглянути в цій статті, - це проаналізувати різні наукові підходи щодо зв'язку даної проблеми. Інший аспект полягає у використанні даних Статистичного бюро Європейського Союзу, а саме Євростату, аналіз джерел відходів кожної країни, про який йдеться у цій статті, тобто, знаючи виробничий район країни, типи енергетичних ресурсів, культурну поведінку, сільське господарство та інші соціально-економічні. У цій дослідженні для аналізу результатів аналізу передбачено результати аналізу для спостереження за утвореними відходами та їх ресурсами. Аналізуючи цифри соціально-економічних структур, можна передбачити майбутні дані про відходи, зрозумівши взаємозв'язок. Сьогодні стає все важливішим прогнозувати утворення відходів, оскільки, як згадувалося в цій статті, не у всіх країнах є достатньо землі, щоб застосувати процес звалища, який є як неефективним з точки зору економічних причин, так і з повагою до природи. Оскільки поводження з відходами - це факт, з яким потрібно поводитися залежно від способу утворення відходів; таким чином, для визначення найкращого варіанту необхідні соціально-економічна структура, точні методи прогнозування. У цьому дослідженні дані Європейського Союзу здебільшого розглядаються та аналізуються, оскільки Туреччина включена до цього дослідження роками. Необхідно зазначити, що всі ці дані належать до 2018 року, оскільки кожні дані збираються двічі на рік та надаються через 2 роки. Таким чином, дані за 2018 рік - це найсвіжіші дані, які були опубліковані в жовтні 2020 року згідно з пояснюваною статистикою EuroStat.

Ключові слова: 2018 рік, економічний розвиток, Європейський Союз, соціально-економічна структура, поводження з твердими побутовими відходами