Introducing New Metrics for Visualizing UIC's Waste Reduction Efforts

Independent Research Report

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Abstract:

CAIP Strategy 5.0 Sustainable Materials and Reduced Waste Streams requires that each UIC department creates and implements their own zero waste plan. To better understand their efforts and progress, my research focused on introducing two new metrics to waste reduction data. These two metrics are food recovery and reduction of greenhouse gas emissions. The objective of food recovery is to recover non-contaminated prepared food for donation among neighboring communities or UIC students. The purpose of the greenhouse gas emissions metric is to find out how much emissions are reduced through UIC's waste reduction data in recycling, composting, and landfilling.

Methods:

Data

I used two Excel datasets from UIC's waste reduction data:

1. Data on all the information of the food recovered which includes date, school, food donor, total pounds, types of food, etc. The dataset is divided by excel sheets representing the academic semesters of Fall, Spring, and Summer, starting from Summer of 2014 to Fall of 2020.
2. Data that breaks down the materials in UIC's waste stream. These materials are tons of landfilled material, recycled shredded paper, recycled concrete, recycled wood, recycled mixed metal, recycled drywall, recycled cardboard, recycled bottles & cans, composted yard material and composted food scraps. The data spans for 20 years, from fiscal year of 2001 to the fiscal year of 2021. This dataset was parsed and created by Joe Iosbaker, UIC recycling coordinator.

Tools

- Tableau, a software for data visualization, to create all the graphs and charts in my research.
- Python to clean up data and combine sets as required
- EPA's Warm Model tool to calculate greenhouse gas emissions reductions from three different waste management practices: recycling, composting, and landfilling.

Data Analysis steps:

Food Recovery Metric

I considered two perspectives for visualizing the food recovered dataset (1) the total tons of food recovered annually starting from the fiscal year of 2015 and (2) the count of how many times a food donor donated throughout all the years.

Since the food recovery dataset is divided by academic semesters and I wanted all the information in one sheet, I used python to combine the sheets. I removed all columns except for the columns of date, total pounds, and food donors. Then I created individual Excel files for the fiscal years of 2015, 2016, 2017, 2018, 2019, 2020, and 2021.

I used the date and total pounds data to get total tons of food recovered annually. I combined totals pounds for each fiscal year and converted pounds to tons. Once I had all the information I needed, I used Tableau to graph the data. Because the data is not continuous, the most appropriate graph type to use is histograms.

For the second perspective, I experienced some challenges counting the number of times a food donor donated. These challenges included misspelling of food donor names and different spelling of the same donor. To correct misspells I used the python package pyspellchecker. I ran every single food donor name in all the years through the pyspellchecker correction tool and retrieved the correct spelling of each food donor name. As for the problem of different spellings, I used a python library by the name of regular expressions. This library allows for searching a text for a specific sequence of characters. For example, if I have the spellings UI Hospital & UI Health Hospital, both refer to the same thing but, in a graph, they will be labeled separately. Since they both share the same sequence of "UI" followed by "Hospital," I would use this sequence in the regular expression and label any food donor that matches the sequence as UI Health Hospital to keep the naming consistent.

I graphed the data as a percentage pie chart, to represent each food donor's percentage contribution throughout the years. I also wanted to know what each food donor's contribution was annually, so I graphed them using histograms.

Greenhouse Gas Emissions Metric

To calculate the greenhouse gas emissions reduced through recycling and composting, I used EPA's WARM Model Excel spreadsheet version 15. The spreadsheet contains various categories for the type of material that is either being recycled, composted, combusted, reduced, landfilled, or anaerobically digested. To use the tool, you would input the total tons of the material in the analysis inputs sheet and view results through the summary report sheet.
The dataset I used was provided by Joe Iosbaker and it broke down the type of materials that are recycled, landfilled, or composted in UIC's waste stream. The material I inputted into the EPA tool from the dataset are as listed:

