NO WASTE TO SPARE:

AN ECONOMIC AND SPATIAL ANALYSIS OF MASSACHUSETTS' REUSE ECONOMY

UEP FIELD PROJECTS 2021

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Tufts UEP Field Projects
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Cover photo source: Carly Thibodeau

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EXECUTIVE SUMMARY

Solid waste management has changed in recent years as methods such as landfilling, incineration, and recycling are becoming increasingly problematic. Massachusetts landfills and waste combustors are operating at capacity. There have been recent landfill closures and more forthcoming due to reaching max capacity. Additionally, the cost to process recyclables has increased due to consumers overwhelming recycling facilities with materials that are not acceptable, also known as “wishcycling.” Alternative waste management strategies include reduction and reuse. These methods reduce the amount of waste that is sent to a landfill, incinerator, or an energy-intensive recycling facility.

The Massachusetts Department of Environmental Protection (MassDEP) manages the energy needs and environmental resources in the state of Massachusetts. Its Solid Waste Master Plan is the guiding framework for the management of solid waste in Massachusetts. Revisions are underway on the Draft 2030 Solid Waste Master Plan, but progress has already begun on some of the major initiatives, which include the “Source Reduction and Reuse” program. This initiative will inform the “Strategic Reduce and Reuse Action Plan.” In order to develop this plan, the impacts of the reuse sector need to be better understood. This sector has been understudied compared to other methods of waste reduction, namely recycling. MassDEP requested that methodology be developed to accurately capture the economic impact of the reuse sector in Massachusetts.

The purpose of this project was to conduct an economic and spatial impact analysis of the reuse sector in Massachusetts. By doing so, MassDEP now has access to aggregated data that can be utilized as a baseline measure of the reuse economy as it moves forward with strategic planning initiatives. We used three research questions to guide our study:

1. What is the current state of the reuse economy in Massachusetts, excluding the automotive industry?
2. What geographic areas (counties) of the state currently have the most/least reuse activity?
3. What ways can MassDEP support and grow the reuse economy?

In order to answer these questions, we conducted a literature review of reuse economy studies that had been done in Maine, Minnesota, and Oregon. We used these case studies to inform the development of our own methodology. We then conducted an economic analysis of the reuse sector in Massachusetts by aggregating the number of businesses in each sub-sector (reuse, repair, and rental) by county. We also presented the number of jobs in each county, as well as the percentage of reuse jobs out of total

employment per county. This data was aggregated to provide MassDEP with a baseline measure as to which counties require more state assistance to grow the state's reuse economy. To support this data, we conducted a spatial analysis of the reuse economy in Massachusetts and mapped where the sector is most active, as well as how that activity relates to population density. We conducted interviews with professional reuse experts that worked on the case studies previously mentioned. This was done in order to gain a deeper understanding of how they developed their methodology, and provided us with insight into the best ways to utilize the data accessible to us. Interviews were also conducted with reuse business owners across Massachusetts to provide us with first-hand accounts of the challenges of being a part of the reuse sector. We were able to gain unique perspectives about what business owners need from the state in terms of support.

The reuse economy in Massachusetts presents significant opportunity for growth as it represents about 2 percent (6,438) of total businesses and employs about 1 percent (32,828) of the total workforce. The reuse sector does create significant economic activity, as it is a 7.3 billion dollar industry statewide with $1,067 of spending per capita.

Spatial analysis revealed that reuse businesses in Massachusetts are most densely located in Suffolk County, Hampden County, and Hampshire County. There are also notable hotspots in Bristol County, as well as Barnstable County. Further analysis showed that there may be a correlation between population density and reuse business density. There is also the potential that reuse, and particularly rental business density is linked to tourism, especially in areas located in Cape Cod. Some reuse business owners confirmed that prior to the COVID-19 pandemic, much of their business was from tourism.

Business owners across the state provided insight to how MassDEP can better support the growth of the reuse economy. A majority responded that the most significant challenges they faced were financial ones. Some recommendations as to how MassDEP could support the reuse economy include direct financial aid to help with losses due to the COVID-19 pandemic and minimizing taxes and fees for small businesses. A very interesting suggestion that business owners brought up frequently was to stop charging sales tax on used goods. Many felt that this would encourage consumers to seek out and purchase from reuse businesses and in turn grow the reuse sector in Massachusetts.

We have developed some recommendations for future studies so that MassDEP and other organizations can delve deeper into this topic and explore additional avenues of the reuse sector. Our major recommendations include:

1. Conduct a more in-depth economic impact analysis using different types of data to assess wages, tax revenue, and business revenue in relation to reuse
2. Investigate the environmental and social impacts of the reuse sector in Massachusetts
3. Develop methodology to accurately analyze the informal reuse economy

Overall, we recommend that there be continued study of the reuse economy so that MassDEP has a more holistic view to best inform its strategic planning efforts.

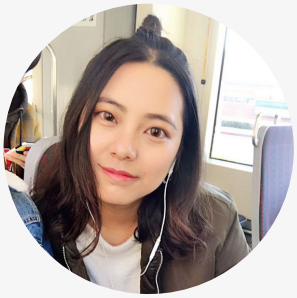
MEET THE TEAM

Brianna Eassa

Carly Thibodeau

Joann Lai

Maxwell Dorman



Zhining Sun

MEET THE TEAM

Brianna Eassa is currently pursuing an M.S. degree in Environmental Policy and Planning at Tufts University. She earned a B.S. in Biological Sciences from Le Moyne College in 2019, where she researched respiratory responses in transgenic mice. In the future, she hopes to work as an Environmental Planner to promote wildlife conservation.

Carly Thibodeau is working towards a M.S. Sustainability degree at Tufts University. She completed her undergraduate education at Westfield State University where she earned her B.A. in Economics and her B.S. in Environmental Science, with a minor in Spanish. Currently, she works as the Recycling Intern with the Tufts University Office of Sustainability, where promoting the reuse economy is a key part of her responsibilities, along with other sustainable practices.

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INTRODUCTION

Photo source: MassDEP

Solid waste management has seen great change over the years as new strategies are being developed in response to capacity and operating constraints, as well as emerging economic and environmental concerns. The Massachusetts Draft 2030 Solid Waste Master Plan discusses that the historical methods of dealing with waste- namely landfilling, incineration, and recycling- are becoming increasingly problematic even just since 2010. Globally, recycling markets are changing which has been causing tightened recycling capacity, lower recyclable commodity selling prices and profits, and higher costs of processing recyclables within Massachusetts. In terms of landfills, overall capacity is decreasing as landfills within the Northeast are reaching maximum capacities and are not being replaced by new facilities. Incineration is also used, and while incineration facilities decrease the volume of waste landfilled and are used to create energy, the resulting ash is often toxic and is sent to landfills anyway. Incinerators are working at full capacity as well, and largely consist of aging infrastructure which is a concern[1]. The closure and lack of replacement of incineration and landfill facilities are largely the result of public and political pressure surrounding the environmental concerns associated with landfills. Common issues include the pollution of groundwater and land due to the leaching of chemicals, and the release of methane gas from decomposition activity; these are major contributors to public health problems resulting from decreasing water and air quality. Nationally, landfills are the third-largest source of methane emissions due to anthropogenic activities[2], which carries huge implications for climate change; country-wide total municipal solid waste generation (as of 2018) has increased by 84.1 million tons from 1990 levels[3].

As our ability to dispose of and recycle solid waste diminishes, we must turn to alternative solid waste management strategies, such as reduction and reuse. These strategies work to eliminate or reduce waste that is sent to a landfill or incinerator or goes through energy-intensive recycling processes. Waste reduction and the reuse of items saves natural resources and energy, reduces pollution and waste toxicity, and provides more cost-effective solutions for consumers, municipalities, and businesses[4].

[1] MassDEP. (2019a). *Massachusetts materials management capacity study.* https://www.mass.gov/doc/massachusetts-materials-management-capacity-study-february-2019/download

[2] US EPA. (2021, March 11). *Landfill Methane Outreach Program (LMOP): basic information about landfill gas.* https://www.epa.gov/lmop/basic-information-about-landfill-gas

[3] US EPA. (2020, March 13). *National overview: Facts and figures on materials, wastes and recycling.* https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

[4] US EPA. (2020, April 28). Sustainable materials management: non-hazardous materials and waste management hierarchy. https://www.epa.gov/smm/sustainable-materials-management-non-hazardous-materials-and-waste-management-hierarchy

BACKGROUND

Photo source: Carly Thibodeau

SOLID WASTE MANAGEMENT HIERARCHY AND REUSE

Most governments and organizations working to handle solid waste develop solid waste management plans which include waste management hierarchies. These hierarchies vary by organization, but all rank waste management approaches from the most to the least environmentally preferred. A generalized hierarchy categorizes reduction as the most preferred, followed by reuse, recycle, incineration, and finally landfill.

Figure 1: EPA's Solid Waste Management Hierarchy (US EPA 2020, April 28)

> "If you look to the future, the quality of goods being sold today is so bad that they won't have a long life. Furniture, for example, that is not made with solid woods cannot be repaired and often is tossed into a landfill"
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

Recycling has been one of the most popular approaches because it promotes a circular or closed-loop economy, where materials are repurposed and remanufactured into new items at the end of their lifetime, reducing the need for raw or virgin material extraction and landfill capacity, and getting more use out of the material.

Figure 2: Transition from linear to circular economy (Temarry Recycling 2019)

Although recycling can result in benefits similar to reuse by recovering materials and turning them into new products, reuse differs from recycling in that it consists of the use of a material repeatedly in its same form for the same purpose or for different purposes[5]. While carrying less of an impact than extracting raw materials to make products from scratch, the significant changes which occur in recycling processes such as baling/crushing, sterilization, melting, etc., can be costly in terms of energy and emissions. This can create substantial environmental and financial impacts. In addition, not all materials are recyclable or can only go through the recycling process a few times, meaning they will eventually end up in landfills or incinerators[6]. Therefore, reuse, as one of the highest tiers in the waste management hierarchy, is an incredibly important solid waste management approach as it is superior in terms of cost and energy savings as well as environmental impacts in comparison to the lower tiers. According to reuse economy studies conducted in the state of Minnesota (Butler et. al 2011 and ReUSE Minnesota 2020), reuse activities reduce virgin-material demand and solid waste in cases when they replace or delay the need for new items and result in economic, social, environmental benefits.

> "The other is to create awareness that there are outlets for the goods beyond throwing things in a dumpster. I find some people donate or throw away things of value without calling in an antiques dealer. Some people don't know that there are people who buy things"
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

PARTNER ORGANIZATION: MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

The Massachusetts Department of Environmental Protection (MassDEP) is a part of the Massachusetts Executive Office of Environmental Affairs (EEA), a unique state department which effectively combines the responsibilities of managing the energy needs and environmental resources of the state. The mission of MassDEP is to protect and ensure the health of our land, air, and water. To accomplish this, MassDEP enforces environmental laws, provides technical assistance to cities and towns, and writes permits that support natural resources, public health and the economy. Additionally, MassDEP inspects contaminated sites to ensure proper cleanup and partners with federal, state, local and citizen partners to work towards a cleaner environment.

MassDEP's Bureau of Air & Waste division is responsible for the management and recycling of solid and hazardous waste. Its efforts are guided by the policy framework presented in the state's Solid Waste Master Plan. The earliest version of a Solid Waste Master Plan for MA, a draft of which was distributed in 1989, described for the first time, "a goal--to establish an integrated solid waste management system".[7] It did not detail a

[5] *Reducing and reusing basics*. (2021, January 15). US EPA. https://www.epa.gov/recycle/reducing-and-reusing-basics

[6] *The recycling process. (2014). All-Recycling-Facts.com. https://www.all-recycling-facts.com/recycling-process.html*

[7] EEA. (1989). *The Massachusetts solid waste master plan: Toward a system of integrated solid waste management : second draft*. Office of the Secretary of State. https://archives.lib.state.ma.us/handle/2452/836515

specific waste reduction goal, but the plan did make a commitment to “reduc[ing] the amount of waste produced,” especially toxic waste, and to “landfill only those wastes which cannot be reduced or recycled.” The plan has evolved considerably over the last thirty-two years.

First issued for public comment in September 2019, the Draft 2030 Solid Waste Master Plan MassDEP proposed a goal to reduce disposal of solid waste by 30% by 2030 and 90% by 2050 from a 2018 baseline of 5.7 million tons annually[8]. As of 2018, 14% of solid waste has been reduced (890,000 ton decrease), reflecting progress towards the 2020 Master Plan goal of reducing disposal (compared to a 2008 baseline) by 30% by 2020. This is a substantial achievement especially with 5% growth in the state population and 16% growth in gross state product. This shows that the work that has been done by the state so far to address sustainable waste management in the commonwealth is making a difference. While the final Solid Waste Master Plan has not been completed, and revisions are currently being made following the close of the second public comment period in September 2020, progress has still begun on several initiatives from the draft policy. A major program that MassDEP has started work on is its “Source Reduction and Reuse” initiative. One of the goals of this initiative is to “develop and implement policies and programs that extend the lifespan of products through reuse, repair, and remanufacturing” to inform a “Strategic Reduce and Reuse Action Plan.” In order to accomplish this goal, the reuse sector needs to be better researched and understood. Specifically, the economic impact of reuse has not been well researched and remains poorly understood in comparison to other sectors, namely recycling. A few states (described in the Literature Review section) have conducted studies on their own reuse economies, but there is currently no general consensus on best practices for how to go about collecting information on the reuse economy or measuring formal or informal reuse activity. Clear and consistent methodology needs to be developed to accurately capture the economic impact of the reuse economy in Massachusetts in order to better inform MassDEP’s future work in waste reduction.

[8] MassDEP. (2019b). *Draft Solid Waste Master Plan*. https://www.mass.gov/doc/draft-2030-solid-waste-master-plan/download

DEFINING REUSE ACTIVITIES AND THE REUSE ECONOMY

For the purposes of this project, we classify the reuse economy into three sectors, each of which is active in Massachusetts- 1) secondhand retail or direct reuse services, 2) repair services, and 3) rental services. Reuse activities are defined wherein the original possessor of an object sells, gives away, or donates the object to another person, entity, charity, or community group so that it is used again, replacing the purchase of a new item. Repair services involve salvaging, refurbishing, or otherwise repairing materials or products to extend their life and reduce costs of sourcing and constructing new materials and products. Finally, rental and share services consist of products or items that are loaned from one owner to another, as an alternative to many individuals purchasing new items[9]. Massachusetts has a long history of reuse[10-15], and the share economy (which we include as part of the rental sector) has exploded in popularity in recent years[16].

Figure 3: Sectors of the reuse economy (graphic created by Carly Thibodeau).

Moving forward in this report, when using the term **reuse economy** we are referring to the number of jobs, wages, and revenue that are a direct result of reuse business. When we mention the **reuse sectors** we are referring to any business that conducts secondhand retail (reuse), repair, and formal rental or share services (both of which we classify as rental).

[9] These definitions are derived from those used in the MPCA study- Butler, P., Clausen, B., & Batson, K. (2011). *A Study of the Economic Activity of Minnesota's Reuse, Repair and Rental Sectors.* Minnesota Pollution Control Agency.

[10] Howe, P. (1998, September 2). *Push is on to recycle computer, TV tubes*.

[11] Coleman, S. (2003, December 11). Holiday Plea: Think Green Recycling, Reuse is Urged During Season of Excess.

[12] For Electrical Service... (1940, January 22). *Fitchburg Sentinel*.

