Garbage Data Collection Analysis

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Abstract

Due to inadequate recycling and waste management, plastic pollution is increasing steadily. Factors contributing to this issue include rapid population growth, limited waste management infrastructure, changing consumption patterns, and cultural norms. Comprehensive waste management reforms, infrastructure investments, and public awareness campaigns are vital for addressing this environmental challenge.

I. INTRODUCTION

Solid waste management is a critical issue with far-reaching implications for the environment, public health, and overall quality of life in countries worldwide. Effective waste management is not only crucial for maintaining clean and healthy living conditions but also for conserving natural resources and mitigating the impact of waste on climate change. This project aims to investigate the relationship between a country's waste management policies and the volume of garbage waste generated, with a central focus on understanding potential correlations. The dataset we are working with provides comprehensive information on solid waste management, including garbage composition, policies, and related factors for a diverse set of countries. This data encompasses details such as a country's income level, population, types of special waste (e.g., agricultural waste, hazardous waste), waste treatment methods, and the percentage of the population covered by waste collection services, among other factors. The goal behind this project is to better understand the disparities in waste management practices and their impact on the environment and society. In this project, we will be looking at the relationship between a country's income level and its waste generation and management practices, potential correlations between the percentage of the population covered by waste collection services and the amount of waste generated, the prevalent waste treatment methods used by countries and their influence on overall waste composition, and the potential connection between national policies, including regulations and enforcement, and a country's waste management outcomes. This report aims to help better understand the complexity between these variables holds significance not only in academic circles but also for policymakers, environmentalists, and the broader community. The insights gained from this research can guide the development of more efficient and sustainable waste management strategies, identify areas where improvements are needed, and contribute to global efforts to address the growing challenges posed by waste and pollution. Ultimately, this project strives to provide valuable insights into the global landscape of solid waste management, offering data-driven recommendations and best practices for countries seeking to enhance their waste management systems. The goal is to encourage evidence-based decision-making and support the development of policies that can lead to a cleaner and more sustainable future for our communities and our planet.

A. Dataset

The dataset that is being examined is a comprehensive collection of data about solid waste management procedures along with factors across multiple nations. This dataset, which includes information on waste creation, recycling, disposal techniques, and the regulatory environment, provides insightful information about how various countries treat and manage their solid waste.The World Bank Data Catalog, a reliable and trustworthy source for a variety of international statistics and economic indicators, is where the dataset was found.

This dataset spans data from a remarkable 216 countries across the world, providing a truly global perspective on solid waste management practices. With a diverse array of attributes, this dataset provides a holistic view of the global solid waste landscape, making it a valuable resource for understanding the sustainability and environmental impact of waste management practices. It offers a deep dive into areas such as waste composition, population-related waste statistics, waste treatment techniques, and the availability of solid waste

information to the public.

This data is of great significance in the context of environmental sustainability and policy development. By analyzing this dataset, researchers, policymakers, and environmentalists can gain a comprehensive understanding of the state of solid waste management across different countries, enabling the identification of trends, disparities, and areas for improvement. Moreover, it serves as a foundation for evaluating the efficacy of various waste management strategies and their implications for the environment and public health. The dataset contains a variety of variables, some of which may contain missing values, and careful data preprocessing and analysis are essential to draw meaningful insights. Researchers and data analysts can employ this dataset to uncover patterns and correlations in solid waste management practices on a global scale, providing valuable inputs for informed decision-making and environmental conservation efforts.

B. Exploratory Data Analysis

1. Data Preprocessing

Data preprocessing is a crucial data mining technique that we will employed to convert raw data into a more usable and efficient format.

2. Steps Involved in data preprocessing: Data Cleaning

Raw data frequently includes both meaningless and missing items. To address these issues, we utilize data cleaning to manage and rectify data that is either missing or noisy.
In our analysis,

1. Column like ‘waste_collection_coverage_urban_percent_of_geographic_area’ and ‘waste_collection_coverage_total_percent_of_geographic_area’ are dropped where 99.5% of data are missing.
2. When there are data missing in the column, they are replaced with the column value’s median.

