# Recycling Efforts: A 20-Year Insight

Introduction

For this study we will be using a dataset of waste in Minnesota counties from 1997 to 2017. The Waste Data 2 dataset contains seven columns: Year, the year in which the data was collected; County, the name of the county the data was collected in; Recycling, the tons of material recycled; Organics, the tons of organic waste; Onsite, tons of physical waste; WTE, tons of waste burned to energy; Landfilled, tons of waste buried. It is generally believed that recycling efforts have been increasing over time. Does this belief hold true? We will analyze whether the weight of recycled materials for the years of 1997, 2007, and 2017 conform to this belief.

The selected variables for this study are Year, which is numeric, County, which is of character typing, and Recycling, also numeric. All 86 counties will be included in the study, but only 3 years. Since we are checking one group (County) over time (Year) the null and alternative hypothesis are:

H0: µ1997 = µ2007 = µ2017

Ha: At least two of the means differ.

Methods

The analysis that we will conduct in this study is One-Way Fixed Repeated Measures ANOVA. This analysis is used when individuals are measured for the same response in different times, locations, etcetera. This analysis is used here because the County variable represents the individual and we are measuring their recycling tons over time, using the Year variable. A significance value α = 0.05 will be used for the analysis.

Conclusion

The analysis results are judged on the associated P value to the F statistic against the α value. For this model, the F statistic is 11.37779 and the P value is less than 0.0001. With these values H0 is rejected. There is sufficient evidence to conclude that the mean recycling tons for each county are different for 1997, 2007, and 2017.

Now, the most important step of this study is complete. It has been determined that the selected years have significantly different means. The next step is to confirm that the means are increasing. The graph of calculated means is below:

A screenshot of a computer

Description automatically generatedThe means do, in fact, increase. The belief stated in the Introduction has been confirmed. Recycling efforts have been increasing over time, significantly.

An aside result to look at is the rate of increase from 1997 to 2007 versus 2007 to 2017. From 1997 to 2007, there is about a 24% increase in recycling efforts. From 2007 to 2017, there is about a 49% increase in efforts. The efforts doubled in the second decade. This could be due to the culture of recycling taking root in the early 2000’s and seeing fruition in the 2010’s. If this trend were to continue, the estimated average recycling for 2027 would be 60,491 tons, nearly doubling the amount from 2017!

Some limitations of this study are that it does not consider if the waste tonnage has increased over time as well, which could mean the ratio of recycling to waste is unchanged or even decreasing despite the total weight increasing. Another limitation is the lack of consideration that individual counties may be fluctuating their recycling efforts, which could mean more populous counties like Ramsey and Hennepin might be overrepresented in this dataset. These details are beyond the scope of our question, but it could merit deeper analysis into explanation.