[13] A&G Rental Concern Opens Second Store on Summer St. With Many Items of Household and Equipment Needs. (1967, March 10). *Fitchburg Sentinel.*

[14] Cunniff, J. (1969, April 10). Rental Business A Trend. *Fitchburg Sentinel.*

[15] TV Rental and TV Service Sections. (1976, March 12). *The Lowell Sun*.

[16] Confino, A. (2014, September 22). Meet the Disruptors: Massachusetts's New Sharing Economy. *GoLocalWorcester*. Retrieved March *2, 2021, from* http://www.golocalworcester.com/news/meet-the-disruptors-massachusettss-new-sharing-economy

PROJECT GOALS

Photo source: MassDEP

The purpose of this project was to conduct an economic impact analysis of the reuse economy in Massachusetts. Environmental impacts and benefits of reuse in Massachusetts are not discussed in this study, but would be useful information to research in follow-up studies. Despite the clear and consistent presence of reuse sectors in MA, little to no research exists on the actual scale and nature of these economies. By conducting an economic impact analysis of reuse in Massachusetts, MassDEP will gain data to serve as a baseline measure of the reuse economy to gauge progress in statewide waste reduction goals moving forward, to inform future planning efforts by MassDEP and other environmental organizations to bolster the reuse economy, and to strengthen the case for reuse by quantifying the value of the reuse economy. These results will also serve an important role in public education to further support the case for waste prevention in the state, as economic impact is relatable and important to a wide audience.

The main deliverables of this project include:

- Literature review to understand what work has already been done on this topic and how to analyze the economic impacts of the reuse economy based on previous studies
- Economic impact analysis of the current state of the reuse economy in Massachusetts as it relates to the number of jobs and sales volume as a proxy for business revenue
- Spatial analysis and mapping of the reuse economy in Massachusetts displaying:
  - a visualization of the location quotient (See “Analysis Strategies”),
  - the relationship between reuse activity and Environmental Justice (EJ) communities, and
  - reuse activity as a proportion of population/density
- Recommendations of paths for MassDEP to support the growth and accessibility of the reuse economy in specific counties and for specific demographic groups

By undertaking a geographic component in addition to an economic analysis, we are able to visually distinguish where the reuse economy is active in Massachusetts and where it could use some support. Noting demographic trends as well as any relationship between reuse activity and Environmental Justice (EJ) communities[17]can provide important insight into equity and access issues which are important for long-term, successful sustainability. The mapped data visualizations are not only useful to MassDEP in terms of understanding the data, but also as an educational tool for the general public.

[17] MassDEP defines EJ communities as neighborhoods where any of the following are true:
(1) block group whose annual median household income is equal to or less than 65 percent of the statewide median ($62,072 in 2010);
or (2) 25% or more of the residents identify as a race other than white;
or (3) 25% or more of households have no one over the age of 14 who speaks English only or very well (English Isolation)

Research Questions

The following questions were used to guide this study to meet the goals above:

- What is the current state of the reuse economy in Massachusetts, excluding the automotive industry[18]?
  - What is the current state of the different sectors of the reuse economy, specifically repair, second hand retail, and share and rental?
- What geographic areas (counties) of the state currently have the most/least reuse activity?
  - What are the location quotients of the MA counties in comparison to the state as a whole?
  - Are there any notable demographic trends among counties with noticeably high or low amounts of reuse activity?
  - Is there a relationship between EJ communities and reuse activity?
- What ways can MassDEP support and grow the reuse economy?
  - Given the results of the economic, geographic, and interview analyses, what are some recommendations for MassDEP to consider integrating into the MassDEP Reduce and Reuse Action Plan?

[18] Note: we exclude the automotive repair sector because this industry is prominent and well-established, therefore better understood than other reuse activities. Additionally, because of its prominence, including it would skew the data on other reuse businesses.

ANALYSIS STRATEGIES

Photo source: Carly Thibodeau

The Field Projects team utilized various methods to meet our project objectives and answer our research questions. First, we conducted a literature review and developed case studies on reuse economies in other states to better understand how the reuse economy is defined and operates. Paradoxically, part of our methodology involved the development of an effective methodology for defining and examining Massachusetts' reuse economy, as this had not been done previously. We developed this methodology partially through the literature review and partially through consultations with individuals who researched the reuse economies of other states. Next, we analyzed existing economic and demographic data, namely employment and revenue of reuse businesses, which we used to assess the economic impact of the reuse sector in MA. We also used this data to conduct a geographic analysis and identify geospatial trends in reuse activity.

Finally, the team conducted interviews with academic and professional reuse experts, and reuse business owners to gather qualitative data about the MA reuse economy. From the academic and professional reuse experts and researchers, we gained insight into the methodologies other analysts used in order to inform and develop our own methods. The interviews with reuse business owners gave us qualitative data from a "boots on the ground" perspective that allowed us to both identify barriers to sustaining and growing reuse businesses and also to develop recommendations for MassDEP to better support these efforts. The data from these interviews was qualitatively coded to pull out themes and trends from participant responses to create these recommendations. Our methods are listed in detail below.

It is important to note here that we only analyzed the formal reuse economy in MA (official, brick and mortar businesses and organizations). Investigations into the informal reuse economy (peer-to-peer exchange, Craigslist and Facebook groups, swap shops, lending libraries, volunteer-led repair events) are beyond the scope of this study. Additionally, the demographic trends we assessed were limited to the variables we had access to and the granularity of the data itself. We ran a regression and a t-test as part of the statistical analysis and reported our results in the Economic Analysis section.

Literature Review

The Field Projects team based our examination of the formal reuse economy in MA on other state-wide case studies. The core of our literature review consisted of three studies of the reuse economy conducted in Maine, Minnesota, and Oregon. These case studies provided us with a nuanced understanding of the reuse economy as it exists in other states, which we took into account when developing a methodology for our collation and analysis of the MA reuse economy. Our definition of the formal reuse economy and its sectors is also based on these case studies[19-21], in addition to the initial proposal for this project provided by MassDEP.

[19] Maine's Culture of Reuse and Its Potential to Advance Environmental and Economic Policy Objectives (2017).
[20] A Study of the Economic Activity of Minnesota's Reuse, Repair and Rental Sectors (2011).
[21] Strategic Plan for Reuse, Repair and Extending the Lifespan of Products in Oregon (2016).

We also examined the goals and policies MassDEP promulgates that relate to the reuse economy, primarily its Draft 2030 Solid Waste Master Plan, in order to inform 1) which geographic and demographic trends may be of particular interest to MassDEP (i.e. to direct our methodology for data analysis and visualization) and 2) our policy recommendations to MassDEP concerning how the agency can best catalyze waste prevention by supporting the development of the reuse economy moving forward.

Economic Data Collection, Cleaning, & Collation

Data Collection & Preparation

Our economic analysis is based on existing economic datasets on the activities of businesses in MA. We received access to a dataset from DataAxle (formerly InfoUSA) provided by MassDEP. This dataset provides an exhaustive list of businesses in MA, including demographic information, number of employees, and types of business (as indicated by North American Industry Classification System codes, as well as primary and secondary Standard Industrial Classification codes- abbreviated NAICS and SIC). Unfortunately, the DataAxle data does not include information on tax revenues or employee wages. We were not able to access public data on these variables, so we used the "Sales Volume" variable from the DataAxle data as a proxy for business revenue. For this stage of the project we examined the DataAxle data in Excel to choose which variables we wanted to keep for subsequent data cleaning and analysis.

Data Cleaning

It was necessary to modify our dataset to prepare it for subsequent analysis. We searched the dataset to ensure that all information was entered correctly (spelling errors or other mis-entries crop up in most datasets). We ran SQL scripts in Microsoft Access to modify the data as necessary. The DataAxle database was tailored specifically to internal use (ex. The NAICS and SIC codes contained extra digits that only have meaning within DataAxle) and many of the variables did not contain descriptions in the data dictionary, so we standardized the data and removed the variables without descriptions. The lack of information provided by DataAxle is an issue that future teams may run into.

Data cleaning involved the following processes:

- Converting the raw data .xls file to a .csv
- Changing the names of columns to work with SQL
- Converting the numerical data of NAICS and SIC codes into string data
- Creating new columns that eliminate the rightmost digits of the NAICS and Primary SIC codes to make them universal (the originals were specific only to DataAxle, and we are using universal NAICS & SIC codes)

Data Collation

Data collation is the process of taking raw data and structuring it into a form that is suitable for analysis. Here, our primary variables of interest are the number of jobs provided by the reuse economy and the sales volume of the reuse economy. Isolating the reuse economy from the entire raw dataset (which includes all MA businesses) was part of the collation process. We filtered businesses by NAICS codes and SIC codes to select for the businesses that conduct reuse activity (see Appendix B for list of codes). These identification codes allowed us to determine in which sector of the reuse economy (repair, reuse and/or rental) each business belongs. Discussions with the Minnesota research group indicated that we also needed to manually identify and include certain specific businesses such as Goodwill that are not identified as reuse businesses according to NAICS or SIC codes because it is a non-profit organization. We also included businesses with certain keywords such as “Rent” in their business name and excluded businesses with business names related to the auto sector (see Appendix B for list of included and excluded keywords). To make subsequent analysis easier, we created a new column of information detailing the sector of each business. At this stage, we eliminated all columns in the spreadsheet besides a few demographic variables (female business owners and self-identification as “small” businesses) and the information necessary to identify businesses, their economic activity and number of employees, and their location. We conducted this process primarily using SQL scripts in Microsoft Access.

Data collation involved the following processes:

- Creating a new dataset that includes only variables of interest
- Ensuring only businesses located in MA were included in our analysis
- Filtering the dataset to represent the three sectors of the reuse economy (and the reuse economy in aggregate) by only selecting businesses that have:
  - The NAICS & SIC codes for each of the three reuse economy sectors; OR
  - Certain keywords in their business name, excluding certain automotive-related keywords in the process (see Appendix X for search terms); OR
  - A secondary SIC code that identifies it as part of the reuse economy
- Exporting results into .xls spreadsheets for each of the three sectors of the reuse economy

Economic Data Analysis

Aggregating the Reuse Economy Data

Our economic analysis detailed aggregated information about the jobs and business revenue of the formal MA reuse economy. Our team provided this information for the entire formal reuse economy and for each sector (repair, reuse and rental). We also compared these values to the economic activity of businesses in MA as a whole. These values excluded data on the MA automotive repair sector. The automotive

repair sector is excluded since this industry is prominent and already well-established; it would skew the data on reuse businesses if it was included. We provided information on the activity of the reuse economy as it relates to certain demographic variables, which we have discussed further in the Spatial Analysis section. We conducted this stage of data analysis using Microsoft Excel (primarily employing pivot tables to summarize data by sector and by the whole reuse economy), and Microsoft Access (for grouping, filtering, creating new spreadsheets and exporting for subsequent analysis).

Statistics

We conducted our analysis using the software Stata and R Studio (for R Studio, specifically the package ggplot2). We presented any notable economic findings (given time constraints) in tables or graphs rather than in maps. This is to avoid the possibility of misleading results. For example, it would be far too easy to apply a generalized quality like all “low income” counties to each individual county belonging to that group.

We performed the following types of statistical tests to find significant trends in the reuse economy:

- **Regression Analysis:** A regression model is used to study the correlation between reuse business and county’s economic activity. The correlation is expected to be positive. The regression model used the number of reuse businesses as the independent variable, the county-level GDP as the dependent variable, and used lagged values as control variables.
- **Hypothesis test (t-test)**: The hypothesis test is used to test whether the difference in two means is statistically significant as a way to determine the impact on the economy. The test is expected to determine the effective contribution made by reuse businesses to combating poverty, assuming we have access to county-level reuse business data over years. The sampling distribution needs to be approximately normal for this test to apply.

Spatial Analysis

A major component of our geographic analysis, inspired by Maine’s reuse economy case study, is a visualization of the location quotient (LQ) of the formal reuse economy for each county in Massachusetts. LQs tell us how much reuse activity (meaning jobs in this research study) is taking place in an individual county as a proportion of overall economic activity relative to that same proportion in the state as a whole. A LQ higher than 1 indicates that a county has more reuse activity as a proportion of their overall economic activity than the state as a whole, and LQs lower than 1 mean that a county has a lower proportion of reuse activity than the state as a whole. We presented LQs for the entire reuse economy and by sector (repair, rental, and reuse).

The generalized formula we used for calculating LQs is as follows:
Proportion of reuse economy jobs out of total jobs in MA, P_{MA}:
P_{MA} = [# reuse economy jobs]/[# jobs total in MA]
Proportion of reuse jobs for each county in MA, P_C:
P_C = [# reuse jobs in county]/[# jobs total in county]
Location Quotient Calculation: **P_C / P_{MA}**

Our specific calculations can be found in a table in Appendix B. We also created several heat maps of reuse activity (business density, revenue, employment), like the ReUSE MN study produced, as well as a visualization of reuse activity in conjunction with population density. Heat maps visualize data magnitudes by color, with opposite colors at either end of the scale designating higher or lower intensity data. For example, a heat map of population density may show areas of high population density in warm colors ("heat") and areas of low density in cool colors. We used ArcGIS Pro, QGIS, and ArcGIS Online for this analysis.

Interviews and Qualitative Data Analysis

Our Field Projects team conducted interviews with both academic and professional reuse experts and reuse business owners to identify areas where the Commonwealth could better support reuse initiatives. Academic and professional reuse experts included researchers with similar objectives from other states to better understand the reuse economy. Interviews with researchers were heavily focused on their methodology, however we asked about their work as a whole to understand the goals and also the limitations. The team also conducted interviews with business owners in Massachusetts that are part of the reuse industry to help collect qualitative information on understanding what difficulties businesses in the reuse sector may have, as well as information on the social impact of reuse.

Interview Procedures and Data Collection

The academic and professional reuse expert interviews were recruited via introduction from MassDEP, which has already established a relationship with the state case study groups and data experts. The business owner participants were selected based on the Data Axle dataset purchased by MassDEP, which contains information about the reuse sector in Massachusetts. The goal was to interview one business owner per county and have an equal representative sample from each sub-sector of the reuse industry (reuse, rental, and repair). The businesses were selected randomly from the Data Axle dataset and were sent an initial email to invite them to participate in the study. The business owners could choose to answer the interview questions via email or engage in a phone interview with a member of the research team.

Once we obtained responses from at least one business owner per county, the data

was analyzed. Major themes were identified across all respondents and any outliers were noted. An outlier in this case is a business owner that does not respond in a similar fashion to the majority of the respondents. We noted any business owners that responded to our original inquiry and did not feel that their business fit the study. We were also able to make observations about participants' attitudes and perceptions about MassDEP conducting a study in hopes to offer support to reuse businesses.

The structured interview guides for each set of populations (academic and professional reuse experts and reuse business owners) can be found in Appendix C.

LITERATURE REVIEW

Photo source: Carly Thibodeau

MAINE REUSE ECONOMY STUDY

Maine's Culture of Reuse and Its Potential to Advance Environmental and Economic Policy Objectives (2017)

Introduction

A team of researchers affiliated with the University of Maine are currently working on a multi-year, interdisciplinary study to "describe the history, development, and contemporary form of Maine's reuse economy with particular intent to describe its economic, social, and environmental character and analyze its potential in the context of sustainability and community resilience" (Isenhour et. al 2017). The most recent publication from this group of researchers outlines the methods and preliminary results from the first three stages of their investigation. The first three stages are:

1. A National Level Spatial Analysis
2. Textual Analysis of Primary Sources
3. Surveys and Interviews with Reuse Establishment Owners and Managers

The authors of this study originally hypothesized that Maine already had a relatively strong reuse economy based on observations of numerous garage sales, the popularity of Uncle Henry's (an online and printed advertisement repository that helps people buy, sell, swap, or trade a variety of items), and the growing secondhand market on social media. They inquired then, if Maine does in fact have a strong reuse economy, could it be used to support the advancement of economic, social or environmental public policy incentives? The first three completed stages of this study sought to determine whether Maine's reuse economy is advanced relative to other states and to explore the strength of the reuse sector across the nation and from within Maine.

