Project Zero Waste

Hannah Gettman, Will Harrison, Caroline Moy, Deven Parikh
ZeroWaste.Org
Graham Sustainability Scholars Final Report
2024

Executive Summary

[ZeroWaste](#).org is a non-profit organization dedicated to the reduction of waste in communities and achieving a circular economy. This organization works collaboratively with municipalities and directly with the community. Acting both as a consultant and an organ for tangible community behavioral change, Zero Waste seeks to restructure local economic structures in both realistic and conceptual ways. Many organizations and actors dedicated to waste reduction focus on the transition to compost and recycle, and thus reducing trash waste. Alternatively, zero waste pursues a goal of reduction of all waste; trash, compost, and recycling. This reduction seeks the broader, more abstract goal of achieving a circular economy where there is no waste or emissions outside of a closed loop flow of resources.

In order to assist ZeroWaste.org, our project activities involved researching and designing metrics to evaluate the success of zero waste programs with the end goal of contributing to a replicable and user-friendly scorecard. To establish these metrics, research was conducted to better understand the concepts of zero waste and the circular economy. Our next steps involved applying our individual skill sets to measurable dimensions of ZeroWaste.org's activities. These included developing metrics related to economic parameters, the relationship between businesses and ZeroWaste.org, meaningful and relevant waste reduction policies, and members' participation and communication with the organization.

Our overall anticipated impact is an improved system for ZeroWaste.org to measure and communicate progress toward a circular economy using individual waste benchmarks, engagement with ZeroWaste.org, and policy evaluations. Furthermore, our group discussions with ZeroWaste.org leadership provided an important forum to share ideas, combine and build upon knowledge, and make more targeted recommendations. Our metrics and rudimentary score card will provide important insights into the successes, areas for improvement, and direction of ZeroWaste.org initiatives internally. Furthermore, these metrics will be useful tools for communicating with community members and municipalities to promote waste reduction initiatives, share knowledge, and encourage collaboration with the organization ZeroWaste.org.

It is important to note the context and limitation of our metrics in the application of our deliverables. The data we used to produce our metrics is highly contextual and thus the conclusions drawn from the metrics should account for this. In order to draw more specific conclusions around the impact of ZeroWaste.org's communications and engagement strategies, we recommend that ZeroWaste.org invest in the collection of more user data. We also see opportunities for the broader application of these metrics as more communities and programs pursue ambitious waste management strategies, which we expect will therefore, promote the collection of more robust data.

Introduction and Background

The rise and acceleration of technological advancements have not only led to an increase in greenhouse gas emissions but also increased consumption. More consumption unfortunately leads to more waste, which puts a strain on our energy systems, ecosystems, and waste management resources. According to the International Monetary Fund, this problem is especially prevalent in more developed countries because citizens of these nations produce over double the amount of waste than those of developing countries ("Waste Woes…"). Therefore, there has been an effort to decrease our waste by consuming less, hence the zero waste movement. However, the emergence of this movement is fairly new, so its resources and ability to track its success are fairly limited. The zero waste movement is bigger than just the sustainability impacts, as it affects economic practices, local and federal policies, and how individuals change their relationships with the things they own and consume.

Before diving into our specific project, it's important to define some key terms related to zero waste. First and foremost, zero waste is "the conservation of all resources by means of responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health" ("How Communities…"). However, how zero waste goals are set and achieved is heavily dependent on the specific community as some communities focus solely on the diversion rate of waste out of landfills versus the economic goals of achieving a more circular economy. A circular economy is an economic system that prioritizes reducing, reusing, recovering and recycling of materials as opposed to the current linear economic system of consumption - purchasing, using, and disposing (for example, a bike repair shop would be part of a circular economy). Finally, the diversion rate is the amount of waste that's kept out of landfills each year (usually as recycling or compost). However, this metric does not account for a community simply consuming less over time. While diversion rate is often used as a metric, it does not reward reduction in consumption practices.