II. DATA ANALYSIS

1. Countries and the Waste They Produce within a Year

The graphs are sourced from the dataset found in “country_level_data_0.csv” (*Data Catalog)*. The 214 countries and the amount of trash (in tons) its person produces in a single year is graphed and displayed in Appendix 1. The top 10 countries that generated the most trash per person within a year ranges from 0.96 to 1.38 tons (*figure 1*). The bottom 10 countries that generated the least amount of trash produce per person within a year ranges from 0.04 to 0.09 tons (*figure 2*).

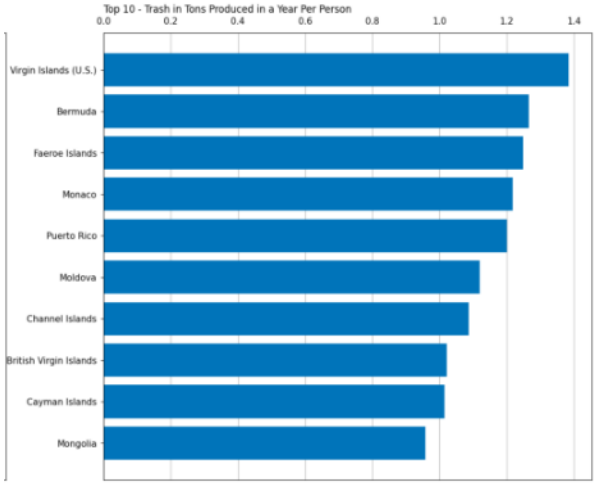

Figure 1. Top 10 countries that produced the most trash (in tons) per person in a year.

Figure 1, represents the top 10 countries that produce less trash, while in consideration of various types of waste such as; food/organic waste, paper/cardboard, and plastic. And these countries are Virgin Islands(US), Bermuda, Faeroe Islands, Monaco, Puerto Rico, Moldova, Channel Islands, British Virgin Islands, Cayman Islands and Mongolia.

The significance of the top 10 countries showcasing lower levels of waste generation is further underscored by empirical evidence provided in various research articles. These studies offer a scientific foundation for understanding the intricate dynamics at play. For instance, research conducted

by Stock et al. (2019) delves into the concept of resource efficiency and the circular economy, shedding light on how these principles are applied in developed nations, resulting in reduced consumption of primary raw materials and, consequently, lower waste generation.

Ananth et al. (2018) contribute valuable insights through their examination of urbanization and its connection to solid waste generation. Their findings not only illuminate the impact of urban planning but also highlight how well-structured urban environments can lead to more efficient waste collection and management practices, which ultimately translate into less waste generation.

The research by Laner et al. (2018) delves into the environmental and health impacts of waste-to-energy technologies. This work demonstrates how the adoption of such technologies can not only help manage waste more effectively but also produce energy, effectively reducing the volume of waste destined for landfills.

Furthermore, Smith and Yang (2019) provide a comprehensive perspective on the influence of consumer behavior and cultural norms on waste generation. Their research uncovers the ways in which public awareness, education, and societal habits shape waste reduction practices, emphasizing the vital role of societal factors in the observed trend.

In stark contrast to the top-ranking countries with lower waste generation, several nations face the daunting challenge of grappling with substantial volumes of solid waste. Rapid population growth, as highlighted in studies such as "Population Growth and Environmental Impact: The Neglected Link" by Bongaarts (2019), has placed immense pressure on these nations' waste management systems. Many of these countries face challenges associated with limited access to efficient waste collection and disposal infrastructure, as outlined in "Challenges of Solid Waste Management in Developing Countries: A Case Study of Gaborone

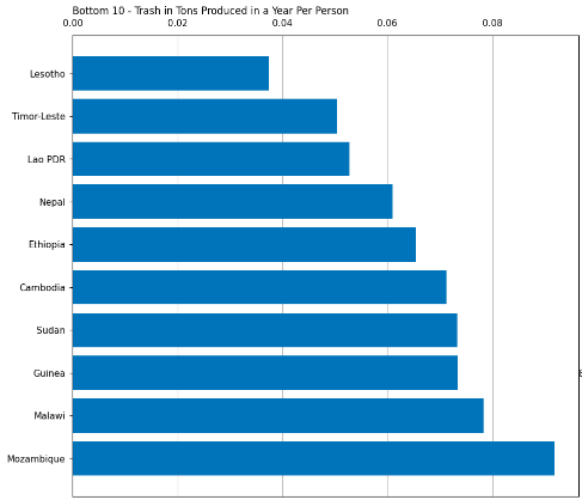

Figure 2. Bottom 10 countries that produced the least amount of trash (in tons) per person in a year.