Methods

The first stage of the study included conducting a national level spatial analysis of the reuse sector based on Bureau of Labor Statistics data between 2005 and 2015. This process utilized NAICS codes which are used by businesses and governments within the US and Canada to identify and sort businesses based on what services they perform. The authors quickly realized that the methods that our society uses to categorize economic activity are not well suited for studying reuse. The issue was that some businesses sell both new and used goods and their NAICS code only accounts for selling new items, not reused. There were no sublayers of reuse that the investigators could use from this data source to conduct a comprehensive analysis. The team then utilized the Dun & Bradstreet (D&B) business directory, a data source that includes business records from all industries, in order to further specify the reuse data. By using this dataset in addition to derivatives of the NAICS codes, and expanding their search to include thrift and antique businesses, the number of businesses increased by almost four times. This led the team to the conclusion that the reuse sector is not fully represented by the NAICS codes. It is also important to

note that these datasets only include the formal reuse sector and do not account for informal peer-to-peer exchanges, such as those on Craigslist or Facebook Marketplace. Informal reuse makes up a significant portion of the reuse sector and is intended to be included in future stages of the authors' study. Although the data from the Bureau of Labor Statistics (using NAICS codes) resulted in a conservative estimate of the reuse sector, this data was used to perform the spatial analysis and calculate the location quotient for the reuse sector in Maine. The researchers describe the location quotient as follows, "A location quotient calculation allows for the comparison of characteristics across areas of various sizes. The value of a location quotient at a regional level indicates how intensive a characteristic is in one place compared to the country as a whole" (Isenhour et. al 2017). The researchers did not include the formula for how the location quotient was calculated in this study. Our team has outlined how we plan to calculate the location quotient for the Massachusetts reuse economy in the preceding methods section of our report.

In the next stage of this study, the researchers conducted an initial review of original and historical primary sources in order to explore the cultural depth and behaviors associated with the reuse sector in Maine. They asked two research questions:

- "What are the historical and contextual roots of any shared ideologies or behaviors that support contemporary reuse markets?
- And what evidence is available to clearly show the presence of a culture of reuse?" (Isenhour et. al 2017).

The keyword searches used to identify references to Maine's reuse economy were "thrift", "reuse", "frugality", and "used goods". The research team identified nearly 70 sources that were originally published between the late eighteenth century and the present. A qualitative analysis of these texts is still underway.

Finally, the research team conducted surveys and interviews with reuse establishment owners and managers in Maine. Using the 2015 Maine Business Directory, they compiled a dataset of 600 formal reuse businesses. Through cross-checking websites and postal addresses, the research team found that nearly 200 of the original businesses listed had gone out of business, suggesting that "some reuse businesses may be short-lived" (Isenhour et. al 2017). The researchers sent surveys to the remaining businesses inquiring about behaviors and motivations to participate in the reuse sector. They also conducted interviews with five reuse business establishment owners in order to better understand "the various social, economic and environmental aspects of participating in Maine's reuse economy" (Isenhour et. al 2017).

Research Findings

An initial review of original and historical sources confirmed the research team's hypothesis that reuse has been deeply rooted in Maine's culture for more than a century.

Additionally, the national level spatial analysis substantiates the claim that Maine has a more active reuse economy than other states in the country. Based on the location quotient calculations, Maine ranked second in the nation for the number of reuse businesses relative to the total number of businesses in the state (Figure 1). The researchers plan to further investigate the possible reasoning behind Maine's active reuse economy in subsequent stages.

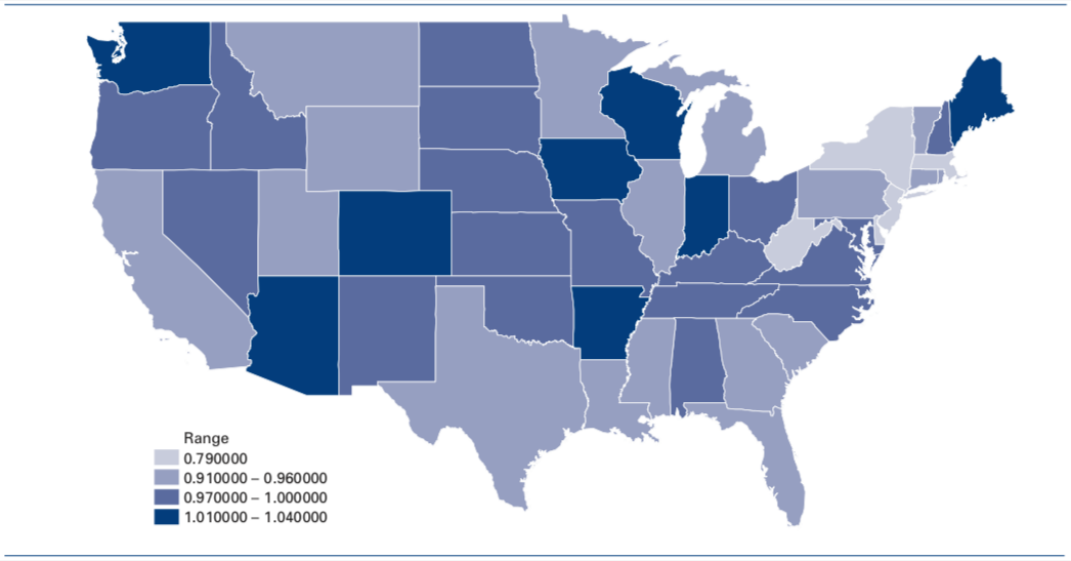


Figure 4: 2015 Establishment location quotient (Isenhour et. al 2017). A LQ higher than 1 indicates that a state has more reuse activity as a proportion of their overall economic activity than the country as a whole. A LQ lower than 1 means that state has a lower proportion of reuse activity than the country as a whole.

The research team also found interesting trends in relation to economic resilience and economic growth in Maine based on the data collected and survey responses from reuse business owners. They specifically found trends that suggest that the reuse economy has already made important contributions to economic resilience, particularly in rural areas. Their analysis suggested that the recession after the financial crisis of 2007-2008 contributed to the growth of the reuse sector. Respondents from business owners noted that this may be because the sector has a "low-cost of entry" and "no-cost inventory" (Isenhour et. al 2017). This allows owners to start businesses with very few resources.

Conclusions

The authors of this study presented preliminary findings to suggest that "Maine already has a strong culture of reuse that is likely already contributing to reduced materials use, climate mitigation and waste reduction" (Isenhour et. al 2017). Additionally, the analysis suggested that Maine's reuse economy has contributed to its economic resilience and growth. The state of Maine has significant potential to grow its reuse economy by enacting policies that expand incentives and support the sector as long as the policies and development programs are consistent with local cultures and institutions. The research team notes that previous scholars have identified the culture of Maine as being

“individualistic” and “distinctive,” therefore any policy initiatives would be more successful if they aligned with the economic priorities of the citizens (Isenhour et. al, 2017). They conclude that Maine’s reuse sector is and can increasingly be beneficial to both the environment and the economy.

MINNESOTA REUSE ECONOMY STUDIES

A Study of the Economic Activity of Minnesota’s Reuse, Repair and Rental Sectors (2011)
ReUSE: Environmental, Economic & Social Impacts of Reuse in Minnesota (2020)

Introduction

The state of Minnesota has completed two notable reuse economic impact studies, one in 2011 by the Minnesota Pollution Control Agency (MPCA), and the other recently finished in 2020 by ReUSE Minnesota, which built off the initial report by the MPCA. ReUSE Minnesota is a 501(c)(3) non-profit founded in 2012 that works to advocate for reuse business in order to establish reuse practices as the norm within Minnesota and eventually the nation as a whole. Both groups hired external agencies to collect and analyze data; the MPCA used the Minnesota government’s consulting group Management Analysis & Development, while ReUSE MN hired the non-profit relationship marketing firm Brio Marketing.

The goal of the MPCA study was primarily to assess the economics of reuse within the state by estimating employment numbers and economic activity across the three reuse sectors (reuse, repair, and rental) and determine whether reuse consumer spending results in more or less local spending overall. The ReUSE MN study had a broader scope, in that the researchers sought to evaluate not only the economic impacts of reuse but also the environmental and social impacts. The ReUSE MN analysis also was aimed more towards promotion and marketing of reuse activities, rather than solely assessing their impact. They created an online interactive map of their results, accessible to the public. Neither study made any initial hypotheses about the state of the MN reuse economy, but both described how reuse is important in reducing the need for extracting virgin materials. However, ReUSE MN was more explicit in their reuse beliefs, stating that current behavior patterns regarding disposing of products are unsustainable and have negative impacts on natural resources and energy use, while reuse is a regenerative process that keeps materials in circulation longer and provides jobs, wealth, and community/economic networks. For these reasons, the ReUSE MN report is more narrative and seems to be focused on reaching the general public, whereas the MPCA study seems more for internal state department consumption.

Methods

Both studies started out by defining reuse and its sectors; the ReUSE MN report used the

MPCA report's definitions of reuse. They define reuse activity as any business involved in the following:

- Reselling an item provided by an original owner either through consignment or through donation of the item to a charitable or community group
- Salvaging and refurbishing materials to extend their life and reduce the overall first costs of constructing materials and products
- Extending a product's life through repair so it can be used longer and replace the need for a new item
- Renting an item for short-term use as an alternative to purchasing that item new[22]

In both studies, this definition was then applied to the process of identifying MN reuse businesses via the NAICS industry codes. ReUSE MN made some slight modifications to the MPCA study at this stage by excluding the automotive and associated industries from their research as it greatly influenced the MPCA study results. Instead, they used more than just NAICS criteria to identify reuse businesses. They also captured businesses that had partial reuse activity or were commonly associated with reuse, such as bookstores or bike shops which often sell used items and repair products in addition to selling new books or bikes. This allowed the economic analysis of the ReUSE MN study to capture both a more expansive and inclusive sample of reuse businesses.

After identifying reuse businesses, both studies primarily used the D&B dataset to obtain information on reuse employment and sales; the ReUSE MN study also drew data from the Minnesota Department of Revenue, Minnesota Department of Employment and Economic Development, and Minnesota State Demographic Center. Additionally, ReUSE MN conducted an online Impact Survey of ReUSE MN member businesses asking them to "report on their business activities and tell the story of their impact" (ReUSE 2020). At this next stage, the two reports diverge. MPCA concluded its study using the REMI Policy Insight 2 region-economic modeling software to report economic activity and also interviewed local economists to determine the impact of consumer reuse spending. The findings of the MPCA study focused almost exclusively on economic impact, with insights into trends and motivations. On the other hand, the ReUSE MN team split their analysis into the three sections of environmental, economic, and social reuse impacts.

To evaluate environmental impact, ReUSE MN used Carnegie Mellon University's Economic Input-Output Life Cycle Assessment (EIO-LCA) model with D&B data as inputs. This model measures environmental impact based on economic activity, and includes supply chain impacts. In general, supply chain impacts could include toxic waste or water pollution, energy use, and hazardous air or greenhouse gas emissions. The study does acknowledge that there are some limitations to using this model, such as its use of 2002 baseline producer price data which is now considered to be out of date. However, it describes how the limitations are overlooked owing to the fact that the same limitations

[22] Butler, P., Clausen, B., & Batson, K. (2011). *A Study of the Economic Activity of Minnesota's Reuse, Repair and Rental Sectors.* Minnesota Pollution Control Agency.

apply to all of the regions of comparative analysis, and so would result in negligible impact. The model gave environmental impact measurements by county in terms of greenhouse gas emissions avoided (total and per capita) and water withdrawal avoided (total and per capita).

For economic impact, ReUSE MN simply totaled up sales and employment data from the D&B dataset and the data from the state agencies, and evaluated economic impact on a series of metrics. These metrics include number of businesses, total revenue, and number of employees for both reuse and all businesses, reported in totals and percentages of totals as well as employment and revenue per capita. Finally, for social impact, ReUSE MN used qualitative data from interviews with Minnesota's public and private reuse leaders and subject matter experts, supplemented by the responses to the Impact Survey. As the ReUSE MN report mentions, this qualitative, social information cannot be obtained from the numbers and statistics drawn from D&B data. Through a series of statements that respondents had to respond to and validate, the survey provided a richer view of reuse in the state.

Research Findings

Both studies showed that reuse activities can significantly contribute to the Minnesota state economy. The MPCA study (using data from 2009) found that the reuse sector employed 46,000 people and generated about $4 billion in annual gross sales, with 50-75% of total reuse business, employment and sales accounted for by the automotive industry; additional results from the MPCA are found in Table 1. ReUSE MN found that the reuse economy accounted for 55,000 jobs and resulted in $5.8 billion in sales in 2017, even with the auto industries excluded. This seems to indicate a huge growth in the reuse industry of Minnesota from 2009 to 2017, but the increased impact could also come from the ReUSE MN study's more inclusive ways of identifying reuse businesses. The difference between the economic results of the two studies is likely because the ReUSE MN study identified so many more businesses that it made up for the exclusion of the auto industry, in addition to the perceived growth of the reuse economy. Regardless, this difference also shows the importance of having current and comprehensive data, as well as the challenges that come with the lack of a rigorous and well-accepted methodology for conducting reuse economy studies.

Table 1: MPCA results - Number of firms, sales in millions, and employees by sector

Table 3. Number of firms, sales in millions, and employees by reuse activity

Activity	Firms	Percent	Sales	Percent	Employees	Percent
Repair	10,918	71%	1,726.3	43%	28,310	62%
Used sales	3,358	22%	2,007.6	51%	12,950	28%
Rental	1,084	70%	239.0	6%	4,580	10%
Total	**15,360**	**100%**	**3,972.9**	**100%**	**45,840**	**100%**

Butler et. al (2011)

However, MPCA did delve deeper beyond these metrics, also reporting metrics such as wages, taxes, and volunteer hours associated with reuse and completing analyses from a centroid (representative center of similarly-populated regions) and county perspective. MPCA also attempted a very informal analysis of the informal reuse economy (person-to-person sales (PTP) and freecycle groups), and determined where/how money spent on reuse stays and circulates within the Minnesota economy. The report's method of assessing the informal reuse economy was to conduct an "unscientific search" (Butler et. al 2011) of online exchange sites such as Craigslist and eBay and count the number of postings within a 24 hour period on each site. The report acknowledged that most of the posts were auto industry related, and non-auto related posts mostly sold for under $100. It also goes on to state that it is likely that many listings go unsold, and that it is not currently possible to obtain total sales for an area from these pages. This would be critical information to estimate economic activity concerning PTP transactions.

Concerning circulation of money from reuse activities in the overall economy, the MPCA report first described the composition of the MN state economy and typical consumer spending patterns. In 2009, the MN economy produced $258 billion in goods and services, with the top industries being real estate rental/leasing, manufacturing, government services, finance/insurance services, and healthcare/social assistance administration. Eighty percent of consumer spending was devoted to housing, transportation, personal insurance/pensions, food, and healthcare. Given these metrics, MPCA interviewed local economists who confirmed that "reuse keeps money local and that the economic impact increases with the amount of activity within Minnesota" (Butler et. al 2011), and that the economic and environmental benefits of reuse increase with the size and cost of items. For example, furniture, cars, and large home appliances are expensive, consume a large amount of materials to manufacture, and are infrequently purchased, so there is great benefit to extending their life over smaller more frequently purchased items. If the value added (price or input energy) to a reused item is greater than the value of a new item, then the new item will be purchased; therefore there are less reuse benefits of smaller items as the ratio of value added to original value is so much smaller. The study allowed that an exception to this is antiques, whose value can exceed new items. No mention was made of smaller but more complex items like cell phones that may require extractive mining/processes to create new products rather than refurbish used ones, or of the impact of individual single use (plastic) items, although these could also be exceptions.