We focused on creating metrics to evaluate zero waste practices at the local level, specifically in Ann Arbor, with the goal of making these metrics generalizable to other cities. Our partner, ZeroWaste.org, tasked us with creating a "scorecard" to define and score zero waste practices in Ann Arbor at the individual, economic, business, and policy levels.

Methods

Our team had a variety of specialties that included economics, statistics, public policy, and business administration. We were tasked with helping ZeroWaste.org strategize on how to

enhance their impact. Our approach was based on dividing the project work into our four specialty areas.

Consumer Profile Development

To better understand ZeroWaste.org's current engagement with businesses and consumers, as a first step we wanted to understand Zero Waste's current capabilities by exploring ZeroWaste.org's website, reviewing ZeroWaste.org's current partnerships, and mapping out how and where resources could be allocated to expand the organization's reach. ZeroWaste.org has a variety of resources that are helpful for households, communities, and businesses; however some of the information could be daunting to people first starting their zero-waste journey. To address this, we reorganized the resources and information on the website to be more accessible to a wider audience and to emphasize the steps and progression a person might take on their zero waste journey. She organized the information into four stages so consumers could self-identify the stage they are in and then make changes in their day-to-day life according to their self-identified stage recommendations. By having information organized in this format, information is more accessible to different user types

Waste and Economic Analysis

The methodology to understand economic benchmarking utilizes simple statistical methods and data sets available from government organizations. Averages and variance are used to determine benchmarks from Ann Arbor waste data. To determine the relationships between economic factors and waste production patterns we utilized data sets on waste from the EPA and economic factors came directly from the Federal Reserve Bank of St. Louis. In order to establish relationships, simple linear regressions with one dependent variable were used utilizing Google Sheets. Lastly, we collected and comparing sister city municipality waste management budgets utilizing data directly from municipal publications.

Individual Engagement Analysis

To understand individual engagement with zero waste practices we used statistical software to perform email contact scoring. We chose to analyze email engagement because it had the most robust data around the percentage of Ann Arbor residents who were engaging with ZeroWaste.org as a whole. We made the assumption that residents who are engaging with the organization via email are practicing zero waste habits in their daily lives. ZeroWaste.org uses HubSpot, an online tool for small businesses to track email habits including: number of emails opened, number of links clicked in each email, number of individual replies, etc. This tool makes data analysis fast and efficient. This information can be downloaded as a CSV file, comma separated values file, into R Studio where data cleaning and metrics of interest can be extracted. When data cleaning, we first extracted the columns of interest and renamed them with more

intuitive names. We then selected Ann Arbor analysis and computed open rates, click rates, and replied rates. Then, in collaboration with the partner, we decided to focus on open rate to determine individual engagement. We defined the benchmarks of different engagement classifications as inactive, new user, low, medium, high engagement, and superstar. We were further able to provide the top 25 ZeroWaste.org email engagers so that future surveys on their zero waste habits can be performed. The file for data analysis is reproducible and in the future, ZeroWaste.org simply needs to input the path of the data file and the program will output all metrics measuring user engagement. All these steps were done in collaboration with the partner to ensure it met their needs in terms of understanding engagement.

Policy Scorecard Development

The methods for creating the policy scorecard involved researching the top sustainable cities worldwide. We looked for press releases and information on city websites to determine the policies they had implemented. We also explored legislative websites for various cities, searching for information related to zero waste. We compiled information from these sources into a master document, removing duplicates. Then, we organized various legislative actions into categories. Using policy examples from these model cities, we developed a survey targeting municipalities interested in learning about policy options. After a municipality completes the survey, they are given a scorecard which identifies actionable opportunities for improvement based on the initiatives of the model cities.