City Council, Botswana" by Mmereki and Baldwin (2005). These challenges often result in a substantial portion of waste ending up in unregulated landfills or open dumps.

According to meta-analysis conducted by Chen et al. (2020) examines the effectiveness of waste reduction campaigns. This research sheds light on the power of targeted campaigns in encouraging citizens to reduce waste, recycle, and adopt sustainable practices. Such campaigns not only raise awareness but also instigate behavioral changes that contribute to the overall reduction in waste generation.

These research articles, among others, serve as pillars of evidence, offering a nuanced understanding of the multifaceted factors driving the lower waste generation patterns in these top-ranking countries. They provide valuable insights that resonate with the interplay of advanced waste management practices, cultural norms, and public awareness, ultimately shaping the observed trend.

2. Country's GDP Versus Total Waste Generated within a Year

The coefficient between the country's GDP and total trash generated within a year is about 0.67 (figure 3). Therefore, there is some correlation

between these two variables. According to the data, the higher the GDP a country has, the more trash per person a country produces. This is consistent with society's belief that the more afluent a country is the more wasteful the population is due to higher production means higher consumption. However the correlation is not one, even though there is a positive trend. Thus, the average is that countries with relatively high GDP do create more waste to some extent (Blagoeva et al., 2023).

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Correlation Coefficient: 0.669037547320491
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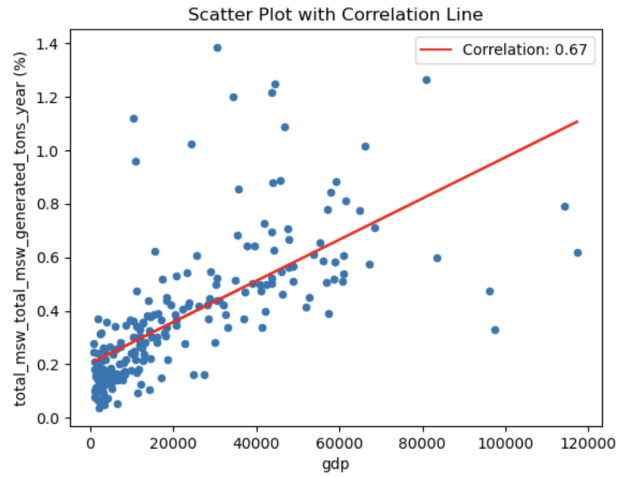

Figure 3. The correlation between the country's GDP and total trash generated within a year.

By examining figure 4 and 5 on the ten highest and ten lowest GDP countries relative to the total trash they generate, the ten lowest GDP countries produce a lot more trash over the GDP they produce. In comparison, the ten highest GDP countries produce relatively less trash in comparison to the GDP it has. This is the result of countries with more wealth have more money to spend on creating better waste management and waste infrastructure. Therefore, resulting in more less waste in comparison to its GDP. On the other hand, poor countries do not have the funds to manage their trash production nor create an efficient waste collection infrastructure. This creates inefficient use of resources. Thus, more waste generated (Blagoeva et al., 2023).