The economists interviewed also determined that reuse spending has primary benefits to the consumer rather than to the macroeconomy; however, they also asserted that economic value of reuse should not only be measured in terms of monetary success but also energy savings, transportation and sorting costs, and resource scarcity factors (extraction, production, and manufacturing cost). Finally, the report discusses growing and

shrinking trends in the reuse industry, such as the shrinking of the video/DVD rental market but the increase of reuse spending during the 2008 financial crisis as consumers had less disposable income. To sum up the qualitative findings of the MPCA report, reuse activities retain and recirculate money in the local economy, give consumers increased choices and stretch their dollar. However, the economic impact of reuse is greatly influenced by changing economic conditions and consumer finances, tastes, and needs which determine the demand for reused products and services.

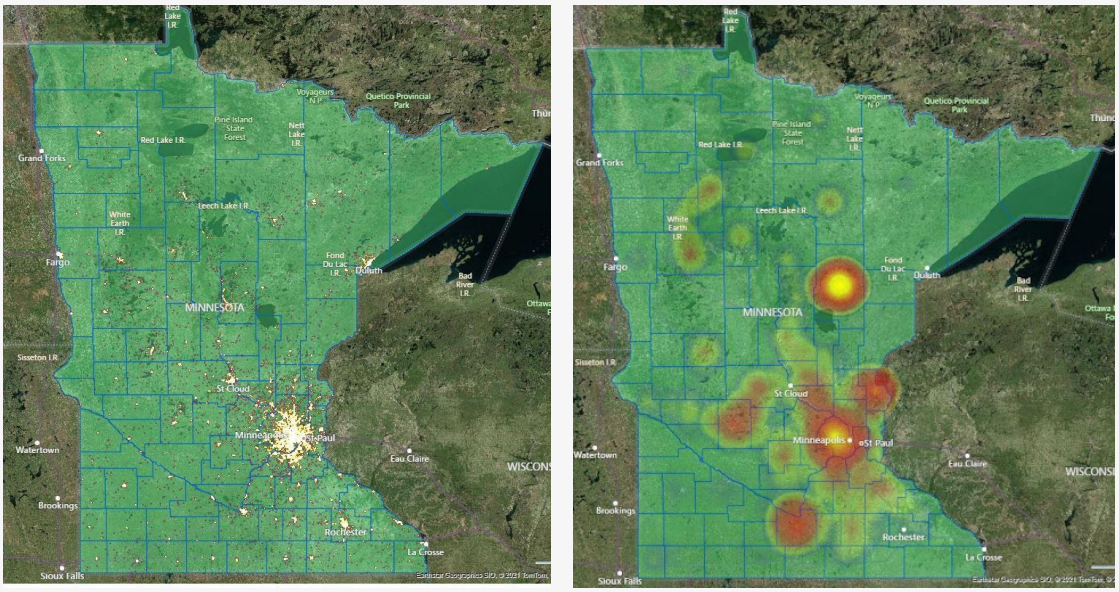
In terms of environmental impacts, the ReUSE MN study results are much more comprehensive, because the MPCA self-admittedly assessed the economic impacts over environmental. MPCA does discuss how reuse retail businesses were able to divert 11,000 tons of items from landfills during the study year, but even this is framed anthropogenically in terms of the value and avoided disposal costs of the diverted items, rather than the ReUSE MN's environmental metrics of GHG emissions and water withdrawal avoided. According to the ReUSE MN environmental impact findings, reuse activities resulted in an avoided 2.7 million metric tons of CO2 equivalent emissions per year, and reduced over 67 billion gallons in withdrawals of freshwater each year from ground or surface water sources. The report also pointed out how metro area reuse activities result in significantly higher environmental benefits, because more reuse behavior occurs with increased population density.

Though the ReUSE MN Impact Survey only collected 12 responses, the study was able to gather sufficient information between the survey and interviews with MN reuse leaders to determine social impact. Resale business owners described how there was great camaraderie amongst regular customers and social bonding among large groups through bargain hunting. From the data, the report also described how rental businesses were very important to the MN "lake country" cultural identity, because they provide recreational gear/vehicles for people to enjoy the natural resources of MN. In general, the study also found that reuse provides people with a variety of opportunities not available when only purchasing new products. Some of these opportunities include: access to expensive and high quality items at an affordable price, affordable access to recreational activities (ex. skiing/boating) which creates strong/close family and community bonds, extended use/enjoyment of belongings, and pride/satisfaction in skills for repair/restoration. These opportunities for the most part provide intangible value, which can only be measured via personal satisfaction or opinion surveys.

Conclusions

Both the MPCA and the ReUSE MN reports on the reuse economy in MN offer valuable assessments of reuse activities that can be used to inform similar studies in other states, such as ours in Massachusetts. The MPCA report, while focused solely on economic impacts, provides insights on how valuable reuse activities can be to the larger economy

and the consumer. It also provided the basis for the ReUSE MN report, which built off of and expanded on the MPCA report by diving into environmental and social impacts as well. The ReUSE MN report made the impact data accessible to the public via an online interactive map displaying visualizations of reuse revenue, employment, GHG emissions and water withdrawals avoided, as well as business locations primarily in the form of heat maps (see Figures 5 and 6). According to our team's conversations with the REUSE MN research team, this tool is still being finalized and while it is live, it is unclear if the resource is being widely promoted yet[23]. This essentially serves as a public education tool which Minnesota can use to show the impacts of reuse in certain areas of the state. Additionally, on the business side, ReUSE MN developed marketing and "storytelling" strategies to help the businesses themselves promote their positive impacts on the economy and community, which in turn promotes reuse in general.



Figures 5 and 6: ReUSE MN heat maps of reuse businesses by location (left) and greenhouse gas (GHG) emissions avoided by reuse activity (right). ReUSE Minnesota (2020).

Each report serves as a roadmap to help our Field Projects team to conduct our own reuse economic impact study in Massachusetts. The MPCA report provides detailed methodology on collecting data on reuse businesses using NAICS codes, important metrics to include to assess economic activities, and more involved economic analysis for further study by Massachusetts researchers. Meanwhile, the ReUSE MN report provides even more details on data collection methodology and how to expand collection of reuse business data beyond the explicit NAICS codes. It also provides opportunities for future research in MA, but focused on environmental and social impacts rather than a deeper look at economics. The second report also shows how the currency and type of data collected can change study results, and how data can be visualized to facilitate public understanding. Both reports are important resources to learn from and model in order to produce new reports on the economic impact of reuse to support the case of promoting reuse activities and practices to a larger audience.

[23] J. Kedword, personal communication, February 24, 2020

OREGON REUSE ECONOMY STUDY

Strategic Plan for Reuse, Repair and Extending the Lifespan of Products in Oregon (2016)

Introduction

In December 2016, Oregon's State Department of Environmental Quality (DEQ) released a six-year strategic plan to extend the lifespan of products and slow the buildup of waste. DEQ is a regulatory agency committed to protecting the quality of Oregon's environment. Its strategic plan included background information and a literature review to guide the planning process. Its review discussed potential environmental and economic benefits as well as the challenges and barriers of product reuse and repair. Instead of analyzing Oregon's current reuse economy, the report offered strategies and actions to reach a future goal of extending product lifespans consistent with Oregon's 2050 Vision for Material Management. Although the state of Oregon did not conduct an economic analysis, many cities in Oregon have. Some of the cities, such as Portland and Eugene, have published studies on the local reuse and repair economy in their respective city.

Methods

The DEQ team identified three materials that they considered high-impact on the environment to prioritize in their strategic plan for reuse. These include building materials, textiles, and products that are amenable to remanufacturing depending on a separate national planning process. Those products could be appliances, furniture, consumer electronics, or machinery whose environmental impact may be mitigated through reuse, repair, or remanufacturing. These items were prioritized based on a literature review. The lifecycle of textiles has a significant impact on the environment from beginning to end. Products such as appliances, furniture, electronics, or machinery are identified as having the greatest potential for repair or reuse. DEQ also noted, however, that products that are inefficient or polluting should not be considered for reuse. An example of products that should not be considered for reuse are large appliances that are not energy efficient such as outdated refrigerators, washers, or dryers.

The DEQ team has four overall strategies:

- Conducting foundational research
- Developing infrastructure and building capacity
- Driving demand to use that infrastructure
- Supporting policy

Their research is targeted at understanding the issues with the current systems as they relate to the high-impact materials described previously, with a greater emphasis on textiles. They also plan to evaluate the environmental impacts, price gaps, and health impacts of buildings that are set for demolition or repurposing. Another focus area is

understanding the needs and gaps in specific industries, as well as becoming familiar with the remanufacturing industry. Their second strategy, building infrastructure and capacity, focuses on providing financial support to bolster the reuse and repair services. Providing grants for market development could support businesses' online inventory systems. To encourage consumers, DEQ plans to develop community-scale initiatives to educate consumers about reuse, repair, and product lifespan. These planned actions would shape the types of policies that DEQ would support. The DEQ team would support policies that align with their goal of waste reduction in Oregon. However, the DEQ team must first establish a strong research foundation before doing so. Supporting policies that are related to waste reduction is also dependent on Oregon's infrastructure and market development. DEQ must also consider the changing infrastructure and market of the reuse economy before deciding what type of policies to support.

Conclusions

DEQ's strategic plan is a response detailing how the agency would meet Oregon's 2050 vision. This report is beneficial for other agencies that are considering a work plan to reduce waste on a state-wide scale. The department's action plans are broad but encapsulating. They can help other states like Massachusetts think about what type of material waste should be considered. Other states could either develop a strategic plan similar to Oregon's or follow a similar structure. One drawback is that their report did not cover an analysis about Oregon's reuse economy; it would have been beneficial to utilize this information to curate a plan that is unique to Oregon. DEQ also made clear that very few U.S. governments have analyzed the economic benefits of the reuse, repair, and rental industry. This report provided a broader guide of how states can start addressing waste management through reuse and repair.

QUANTITATIVE ANALYSIS RESULTS

Photo source: MassDEP

ECONOMIC ANALYSIS

Summary of the Massachusetts Reuse Economy

Our Field Projects team determined the total number of businesses in the reuse economy in MA using data from DataAxle. The data we utilized was collected by DataAxle throughout 2019 (before the start of the COVID-19 pandemic) and published at the beginning of 2020. We identified the number of businesses in each county in MA categorized by the three reuse sectors. Due to the time limitation of this project, we excluded the automotive industry and more effort was put in the non-auto reuse business economy. We also want to reiterate from prior studies that the automotive reuse and repair industry is already well-established and this research wanted to focus on the lesser-known impact of businesses outside of the automotive industry. We determined the number of small businesses, the number of female-owned businesses, and the number of jobs in the reuse economy. Lastly, we identified whether there were potential relationships between reuse businesses and the economy, and between reuse businesses and population.

Total Reuse Business

Figure 7 presents the percentage of total reuse, rental, and repair businesses out of all reuse businesses in MA. Of these sectors, repair businesses make up a large proportion of the Massachusetts reuse economy, taking the leading role of 48%.

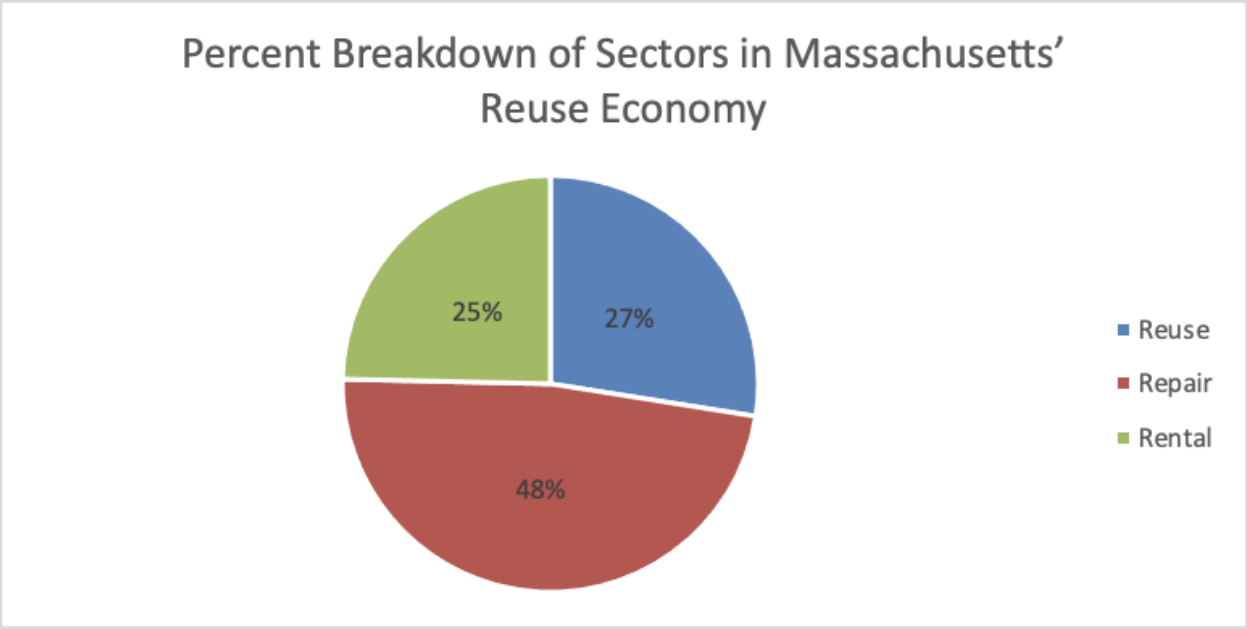


Figure 7: Percent breakdown of sectors in Massachusetts' reuse economy. Figure created by Zhining Sun