Deliverables

Consumer Profiles

Four consumer profiles were created based on the analysis of ZeroWaste.org's email engagement (see Individual Engagement Analysis). As seen in Figure 1, each consumer profile includes guidelines for what each level of consumer can implement to lead a better zero-waste lifestyle. These graphics are being implemented into the ZeroWaste.org site and as a strategy to better target consumer tendencies.

ZERO WASTE CONSUMER PROFILE

BEGINNER

- Start recycling; set aside your plastics, and if in MI, collect your cans to receive 10 cents back

- Choose paper bags instead of plastic bags at the grocery store and use the paper bags as recycling bags

- Opt for electronic mail and bills instead of physical statements; change paper and magazine subscriptions to be online

INTERMEDIATE

- Buy items in bulk to limit waste and refill products as needed from the main supply, instead of repurchasing the smaller packaging

- Bring reusable bags to the grocery store, use reusable water bottles instead of plastic bottles, use reusable cloth napkins instead of paper napkins

- Buy quality items that will last a long time versus multiple items that do not last long

ZERO WASTE CONSUMER PROFILE

ADVANCED

- Start composting using food scraps such as vegetable peels and coffee grounds in a bin under your sink or in your garage

- Unplug electronic devices when not using them to limit energy consumption, reduce the amount of air conditioning in your house or opt for opening window instead; switch to LED lightbulbs

EXPERT

- Reduce meat consumption and opt for vegetarian proteins
- Buy organic products
- Grow your own vegetables
- Support local farms and local restaurants

- Share your zero-waste journey with friends and family
- Donate to zero-waste initiatives

- Drive electric vehicles instead of gas-powered cars
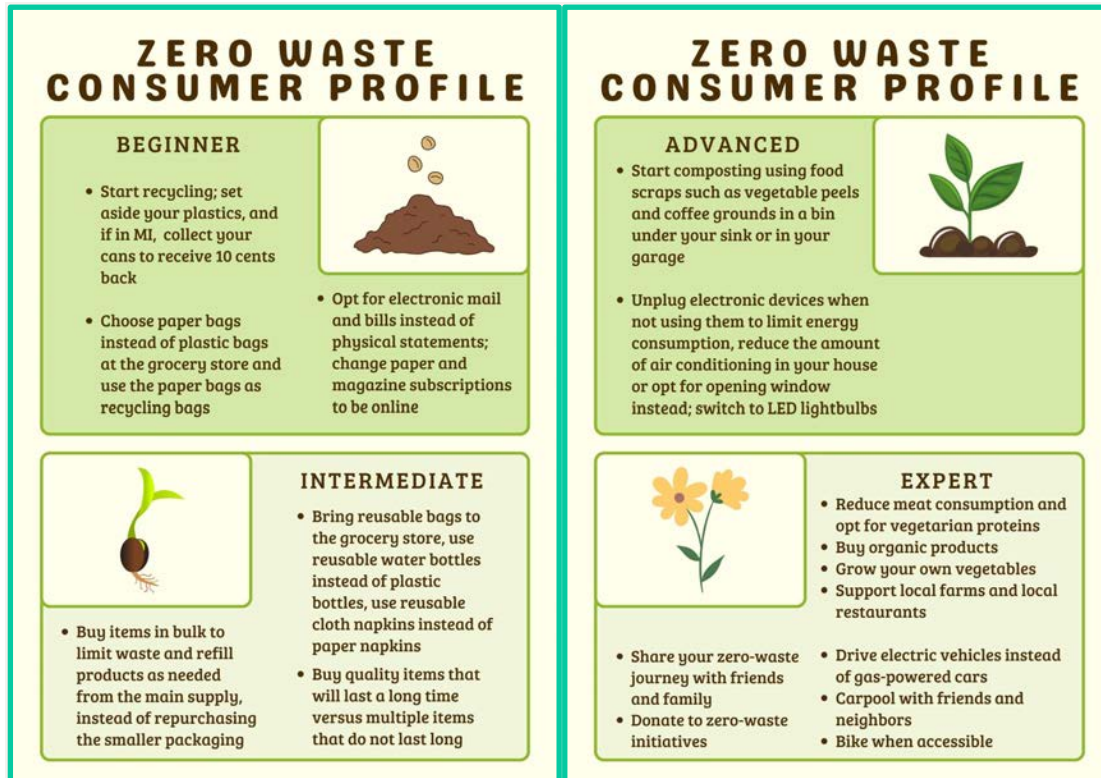- Carpool with friends and neighbors
- Bike when accessible