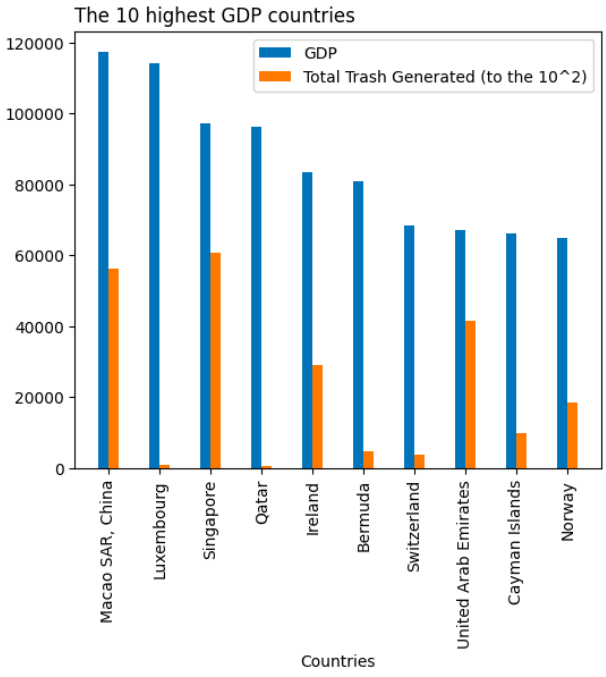

Figure 4. The 10 highest GDP countries measured against the total trash they generated within a year.

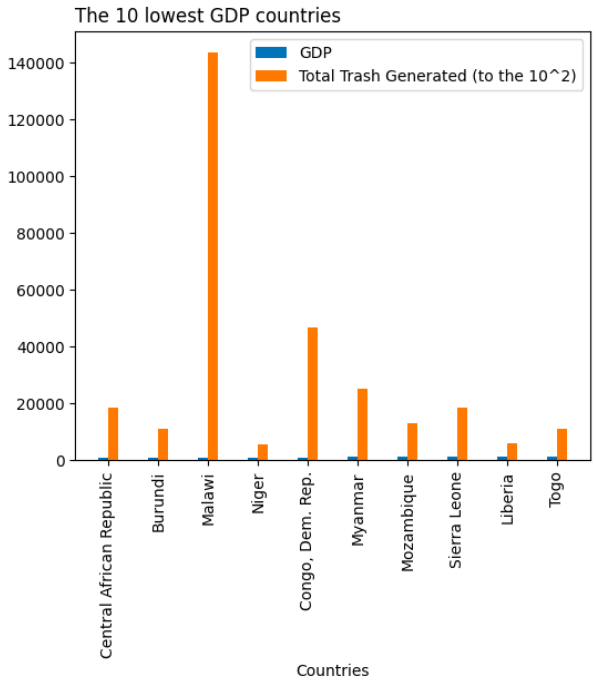

Figure 5. The 10 lowest GDP countries measured against the total trash they generated within a year.

3. Categories of Waste

The amount of waste a country produces can be categorized into nine sections, food organic

waste, glass, metal, paper and cardboard, plastic, rubber and leather, wood, yard trimmings, and other. Figure 5 shows that food organic waste by average encompasses 42.25% of the waste generated by a country.

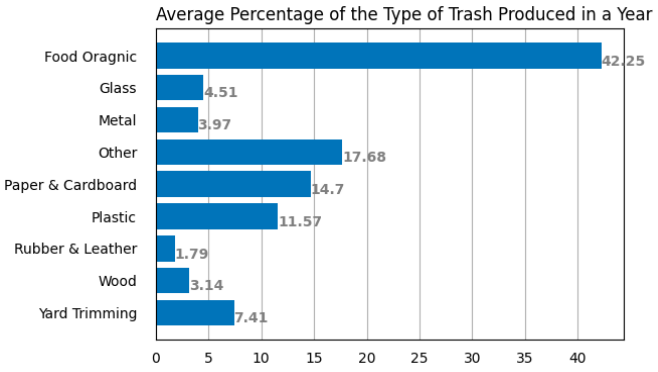

Figure 5. The average percentage of the type of trash produced within a year.

Taking the conclusion of figure 5 and comparing this data trend to GDP, there is a negative correlation of 0.41 between food waste and a country' GDP. This exemplifies that the more GDP a country has, there is some impact of the amount of food waste generated. This may be due to the inefficient use of resources (Blagoeva et al., 2023). Explained in "Impacts of food wastage on economic growth," there is a correlation between food waste and poverty. When food waste is reduced, this stimulates GDP (CM, 2022).