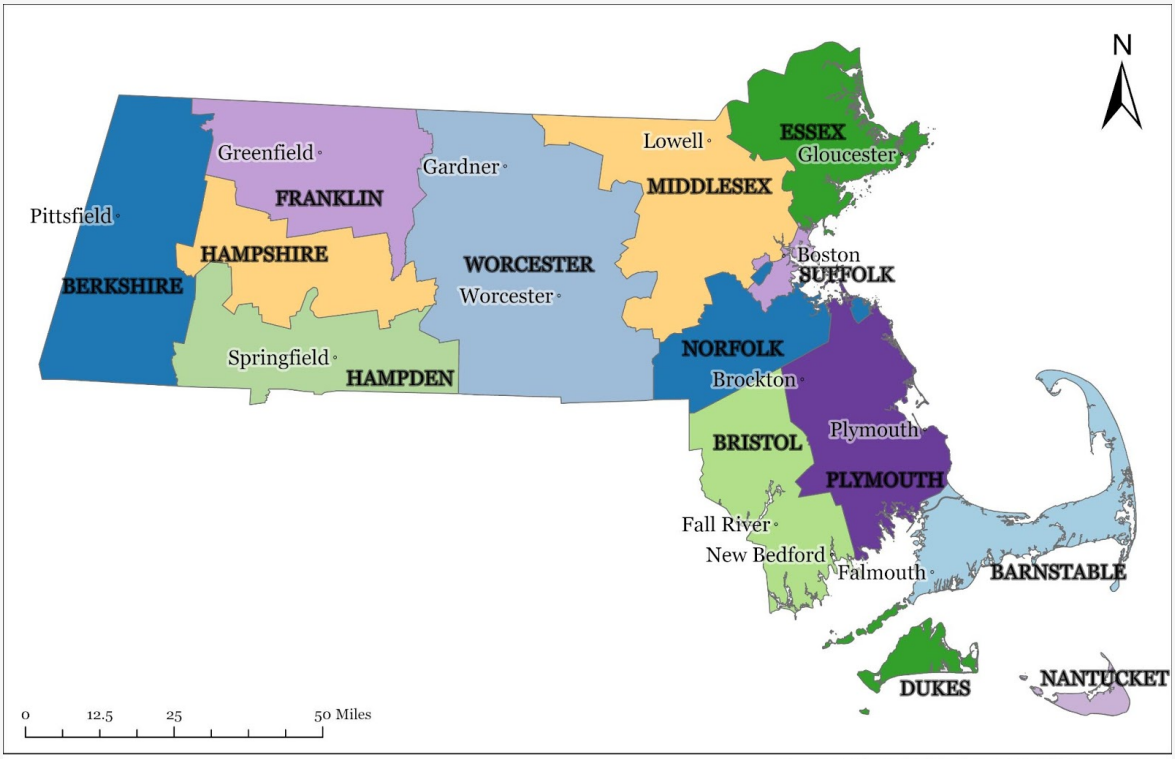


Figure 8: Context map of MA counties and cities

Table 2: Number and share of reuse businesses in Massachusetts

Number of reuse businesses in each county					
County	Businesses Per Sector: Reuse	Businesses Per Sector: Repair	Businesses Per Sector: Rental	Total Reuse Economy Businesses	Percent of Reuse Businesses out of ALL Businesses
Barnstable	191	153	78	422	2.76%
Berkshire	70	64	26	160	2.37%
Bristol	154	254	121	529	2.15%
Dukes	14	9	14	37	2.43%
Essex	267	354	165	786	1.99%
Franklin	42	42	17	101	2.80%
Hampden	91	197	94	382	1.70%
Hampshire	59	83	28	170	2.01%
Middlesex	287	756	306	1,349	1.52%
Nantucket	17	4	12	33	2.10%
Norfolk	108	321	183	612	1.66%
Plymouth	182	266	107	555	2.31%
Suffolk	126	232	243	601	1.07%
Worcester	162	347	192	701	1.91%
Total	**1,770**	**3,082**	**1,586**	**6,438**	**1.76%**

Table created by Joann Lai

For spatial context, Figure 8 displays counties in MA as well as key cities. Table 2 shows a breakdown of the businesses in each sector by county. The repair sector has the largest number of businesses, totaling 3,082 businesses. The rental sector has a total of 1,586 businesses and the reuse sector has a total of 1,770 businesses. Nantucket County has the least amount of businesses in the reuse economy, totaling 33 businesses. Middlesex County has the most reuse, repair, and rental businesses compared to the other counties, with a grand total of 1,349 businesses in the reuse economy alone. Table 2 also shows the prevalence of reuse businesses in each county by percentage. The percentage of reuse economy businesses in a county ranges from 1.07% to 2.76%. Barnstable county has the highest percentage compared to other counties, with 2.76% of reuse economy businesses. Barnstable has a total of 15,293 businesses. The lowest percentage of reuse businesses in a county is Suffolk, with 1.07% of reuse economy businesses. Suffolk's 601 businesses out of its 56,109 total businesses are reuse businesses. **The reuse economy makes up 1.76% of Massachusetts' total business economy. 6,438 businesses out of Massachusetts' 366,520 businesses are either a reuse, repair, or rental business.**

Figure 9 shows the number of reuse, rental, and repair businesses for each county. Middlesex County and Essex County are two counties that play an important role in the reuse business in Massachusetts. Suffolk County has a relatively large amount of rental activity and Barnstable County has a relatively large amount of reuse activity.

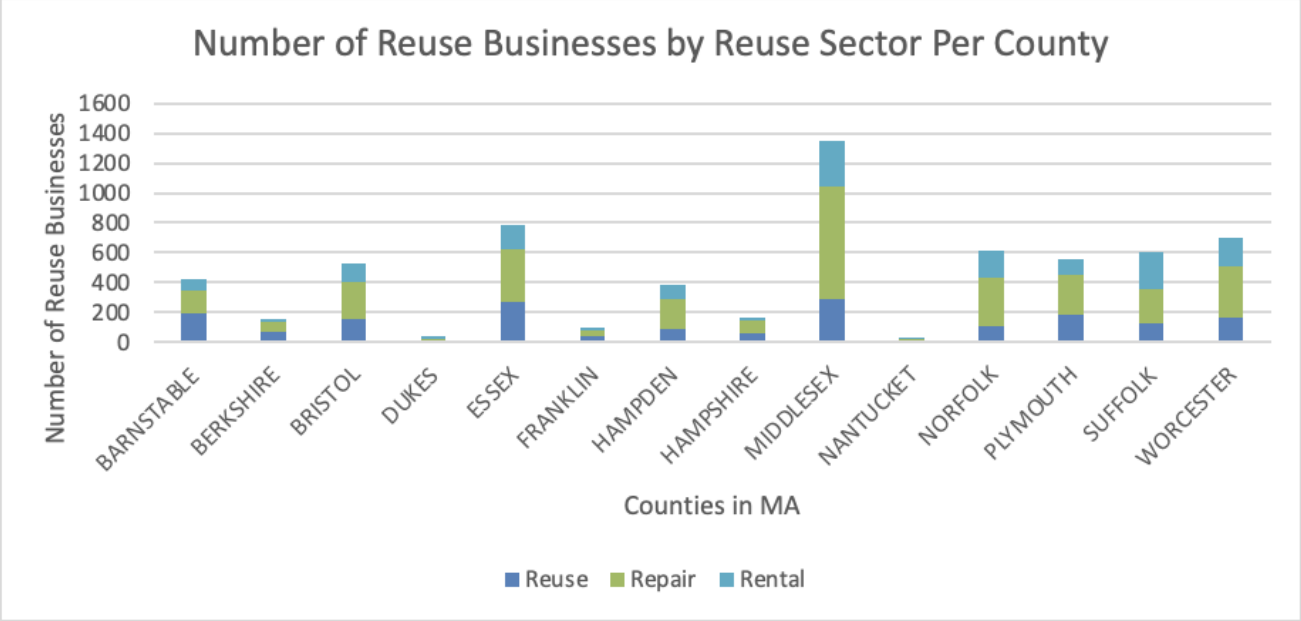


Figure 9: Number of reuse businesses by reuse sector per county. Figure created by Zhining Sun.

Figure 10 shows an enlargement of the number of reuse businesses in Dukes, Franklin, Hampshire and Nantucket counties from Figure 9. These are the counties with the least number of reuse businesses.

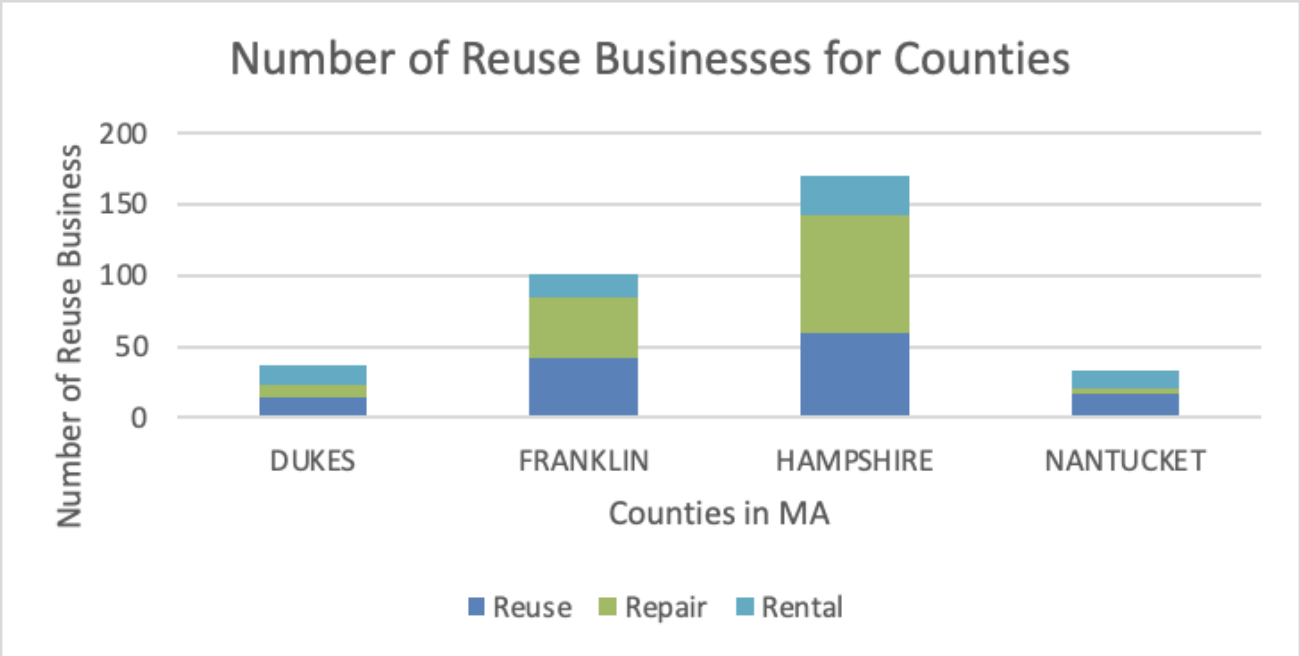


Figure 10: Reuse businesses in Dukes, Franklin, Hampshire and Nantucket. Figure created by Zhining Sun

Small Businesses in the Reuse Economy

We also extracted information from the DataAxle 2020 data (which, again, was collected from the beginning of 2019 right up to the start of 2020) that helped us understand the number of small businesses that contribute to the reuse economy. We used the variable "Small_Business_Entrepreneur" in the dataset. Table 3 below shows that there is a grand total of 3,024 small businesses that are part of the reuse economy. If we compare this to the overall total businesses in the reuse economy, this shows that 3,024 businesses out of the total 6,438 reuse businesses identify as a small business. In other words, 47% of reuse business owners in Massachusetts identified their business as a small business. For this dataset, DataAxle identified which businesses were small businesses.

Table 3: Number of small businesses in each county for the three reuse sectors in MA

Number of small businesses in the reuse economy	
County	**Total**
Barnstable	238
Berkshire	95
Bristol	277
Dukes	19
Essex	364
Franklin	63
Hampden	198
Hampshire	91
Middlesex	629
Nantucket	16
Norfolk	248
Plymouth	265
Suffolk	181
Worcester	340
Total	**3,024**

Table created by Joann Lai

Female-owned Businesses in the Reuse Economy

The DataAxle data contained a value, “female_owner_exec”, which we used to describe the number of businesses that are female-owned. The Women’s Business Enterprise National Council’s (WBENC) define a female-owned business as a business enterprise with at least 51% of the business being owned, operated and controlled by citizens or permanent residents who are women (MWBE Certification Eligibility Requirements | Empire State Development, 2017). Although the data in DataAxle might be self-reported by the business owner, we can borrow WBENC’s definition to understand what a female-owned business could mean. This finding resulted in a grand total of only 135 female-owned businesses in the reuse, repair, and rental sectors. Table 4 below shows the breakdown of female-owned businesses by county. If we compare this information to the total number of businesses in the reuse economy, we are looking at 135 out of 6,438 reuse businesses, or 2% of businesses in the reuse economy are female-owned. This value is about 16 times lower than the 33% of businesses owned by women across MA’s whole economy (NAWBO 2019).

Table 4: Number of female-owned businesses in the reuse economy

Number of female-owned businesses in the reuse economy	
County	**Total**
Barnstable	11
Berkshire	3
Bristol	8
Dukes	3
Essex	8
Franklin	1
Hampden	10
Hampshire	5
Middlesex	24
Nantucket	1
Norfolk	13
Plymouth	12
Suffolk	21
Worcester	15
Total	**135**

Table created by Joann Lai

Employment in the Reuse Economy

We focused on the employment opportunities created by these businesses to better understand their economic benefits. We used DataAxle's value, " actual_location_employment_size" to determine the number of jobs in the reuse economy. In Table 4, We identified all employment (reuse and non-reuse) for each county by adding "actual_location_employment_size" by counties. Our results are presented in Table 5 and Figure 11.

We identified a total of 8,231 jobs in the reuse sector, 11,681 jobs in the rental sector, and 12,916 jobs in the repair businesses in the DataAxle database, the data for which was collected over the course of 2019 and published at the beginning of 2020. The three sectors created a total of 32,828 jobs. The "All Employment" column in Table 5 represents the total number of employment from both the reuse business and the non-reuse business in the DataAxle data. The last column, "Percentage of Reuse Employment", shows that none of the counties in MA have a percentage of reuse business employment of 2% or more. **The percentage of the total employment related to businesses in all of the reuse sectors in MA is 0.93%.**

Table 5: Number of people employed in the reuse economy compared to all employment by county

County	Reuse Job Employment	All Employment	Percentage of Reuse Employment
Barnstable	2,019	120,784	1.67%
Berkshire	847	64,219	1.32%
Bristol	1,960	217,083	0.90%
Dukes	176	10,119	1.74%
Essex	3,370	348,962	0.97%
Franklin	275	29,163	0.94%
Hampden	1,976	212,578	0.93%
Hampshire	668	63,579	1.05%
Middlesex	8,054	870,450	0.93%
Nantucket	138	9,246	1.49%
Norfolk	4,078	324,501	1.26%
Plymouth	2,264	206,677	1.10%
Suffolk	3,911	695,309	0.56%
Worcester	3,092	355,484	0.87%
State of MA	32,828	3,528,154	0.93%

Table created by Joann Lai and Zhining Sun

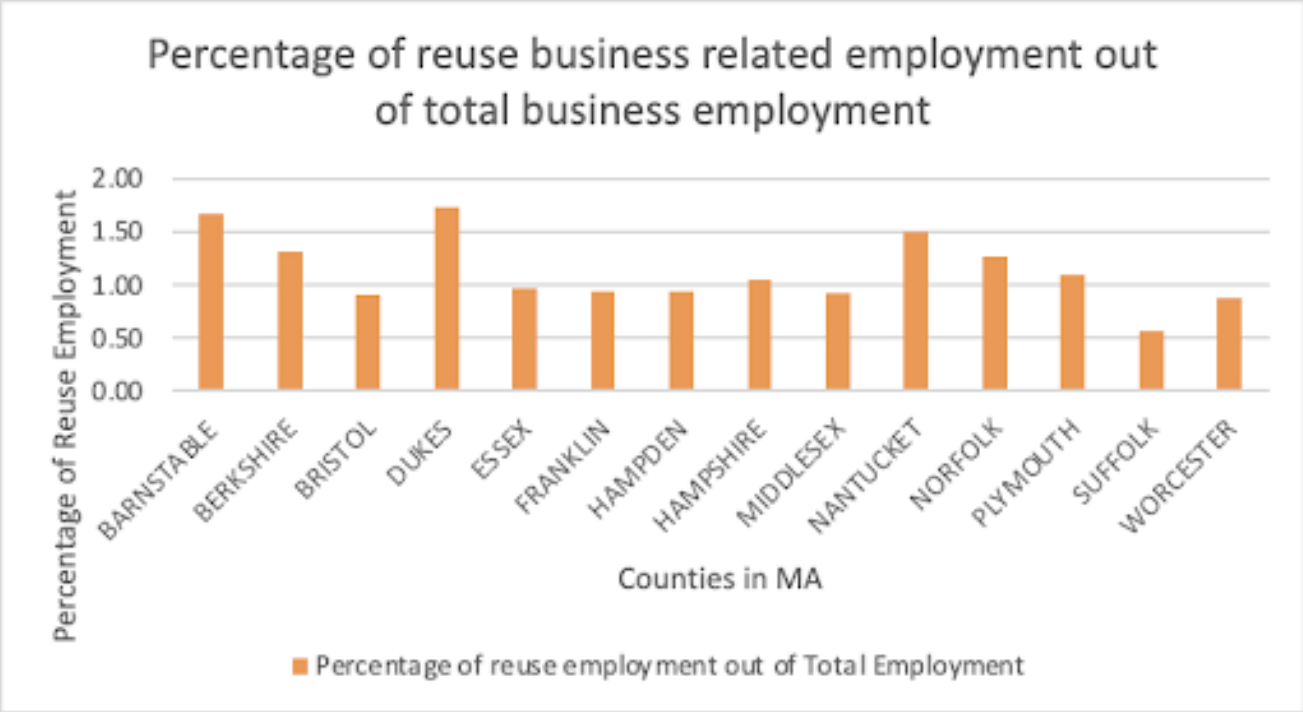


Figure 11: Percentage of reuse business related employment out of total business employment. Figure created by Zhining Sun.