Figure 1: Consumer profiles showing actions consumers can take to reduce their waste based on their level of engagement with zero waste: beginner, intermediate, advanced, and expert.

Waste and Economic Analysis

In collaboration with ZeroWaste.org, we established a benchmark to indicate a municipality had made a significant change in waste production. This was necessary because from year to year, there is consistent variation and noise in the production of data. To do this, we averaged the total waste data for the past 5 years and decided that a reduction of two standard deviations from this average would indicate a significant difference has occurred. Figure 2 below shows the year to year waste data and benchmarks in Ann Arbor. We want to note this assumption does not capture the effect or importance of trends. In other words, this is just one benchmark of change in waste patterns. Nevertheless, it's useful in visualizing and determining loose relationships between these factors and comparing national trends to Ann Arbor to see if there is meaningful, relative

change in Ann Arbor.

Figure 2: "Ann Arbor Total Waste Pattern Compared to Benchmark"

Connecting Waste Data to Economic Factors

Waste production is highly connected to other economic factors. We attempted to understand the relationship between different types of waste production (landfill, recycling, and compost) and economic variables like real gross domestic product per capita (a proxy for income per capita) and gross retail production. Figures 3 and 4 show examples of the linear relationships between these factors.
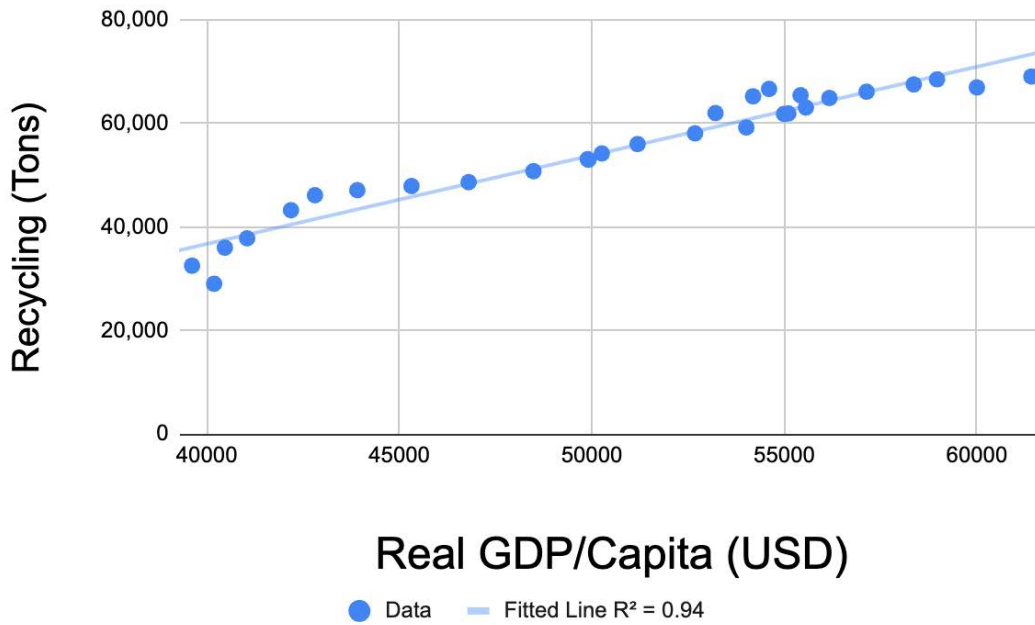
Figure 3: "National Recycling (Tons) and Real GDP/Capita (USD) In the United States (1990-2018)"
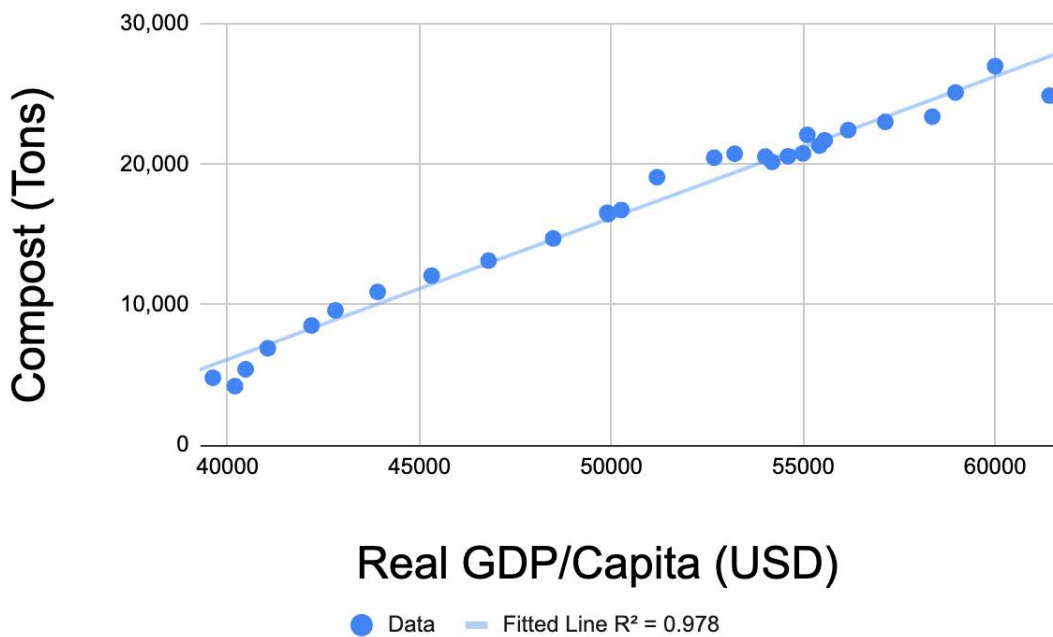
Figure 4: "National Compost (Tons) and Real GDP/Capita (USD) In the United States (1990-2018)"