Figure 7 displays the correlation between food organic waste and paper/cardboard has a negative correlation of 0.47. This implies that as the number of organic food waste increases, the number of paper/cardboard tends to decrease. However, the correlation between organic waste and paper/cardboard is not a strong one. This is further exemplified in figure 8 and can be seen in the 10 countries where trash per person is the lowest. The initial assumption was food/organic waste are stored in containers, often wrapped in material like the paper commonly used in many fast-food establishments such as grocery stores. However, that seems to be not the case. In some countries, there is

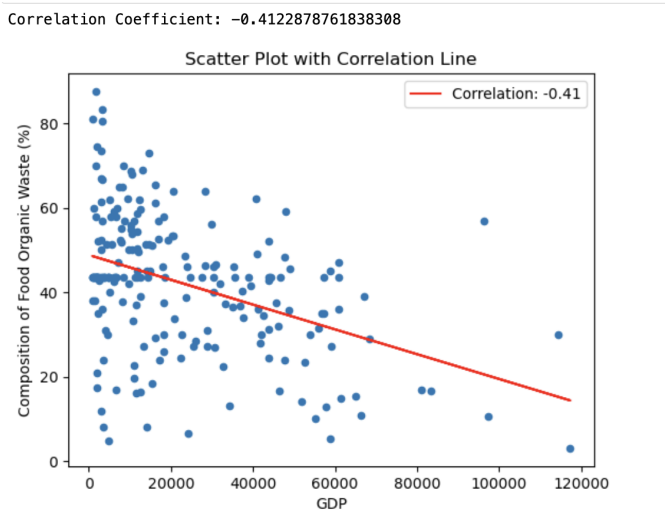

Figure 6. The correlation between the country's GDP and percentage of food organic waste produced in a year.

an innovative approach, referred to as "food waste paper," where it involves recycling food waste and transforming it into paper. This may offer a plausible explanation between the negative correlation between food organic waste and paper/cardboard.

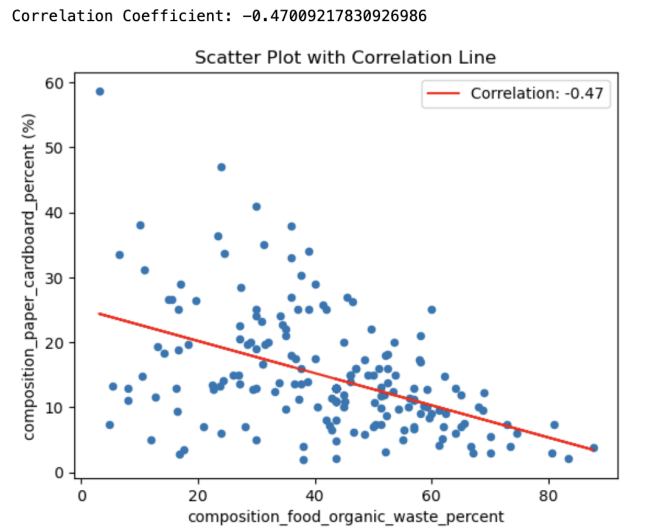

Figure 7. The correlation between the the percentage of food organic waste and percentage of paper and cardboard produced in a year.

III. COMMUNITY CONTRIBUTION

The project focuses on the annual waste production of various countries and holds the potential to greatly benefit our community. By

creating education and analysis on the extensive waste generated globally and the variables influencing lower waste production in certain nations, the community can raise awareness about their own garbage consumption and its environmental impact. This newfound knowledge empowers everyone to make informed decisions about their daily habits and lifestyle choices, paving the way for reduced waste production within the community. Through understanding the correlations between GDP, waste generation, and management practices, everyone can work collectively to adopt more sustainable and responsible waste management strategies, contributing to a cleaner and healthier environment for the local community and beyond.

Advocate for policies aimed at reducing trash waste: The findings in this research can serve as compelling evidence to urge local politicians and policymakers to prioritize sustainable waste management practices and implement regulations that incentivize recycling, waste reduction, and responsible disposal. With a collective voice and a data-driven approach, everyone can work towards a cleaner and more environmentally conscious community while encouraging our leaders to take action in reducing waste generation and its long-term impact.

Community Collaboration: By understanding the reduction of waste potentially stimulates GDP helps country's economy, this encourages collaboration between both beneficial parties, the community and the government. This collaboration will make it easier for the country to get in contact waste engineer experts and help accurately build an efficient waste infrastructure to collect, recycle, and transport waste.