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Sales Revenue in the Reuse Economy

The two tables below break down the total sales volume across all reuse businesses in each county of MA. Total sales volume for the reuse economy across the state exceeded 7.3 billion dollars, which is over 1% of the state's total GDP. Reuse spending per capita exceeded $1,000 for the whole state and varied significantly by county and across each of the sectors of the reuse economy. The rental sector accounted for the largest share of sales volume for the state overall, although in many counties one or both of the other sectors exceeded the sales volume in the repair sector. See "Spatial Analysis" for sales volume hotspots across the state.

Table 6: Sales volume of all MA businesses and the reuse economy in particular

Sales volume in Massachusetts			
County	**All Businesses (millions USD)**	**Reuse Economy (millions USD)**	**Reuse Economy per Capita (USD)**
Barnstable	20,727.04	780.14	3,654.13
Berkshire	11,684.41	98.23	776.94
Bristol	40,029.55	500.59	892.26
Dukes	2,016.05	71.80	4,147.24
Essex	64,043.16	991.42	1,265.09
Franklin	3,504.26	28.85	408.77
Hampden	31,905.06	331.50	708.53
Hampshire	8,950.63	161.11	1,000.48
Middlesex	164,997.87	1,611.23	1,006.49
Nantucket	3,088.98	115.40	10,332.92
Norfolk	64,630.53	874.61	1,248.66
Plymouth	37,136.46	598.68	1,161.81
Suffolk	132,085.08	1,281.33	1,608.49
Worcester	64,156.19	644.96	781.99
Whole State of MA	**648,955.28**	**7,309.71**	**1,067.03**

Table created by Joann Lai and Max Dorman

Table 7: Total and per capita sales volume for each sector of the reuse economy. Data for the reuse economy is displayed in total sales volume for each county and per capita sales volume for each county.

County	Reuse Sector (millions USD)	Repair Sector (millions USD)	Rental Sector (millions USD)	Reuse Sector Revenue Per Capita (USD)	Repair Sector Revenue Per Capita (USD)	Rental Sector Revenue Per Capita (USD)
Barnstable	338.67	102.39	342.23	1586.29	479.58	1602.98
Berkshire	52.67	24.53	25.03	416.59	194.00	197.95
Bristol	247.47	134.02	136.96	441.09	238.87	244.12
Dukes	16.15	4.34	51.44	932.65	250.92	2971.41
Essex	367.54	286.99	381.46	468.99	366.20	486.75
Franklin	10.71	13.96	7.79	151.79	197.76	110.33
Hampden	191.42	115.27	83.11	409.13	246.38	177.64
Hampshire	87.76	54.48	18.87	545.00	338.31	117.18
Middlesex	438.78	594.12	644.47	274.09	371.13	402.58
Nantucket	29.45	9.65	79.16	2636.55	864.17	7088.29
Norfolk	233.09	252.72	407.63	332.78	360.81	581.96
Plymouth	210.06	199.23	203.91	407.65	386.63	395.71
Suffolk	464.66	207.99	626.63	583.30	261.10	786.63
Worcester	237.20	195.37	227.54	287.59	236.88	275.88
State of MA	**2,925.62**	**2,195.05**	**3,236.22**	**9473.51**	**4792.72**	**15439.41**

Table created by Joann Lai and Max Dorman

Identifying Relationships Using Scatterplots, Regression, and T-test

After analyzing the number of reuse businesses in Massachusetts and their employment information, we identified the relationship between reuse businesses and the economy, and between reuse businesses and population.

Table 8 provides an overview of the reuse business employment, number of reuse businesses, gross domestic product (GDP), and population for each county in MA.

Table 8: Overview of reuse business employment, number of reuse businesses, population, and GDP

County	Employment	Number of Businesses	Population	2019 GDP (USD)
Barnstable	2,190	422	213,496	16,094,174
Berkshire	885	160	126,425	7,824,707
Bristol	2,616	529	561,037	29,132,173
Dukes	182	37	17,312	2,337,018
Essex	3,601	786	783,676	50,083,844
Franklin	287	101	70,577	3,299,783
Hampden	2,135	382	467,871	24,256,781
Hampshire	698	170	161,032	8,539,314
Middlesex	8,674	1,349	1,600,842	180,236,765
Nantucket	168	33	11,168	2,430,249
Norfolk	4,212	612	700,437	58,443,676
Plymouth	2,403	555	515,303	29,375,318
Suffolk	4,488	601	796,605	13,776,258
Worcester	3,450	701	824,772	46,776,699
Whole State of MA	**35,989**	**6,438**	**6,850,553**	**472,606,759**

Table created by Joann Lai

[24] The population data is from the Massachusetts Demographics website. The GDP data is downloaded from the Bureau of Economic Analysis, U.S. Department of Commerce. The GDP data uses 2019 GDP in current dollars.

We studied the relationships of the number of reuse businesses, employment, GDP, and population using scatter plots with trendlines in Excel. In Figures 12, 13, and 14, we can see an upward trendline. These charts show the general positive relationship between the number of reuse businesses and employment, population, and GDP respectively. Counties usually have higher employment, higher number of businesses, higher population, and higher GDP at the same time, and vice versa. This indicates that employment, number of businesses, population, and GDP are all positively correlated. Although there is a general trend, this does not equate to causation.

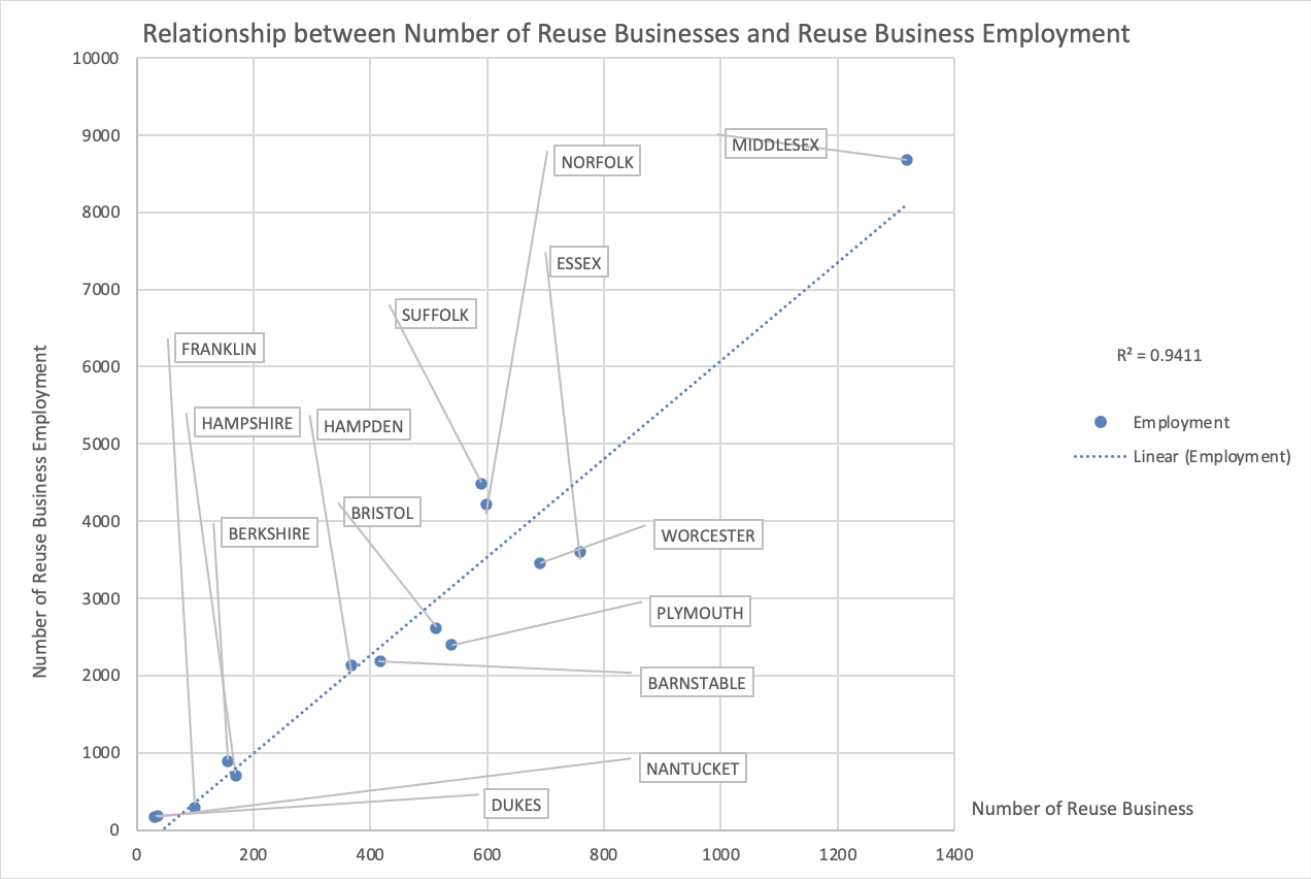

Figure 12: Relationship between number of reuse businesses and reuse business employment. Figure created by Zhining Sun

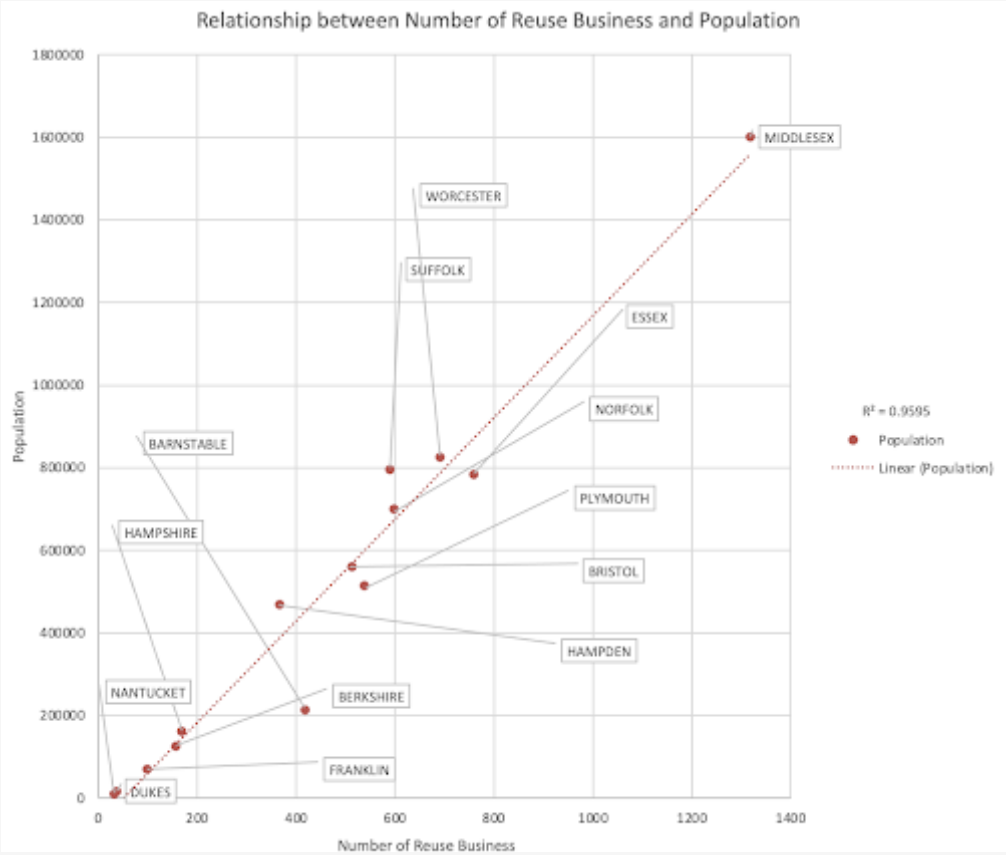

Figure 13: Relationship between number of reuse business and population. Figure created by Zhining Sun.

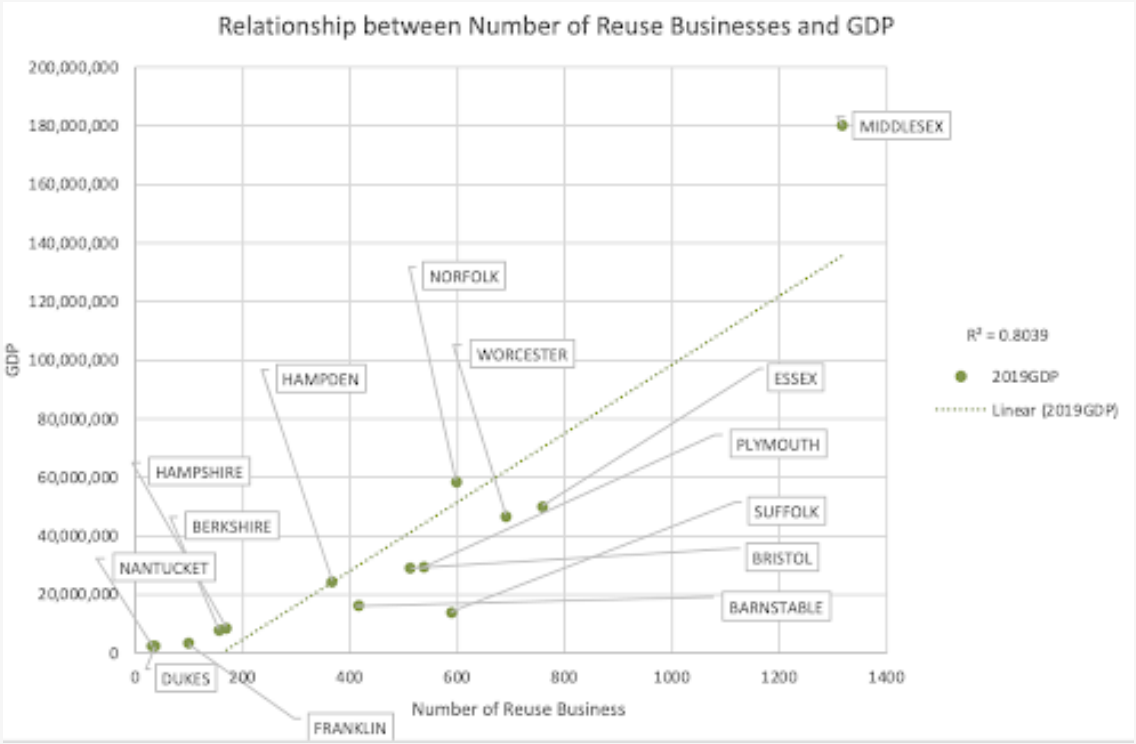

Figure 14: Relationship between number of reuse businesses and GDP. Figure created by Zhining Sun.