Figures 5 and 6 below show comparisons between waste generation and real GDP per capita (a proxy for income per capita) over time in Ann Arbor and nationally. The metric graphed here is the ratio between the amount in tons of waste to real gross domestic product per person. This is essentially done to track the change in waste patterns when controlling for the size of the economy. It is evident that nationally from 1990-2008, the amount of trash waste per unit of economic activity has gone down, demonstrating the economy has become more efficient in regards to reducing trash. Although it should be noted that trash production still does increase. Similarly, Ann Arbor has become more efficient in trash per unit of economic activity, although the gradient is much flatter than the national trend. However, the time frame is different due to data unavailability, so a direct current comparison can not be made. Importantly, neither recycling nor composting has become more efficient on a national or local Ann Arbor scale, demonstrating that the goal for a zero waste economy, which includes limited composting and recycling, is far off. These relationships should be considered in the development of future waste policies.
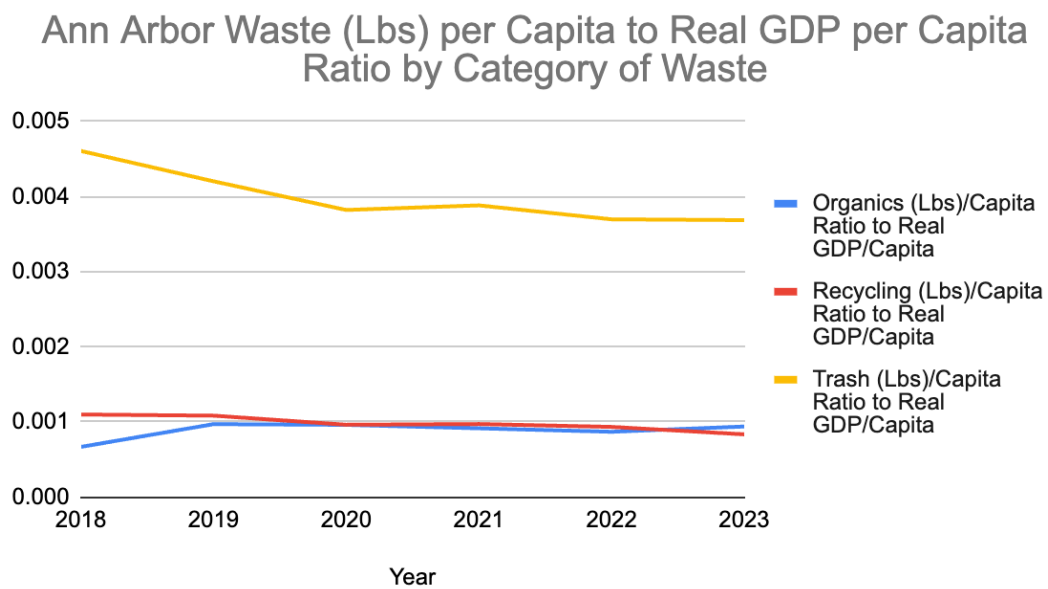