- Tons of Corrugated Cardboard recycled, and the tons landfilled
- Tons of Office Paper recycled, and the tons landfilled
- Tons of Mixed Paper recycled, and the tons landfilled
- Tons of Food Scraps composted, and the tons landfilled
- Tons of Yard Material composted, and the tons landfilled
- Tons of PET plastic recycled and tons landfilled
- Tons of Mixed Electronics recycled, and tons landfilled
- Tons of Mixed Metals recycled, and tons landfilled
- Tons of Glass recycled, and tons landfilled
- Tons of Concrete recycled, and tons landfilled
- Tons of Wood recycled, and tons landfilled
- Tons of Drywall recycled, and tons landfilled

The dataset didn't parse the type of material landfilled as required so I used the percentages of landfill characterization from UIC's 2019 Sustainable Materials Management Plan. Additionally, the initial dataset didn't categorize what material the bottles & cans were made from, so from the

same report I used other percentages, composition of recycled waste, that broke down the material types of bottles and cans.

As recommended by one of my instructors, Cynthia Klein-Banai, I considered two perspectives for the greenhouse gas emissions reduction data (1) total greenhouse gas emissions reduced through recycling and composting plus materials landfilled, and (2) total greenhouse gas emissions reduced through recycling and composting with nothing landfilled. I labeled the former as Model_Original and the latter as Model_Ideal. The metric used for greenhouse gas emission in the EPA's tool is carbon dioxide equivalent ($MTCO_2E$).

Results & Visualization:

Food Tons Recovered

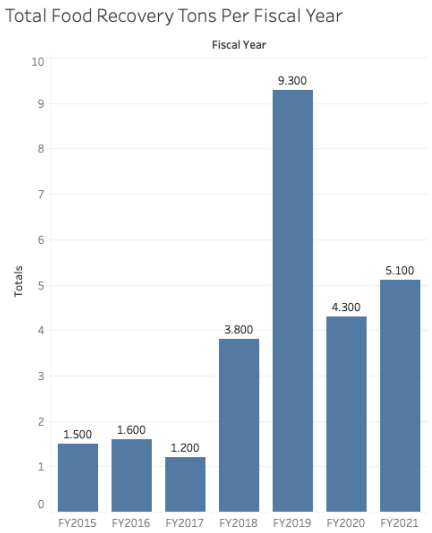

Fig. 1

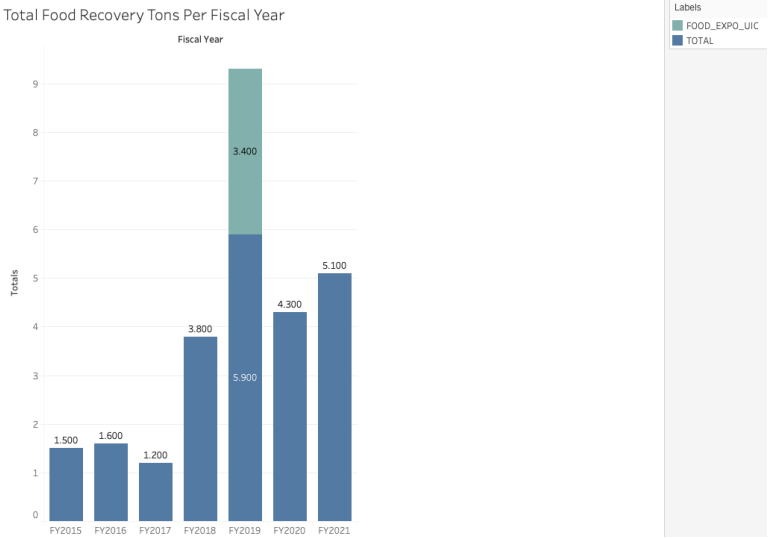

Fig. 2

The data represented by both graphs is the tons of food recovered per fiscal year. The food recovery efforts started in the fiscal year of 2015. From Fig. 1 you can observe that fiscal year 2019 has the highest tons collected. This is because one major event happened in fiscal year 2019 that didn't happen in the other years. This event is the Good Food Expo, and it contributed to quite a lot of tons. Since this event didn't happen in the other years, I further separated the tons in Fig. 2 for better understanding and comparing of the data.