Table 9 displays the regression results, with the dependent variable in our regression model as “GDP in 2019 (in current dollars)” and the independent variable is the “number of reuse businesses” included in all three sectors. We did not separate the reuse business into three sectors and identified their relationships with GDP respectively. The skewness for GDP in 2019 calculated by STATA is 1.67. Because 1.67 is greater than 1, based on the definition of skewness, GDP in 2019 is positively and highly skewed. The skewness is reasonable. As we can see from Table 8 and Figure 13, Middlesex county has much higher GDP than other counties. What’s more, Middlesex county is the only county that has such a large GDP value. This drives the right tail of the distribution to be longer than the left tail. This causes the distribution of GDP 2019 to be positively skewed. To normalize the data, we took the natural logarithm (ln) of GDP2019 and calculated it into “LnGDP2019.” In this case, the independent variable changed to ln of GDP2019. Heteroscedasticity happens when the variability of the values of a variable are not random across the range of values of a second variable that predicts it. We used a robust model to solve the issues of heteroscedasticity and measurement errors. As shown in Table 9, we have 14 observations which refer to the 14 counties in MA. The coefficients for the number of businesses and the square of number of businesses are both significant. Additionally, the positive coefficient which is significant at 1% significance level demonstrates a positive correlation between the number of reuse businesses and GDP. Although there is a strong positive correlation, we **cannot** interpret the coefficients’ magnitude due to two-way causality. This means that we **cannot** say that one additional reuse business results in an increase of .00361 to LnGDP on average, holding everything else constant.

Table 9: Regression results

Regression Results		
LnGDP2019	Regression 1	Regression 2
Number of Reuse business	0.00361***	0.00681***
	(0.000631)	(0.000879)
Squared of Number of Reuse Business		-2.68e-06***
		(6.01e-07)
Constant	15.18***	14.59***
	(0.278)	(0.153)
Observations	14	14
R-squared	0.819	0.916
Standard errors in parentheses		
*** p<0.01, **p<0.05, * p<0.1		

Table created by Zhining Sun and Joann Lai

Last but not least, we used a t-test to determine the significance of the coefficient related to the number of reuse business. A t-test is a statistical tool which is used to test the statistical significance of the coefficient. Our null hypothesis is that the coefficient of the number of businesses is equal to zero and the alternative hypothesis is that the null hypothesis is not correct. We used Stata to conduct a t-test and the result was a t-value of 32.73. This value means that we reject the null hypothesis with 1% significance level. We are 99% confident to say the coefficient of the number of reuse business is not 0. This validates the existence of a significant positive relationship between the number of reuse businesses and the local economy.

SPATIAL ANALYSIS

In this section, we report the results of the spatial analysis. We plotted points of where reuse businesses are in MA. We then created maps displaying the concentration of reuse business, employment, revenue, and population density, as well as maps that show the relationships of location quotients for employment in each county. Lastly, we included a map that displays locations of EJ communities. The analysis of these results is interpreted in the Discussion section.

Where are Reuse Businesses in Massachusetts?

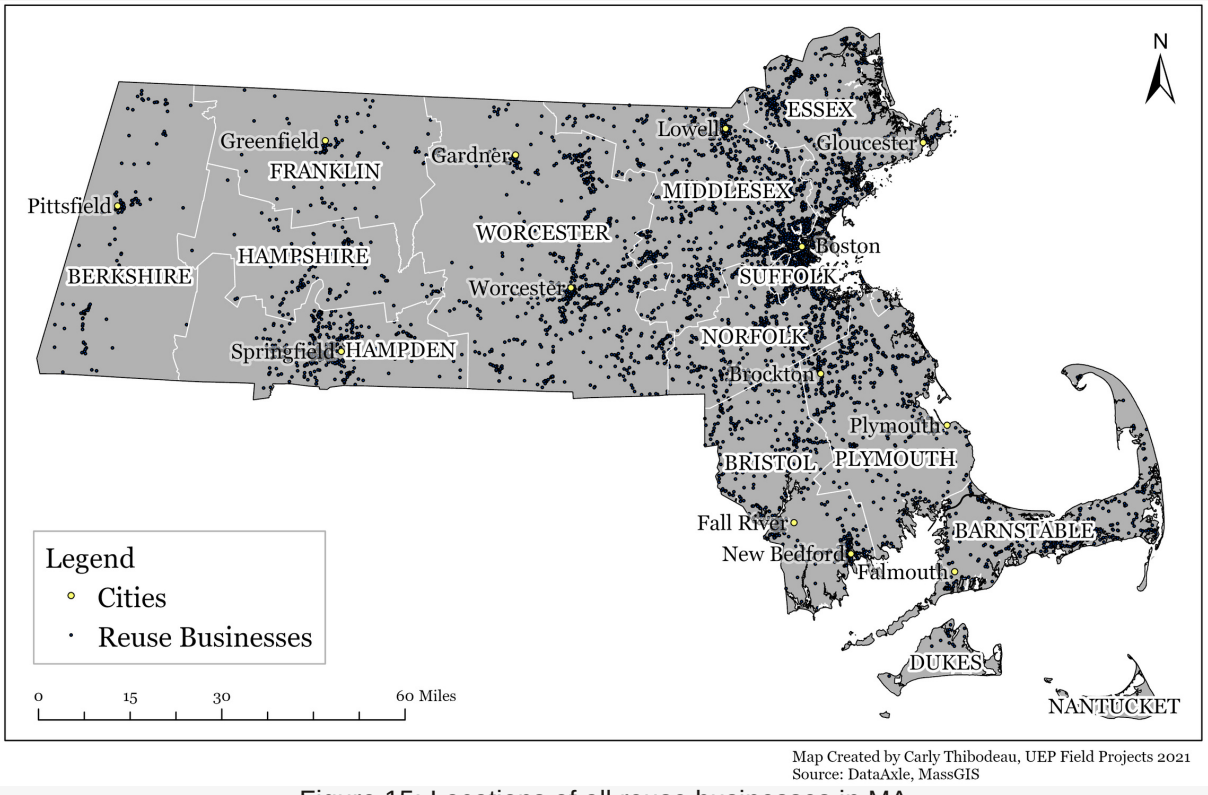

Figure 15: Locations of all reuse businesses in MA

Figure 15 shows the locations of all reuse businesses in the state of Massachusetts as points, with select major cities in each county labeled for spatial context. Each of these

cities has a population of greater than 30,000 people. While there are reuse businesses present in nearly all areas of the state, there are some places in Western and Central MA, as well as the tip of Cape Cod, that are bare of reuse businesses. The Cities of Boston, Springfield, and Worcester have the most dense appearances of reuse businesses, but urban areas in general (Pittsfield, Greenfield, Gardner, Lowell, New Bedford, etc.) have more reuse locations than rural areas.

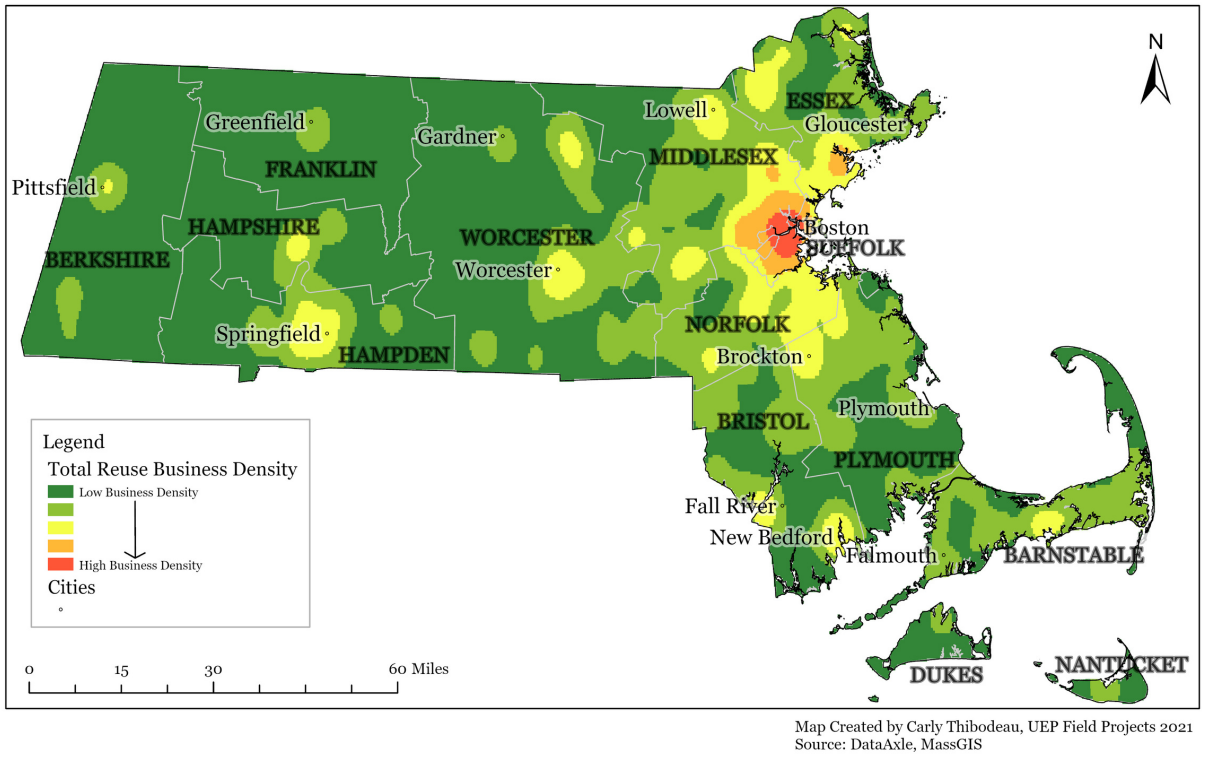

Figure 16: Heat map of total reuse business density in MA

Figure 16 shows where the areas of highest density of reuse businesses are in MA as a heat map. This map displays a smoothed representation of Figure 15, which makes overall trends visible rather than specific locations. As pointed out by Figure 16, reuse businesses are most dense near urban areas. Suffolk County (containing Boston and its neighboring cities) has by far the most dense concentration of reuse businesses, which bleeds out into the rest of the Greater Boston area (Middlesex, Norfolk, and Essex Counties). Hampden (containing the City of Springfield) and Hampshire (containing the town of Northampton) Counties also have high density areas, along with hotspots in Fall River and New Bedford (cities in Bristol County), and one on the Cape in Barnstable County where the Town of Hyannis is located.

Location Quotients

Location Quotients are a tool used to measure how the proportion of employment in a part of the economy varies within regions of a larger overall area (see “Analysis Strategies, Spatial Analysis” section for methodology). The proportion of employment represented by

the subset of the economy over a geographic area of interest (in this case, MA's reuse economy and the three sectors that comprise it) is the baseline for comparison with the proportion of employment within smaller regions of the geographic area (here, MA's counties). If the proportion of employment in a county is identical to the proportion for the state on the whole, the LQ is equal to 1 (indicated with yellow in the figures below). If the proportion is lower than the state average, the LQ is lower than 1. For example, a county with an LQ of 0.5 would have half the proportion of employment of the state on the whole. If the proportion of employment is higher than the state average, the LQ is higher than 1; an LQ of 2 for a county would mean the proportion of employment in the county's economy is twice that of the proportion of employment in the state's economy overall. Figures 17 through 20 illustrate the LQs for MA's reuse economy and for each of the three sectors that comprise it.

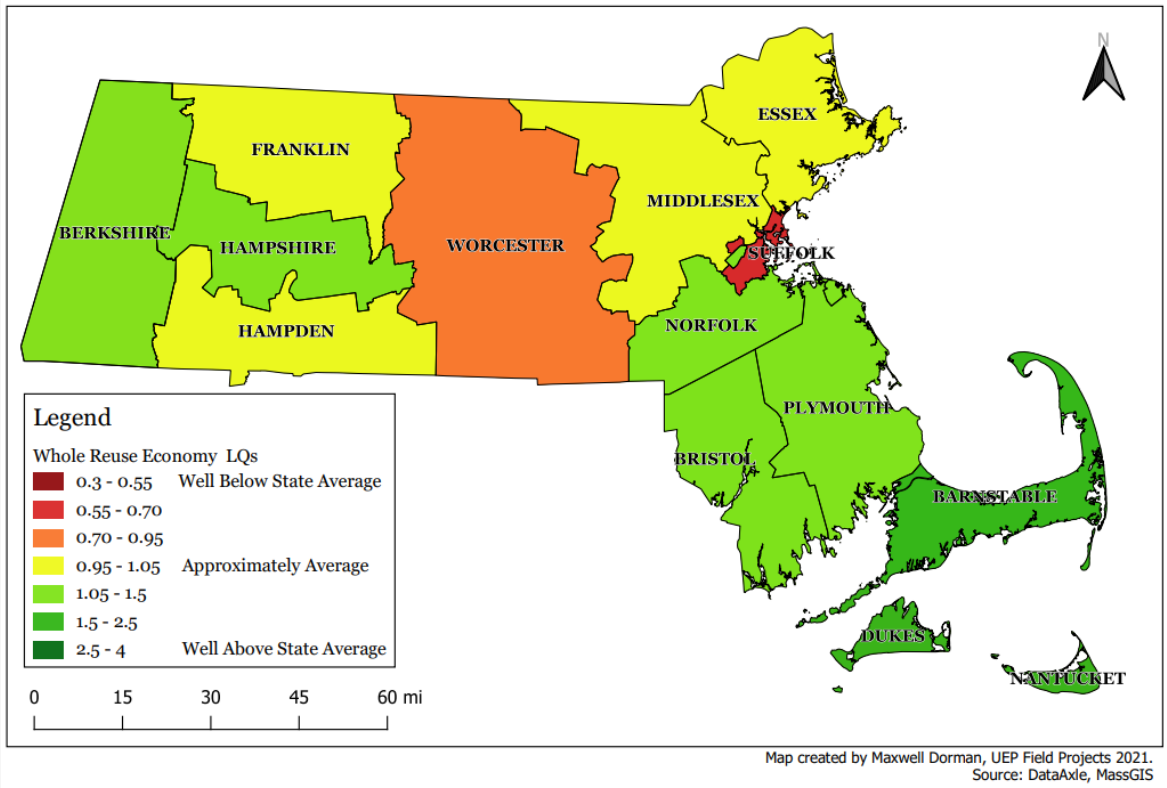

Figure 17: Location quotients (LQs) for the entire MA reuse economy.

Over the whole reuse economy (Figure 17), four counties have roughly the same proportion of reuse economy jobs as the state as a whole (Middlesex, Essex, Franklin, and Hampden), two western counties (Berkshire, Hampshire) and three southeast counties (Norfolk, Bristol, and Plymouth) have LQs somewhat above average, the three southeasternmost counties all have notably average reuse economy LQs, Worcester's LQ is slightly below the state average and Suffolk has a reuse economy LQ notably below the state average. Specific LQ values for each county can be found in Appendix B.