Figure 5: "Ann Arbor Waste (lbs) per capita to real GDP per capita Ratio by Category of Waste (2018-2024)"

National Waste (lbs) per Capita to Real GDP per Capita
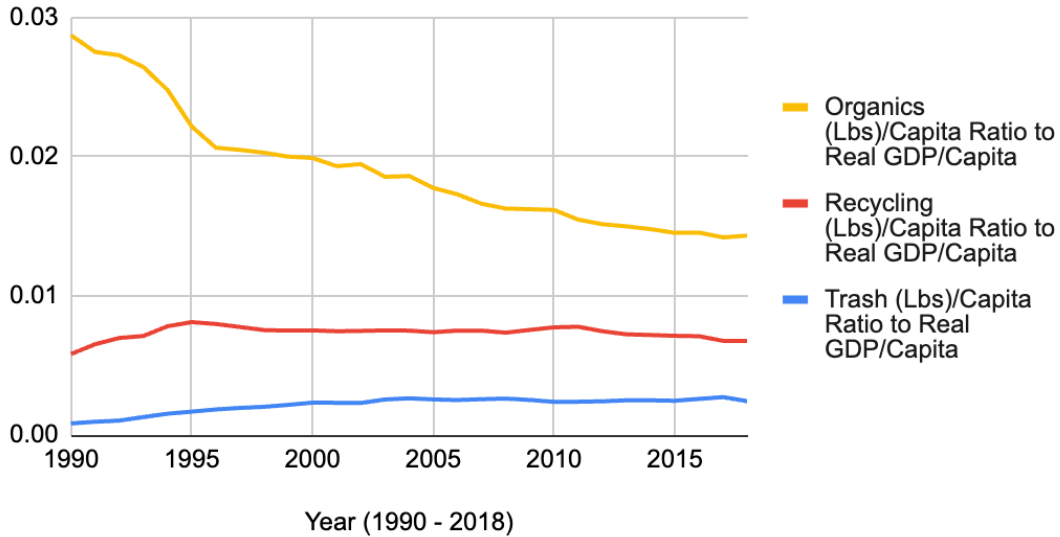Ratio by Category

Figure 6: "National Waste (lbs) per capita to real GDP per capita Ratio by Category of Waste (1990-2018)"