Food Donor Contributions

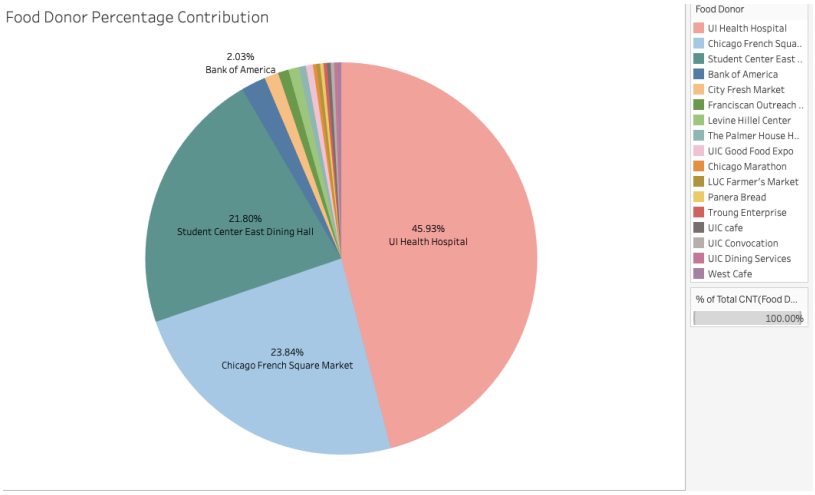

Fig. 3

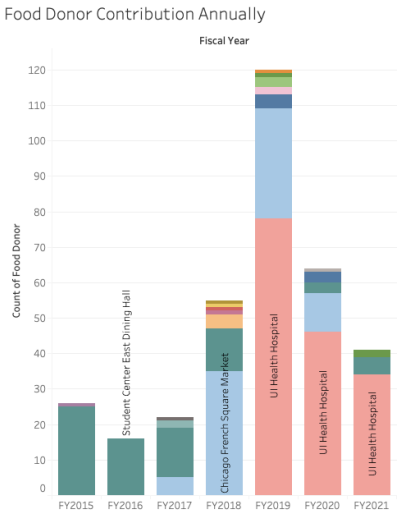

Fig. 4

Fig.3 presents how many times each food donor donated, starting from the fiscal year of 2015 to the fiscal year of 2021. As observed in Fig. 3, the highest contributor is UI Health Hospital followed by Chicago French Square Market. However if you look at these food donors' contributions annually in Fig. 4, you find that UI Health Hospital didn't start contributing until fiscal year 2019 and Chicago French Square Market stopped contributing in the fiscal year of 2021.