Measurement and Reporting: The community and government should continue to keep track and record the volume and quantity of waste. As shown from this research, having these data to analyze allows for consistent adjustment in the country's policies and regulations to better improve the waste infrastructure. Data will help highlight the positive and negative outcomes and what affected the results.

Awareness and Educational Opportunities: This paper can help the future generations better understand their ability to drive change. Not only can they make changes in their day to day lives in reducing waste, but they can also empower themselves by pushing politicians to make more environmentally friendly waste laws that they may have seen in other countries.

Together, we can be agents of change, fostering a more sustainable future for our community. We hope this report serves as a good way to empower the community to lead a less wasteful lifestyle.

IV. CONCLUSION

In conclusion, this research discusses and analyzes global solid waste management, exploring how it plays a role in environmental health and society's well-being. It reveals valuable insights, including the correlation between a country's income level and waste generation. High-income nations generate more waste in absolute terms but manage it more efficiently, emphasizing the need for robust waste management systems. The report also stresses the importance of community involvement, education, and policy advocacy to reduce waste generation and promote recycling. Together, we can foster a more sustainable future, promoting responsible consumption and a cleaner environment.

V. REFERENCE

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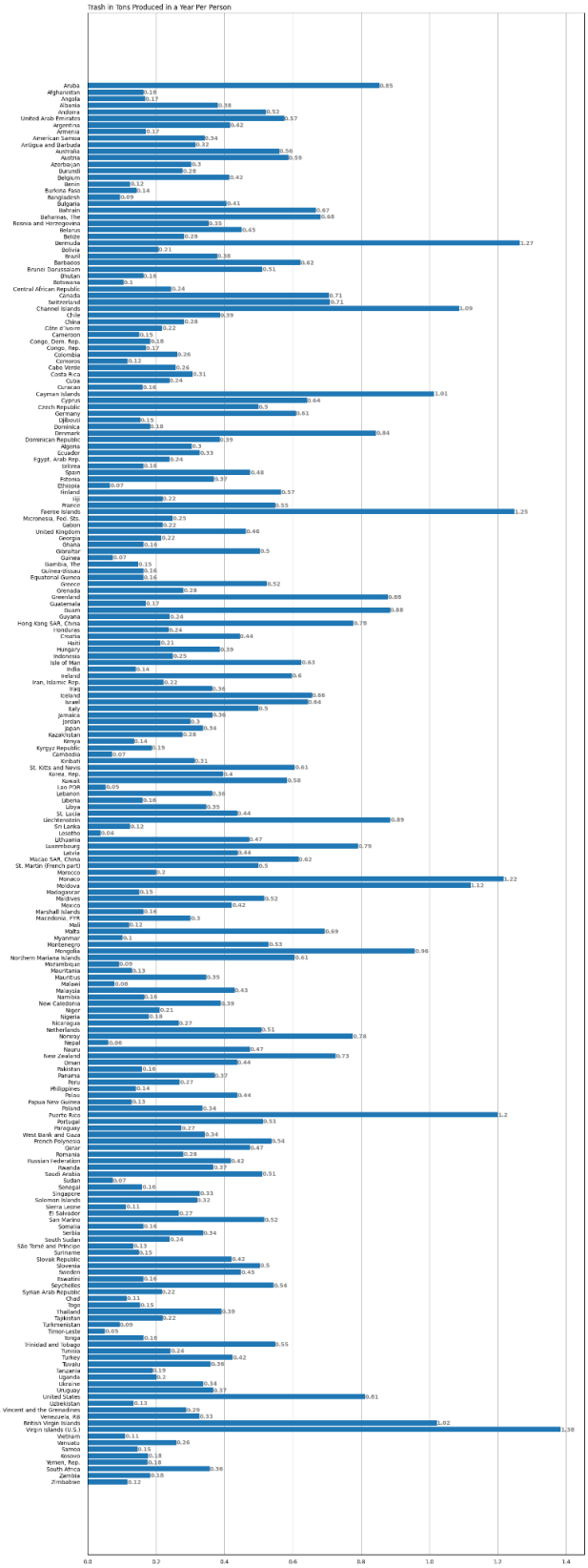
VI. APPENDIX



Appendix 1. The amount of trash (in tons) a person generates within a year in 214 countries.