Determining Municipal Finances

In order to accurately understand waste management financials in Ann Arbor, we compared Ann Arbor's city budget to comparable city budgets. The compiled data can be viewed here: Sister City Municipal Expenditure Benchmarking. The key takeaways from this documentation are numerous and insightful. Firstly, Ann Arbor spends much more on waste management per resident. Over the past 5 years, Ann Arbor spent an average of $162 per resident while the average of the similar sister cities was only $69. This demonstrates that there is likely an opportunity to lessen cost burdens related to waste management. Another important takeaway is waste management for this grouping of American cities is often a source of revenue for municipalities, and thus, a program focused on zero waste should consider the role of waste management programs in supporting municipal budgets.

Limitations of Economic Analysis

In regards to the economic benchmarking, it is imperative to understand the limitations and context of the data and methods. In determining what is significant change in total waste the standard of two standard deviations does not capture the effect or importance of trends. In other words, this is just one benchmark of the aspects of change in waste patterns. It is also important to understand establishing relationships between economics factors and waste patterns is not a robust regression analysis. Nevertheless, it's useful in visualizing and determining loose

relationships between these factors and comparing national trends to Ann Arbor to see if there is meaningful, relative change in Ann Arbor. These relationships should also be considered in the implementation of future policy. There is also opportunity for further expansion of the municipal data collection to be used in contracts with new municipalities.

Individual Engagement Analysis

The individual engagement analysis was performed using current ZeroWaste.org user data. The data analysis program was made to be reproducible so the partner organization can continue to track their engagement overtime. This file is in the form of an R Markdown file, which when run with new data will produce a PDF describing user behavior. In Figure 1 below is an example of what would be outputted in the PDF when the program is run.
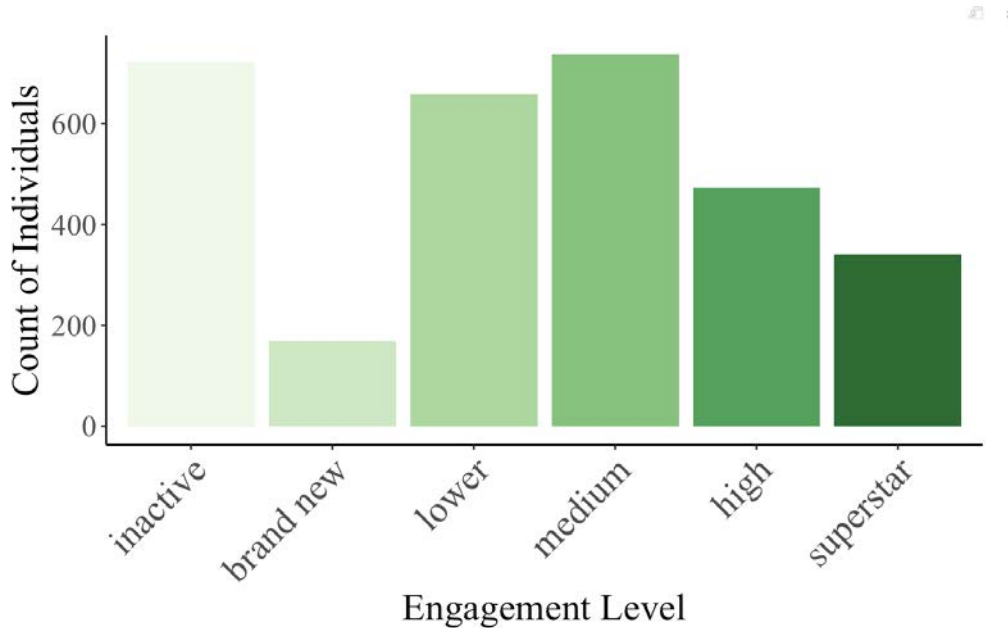

Figure 7: Number of Individuals in Ann Arbor engaging with ZeroWaste.org by Engagement Level.