Greenhouse Gas Emissions

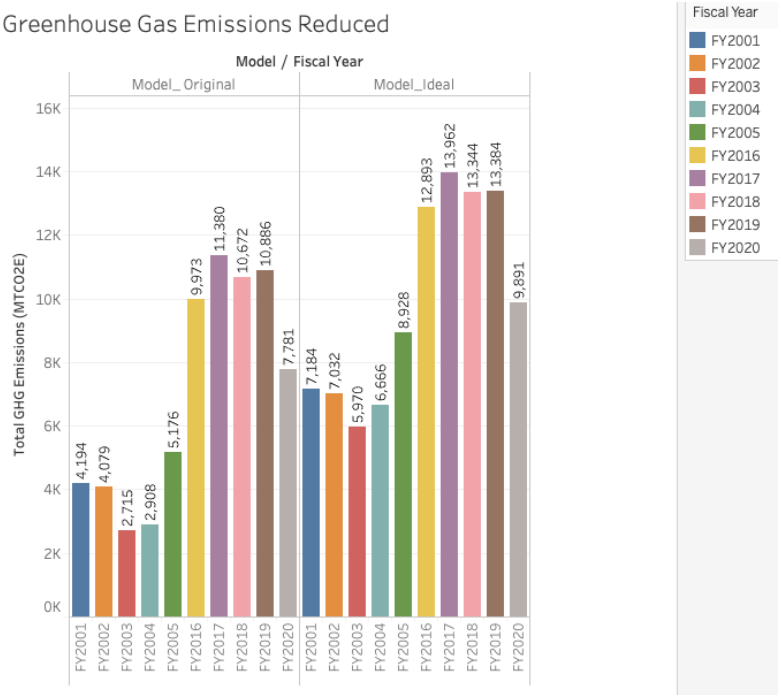

Fig. 5

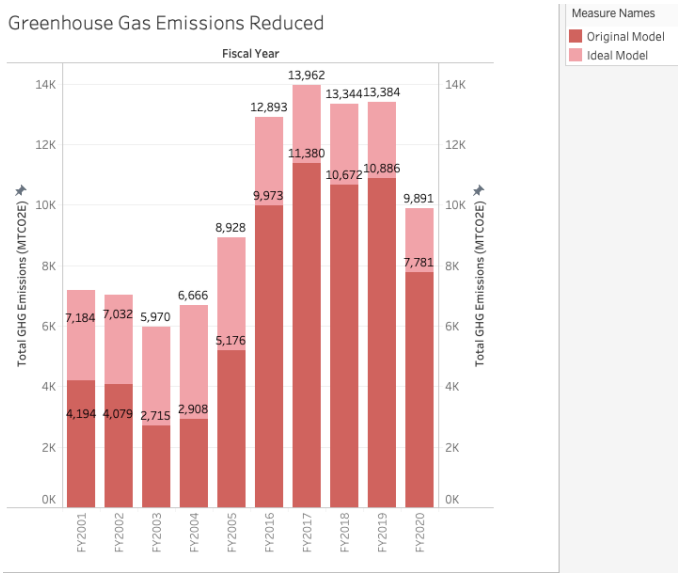

Fig. 6

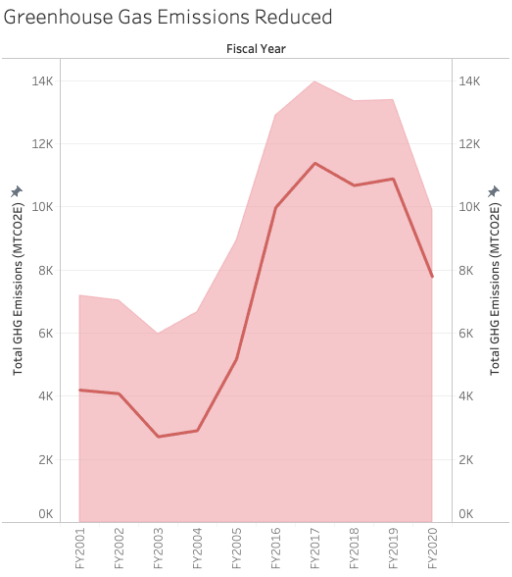

Fig. 7

Fig. 5, Fig. 6, and Fig. 7 graph the total carbon dioxide equivalent tons reduced in the fiscal years of 2001 – 2005 and the fiscal years of 2016 – 2017. The reason being is that the data took a lot of time to process, so only the first five years and last five years were considered.

Fig. 5 graphs the total carbon dioxide reduced through these years and displays both models side by side. However this isn't the best way to compare the two models. Fig. 6 and Fig. 7 allow for better comparison between the two models. Fig. 7 represents continuous data but the actual data is discrete. Fig. 6 is the closest graph that respresents the data properly.

From Fig. 6 we can observe that the first five years have a larger gap between the two models, Original & Ideal, than the last five years.

Conclusion & Discussion for further research:

Through this research I was able to learn several things. This was my first time working in the sustainable field, so I was able to explore and learn sustainable concepts, specifically in waste reduction. I also was able to add new abilities to my skill set, namely Tableau & the python packages/libraries I used.

Food Donor Data

The method used to remove inconsistencies in food donor names can be improved. As discussed, regular expressions were used to group food donor names together. However this method has a problem, because it relies on text sequences and in most cases more than one sequence is needed to group common elements together. This is very inefficient and thus a better method is needed. One improved method could be using machine learning models, specifically models that learn to group text based on a given input. Further research needs to be done here to see whether this method is appropriate for the problem of fixing food donor naming inconsistencies.

Greenhouse Gas Emissions Data

Further research could be done regarding greenhouse gas emissions part. From Fig. 6 we can observe that the last five years reduce quite a lot of emissions compared to the first five years. Something to research here is to look at what exactly is reducing more greenhouse emissions between the years. This would require finding out exactly each material's individual contribution and each waste reduction's method (composting, recycling, etc) to the reduction of greenhouse gas emissions. Knowing this information will help find which materials and methods should be focused on more in the waste reduction efforts.

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