When analyzing email open rate of ZeroWaste.org members in Ann Arbor, we found that 50% of Ann Arbor ZeroWaste.org members are opening the emails 30% of the time or less. Based on these results, we recommend that different email campaigns and strategies are practiced to catch those users that have been less likely to open the emails; for example experimenting with catchier email subject lines. As different email strategies are utilized, ZeroWaste.org can perform the same email open rate analysis to determine if the new strategy results in an increase in the open rate.

Policy Scorecard

The policy scorecard we developed provides a comprehensive and scalable framework for assessing municipalities' progress toward achieving zero-waste goals. It includes multiple indicators to evaluate various aspects of waste management, such as the regular monitoring and recording of waste production, the setting and achievement of specific reduction targets, and public transparency in waste metrics. Additionally, the scorecard reviews the implementation of city-wide programs aimed at reducing waste at the source, promoting repair and reuse practices, and increasing community engagement through educational events and collaborative initiatives.

By collecting data on local policies and programs, the scorecard identifies actionable opportunities for improvement, helping cities adopt best practices in waste reduction and diversion.

The policy scorecard also serves as a valuable tool for collecting information on government initiatives, allowing ZeroWaste.org to identify cities that may benefit from additional support to meet their zero-waste goals. Since the creation of the scorecard, no city has fully achieved zero waste. As new cities adopt policies and innovative ideas emerge, the scorecard should be regularly updated to reflect current developments. As more cities implement these initiatives, we will gain a clearer understanding of the effectiveness of specific policies. Currently, there is limited data comparing which policies work best. Therefore, we should continue to update the scorecard values as new data becomes available.

Since the creation of the scorecard, no city has fully achieved zero waste. As new cities adopt policies and innovative ideas emerge, the scorecard should be regularly updated to reflect current developments. As more cities implement these initiatives, we will gain a clearer understanding of the effectiveness of specific policies. Currently, there is limited data comparing which policies work best. Therefore, we should continue to update the scorecard values as new data becomes available.

Impact

We have provided ZeroWaste.org with tools to measure the results of their engagement with the community, and accessible resources to further engage with community members. We expect these tools and resources to result in the Ann Arbor community engaging more with zero waste practices and ultimately a reduction in waste generation.The engagement metrics will provide multiple benefits. We expect they will help guide ZeroWaste.org in understanding and quantifying its impacts. Additionally, these metrics will be a powerful tool for communicating with the public and municipalities. Visualization of the change in data, compared with economic factors, can be a compelling tool to motivate changes in behaviors and contextualize waste

patterns. These metrics further provide an opportunity to show potential new municipal clients the benefits of waste reduction.The policy scorecard will equip ZeroWaste.org with a structured tool for assessing municipal waste management practices, helping them identify immediate areas for improvement. Over the next year, this tool will facilitate targeted outreach to cities, allowing ZeroWaste.org to provide actionable recommendations, such as enhancing recycling programs, setting measurable waste reduction goals, and increasing community engagement.

Acknowledgements

Thank you to our project partner at ZeroWaste.org, Sam McMullen, for sharing his organization with our team. We enjoyed working with the themes of the organization and the opportunity to apply our specific knowledge to a great cause. We would also like to thank the Graham Sustainability Scholars program and specifically Bridget Gruber for her continued support throughout the past year. Bridget's work with our group in making sure we were on target and answering any questions we had made our project successful and we would have not been able to do it without her.

Works Cited

"How Communities Have Defined Zero Waste." *EPA*, Environmental Protection Agency,
    www.epa.gov/transforming-waste-tool/how-communities-have-defined-zero-waste.
    Accessed 17 Nov. 2024.

"Waste Woes in the World." *IMF*, 31 Jan. 2020,
    www.imf.org/en/Blogs/Articles/2020/01/31/waste-woes-in-the-
    world#:~:text=Economists%20have%20looked%20at%20the,per%20capita%20than%20
    developing%20countries. Accessed 17 Nov. 2024