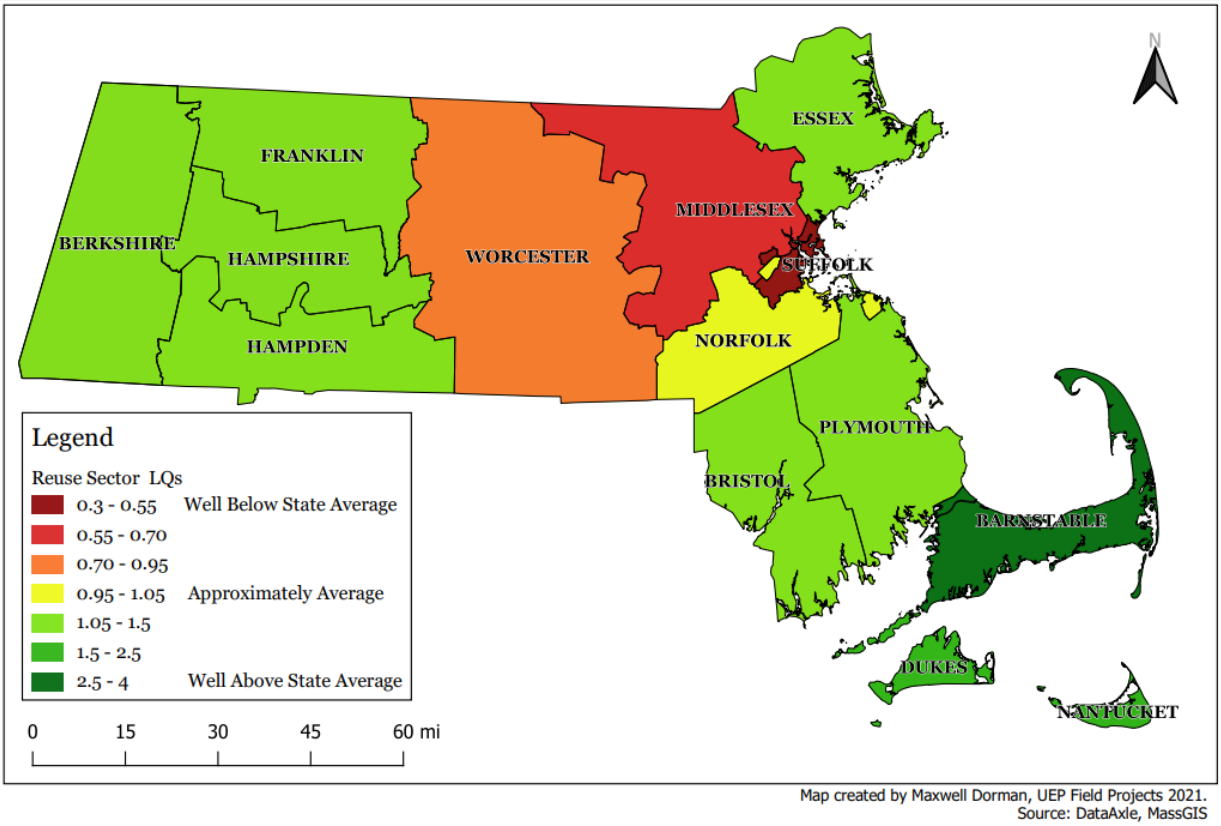

Figure 18: Location quotients for the reuse sector (secondhand retail) of MA's reuse economy. Figure created by Max Dorman.

In the reuse sector in particular (Figure 18), Suffolk's LQ is well below the state average, Middlesex is notably below, and Worcester is slightly below. As with Figures 17 and 20, the three southeasternmost counties (Barnstable, Dukes, and Nantucket) all have LQs for reuse well above the state average. Norfolk has a roughly average proportion of reuse employment and the counties shown in light orange all have somewhat above average reuse employment.

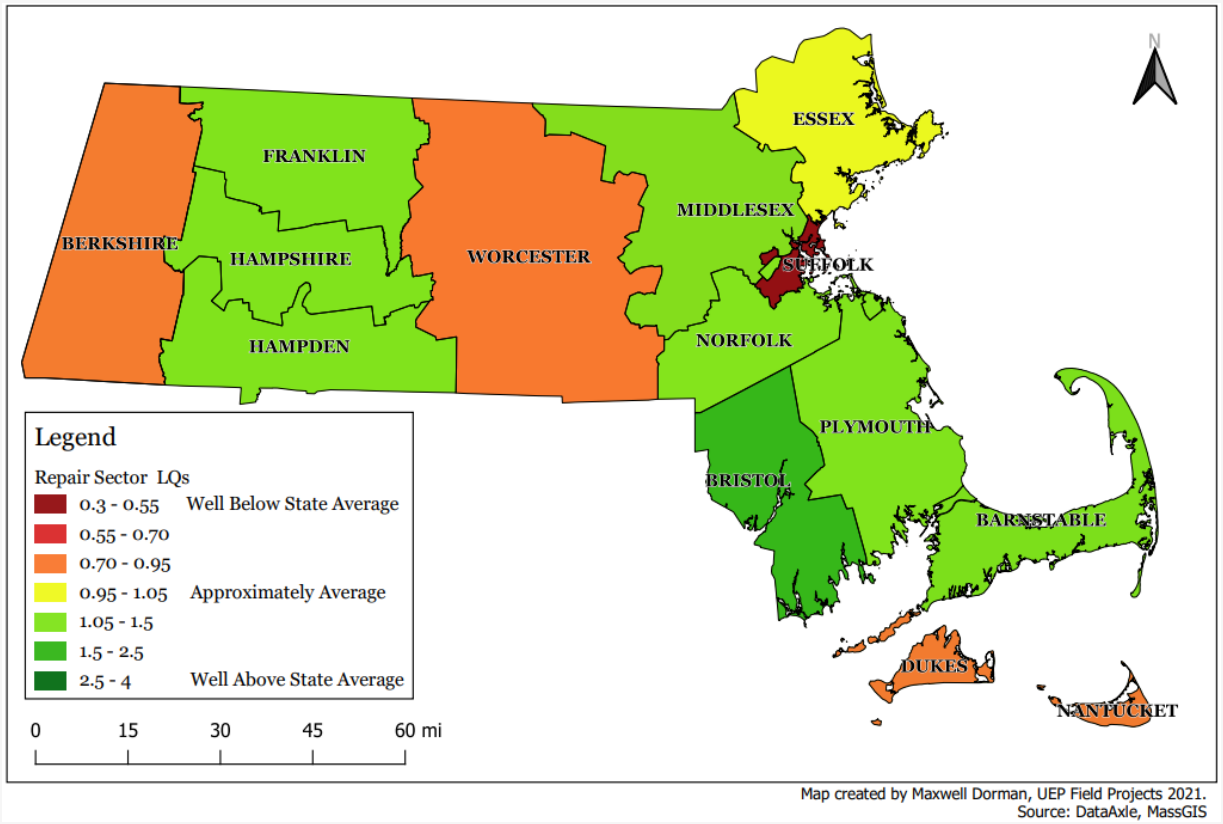

Figure 19: Location quotients for the repair sector of the MA reuse economy. Figure created by Max Dorman.

For the repair sector (Figure 19), as with the reuse sector (see Figure 18), Worcester, Berkshire, Dukes, and Nantucket all have repair LQs slightly lower than 1 (note the discrete departure from the trend of higher LQs for Dukes and Nantucket). Barnstable's proportion of repair employment is slightly above average, as are the LQs for the other counties shown in light orange. Suffolk and Bristol are the only counties with LQs that deviate highly from 1, with Suffolk having an LQ of well below 1 and Bristol having one notably below 1. Specific LQ values for each county can be found in Appendix B.

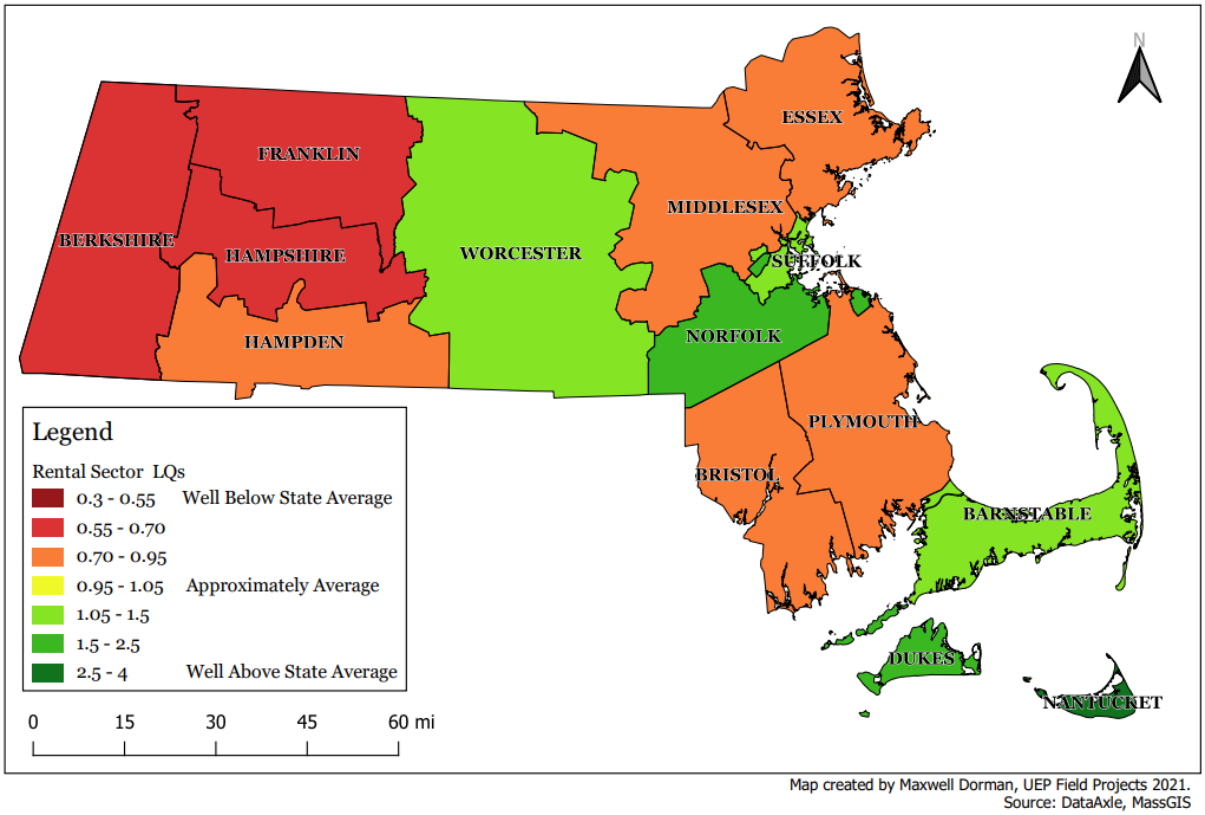

Figure 20: Location quotients for the Rental Sector of MA's reuse economy. Figure created by Max Dorman.

The proportion of jobs provided by the rental sector in each county varies significantly (Figure 20). In fact, none of the counties has a proportion of reuse employment similar to that of the state as a whole. Three of the westernmost counties LQs notably below 1, while Norfolk, Dukes, and Nantucket all have LQs notably above 1, with Nantucket in particular exceeding the state average proportion of rental employment by a large amount. Worcester, Suffolk, and Barnstable all have slightly above average proportions of rental employment while Hampden, Middlesex, Essex, Bristol, and Plymouth all have slightly below average proportions of rental employment. As with the reuse sector, we see the three southeasternmost states exhibiting higher than average proportions of rental employment. Specific LQ values for each county can be found in Appendix B.

Employment and Revenue

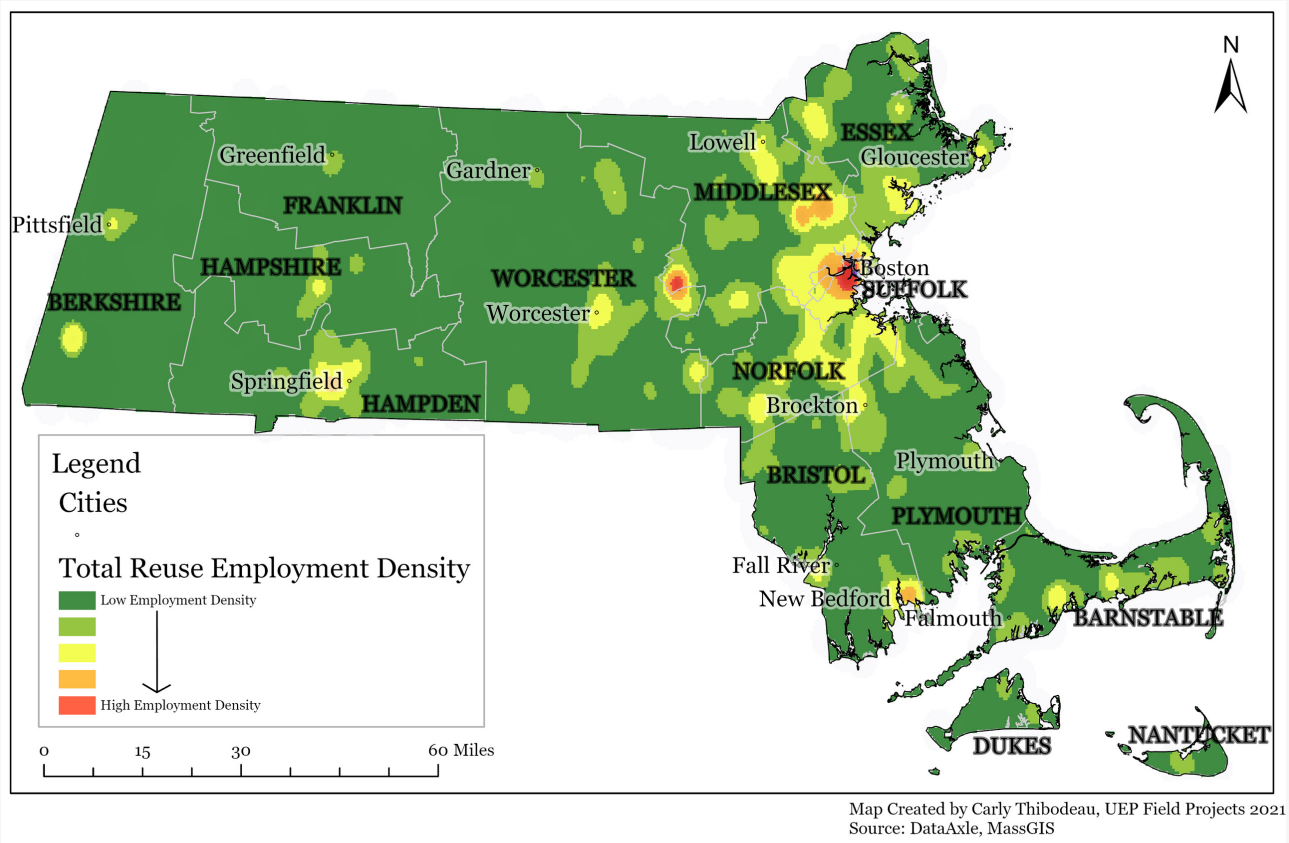

Figure 21: Heat map of total reuse employment in MA.

Figure 21 displays a heat map of reuse employment in MA. The employment heat map has less smoothed (more detailed) results than the heat map of reuse business density, meaning the hotspots are more concentrated in smaller areas. The most dense areas of reuse employment are in Boston and the Greater Boston area (Suffolk, Norfolk, Middlesex, and Essex Counties), but there is also a prominent hotspot on the border of the Worcester and Middlesex County in the area of the Town of Marlborough, and in New Bedford (Bristol County). Other relative hotspots include Great Barrington and Pittsfield (Berkshire County), Springfield (Hampden), Northampton (Hampshire), Lowell (Middlesex), Gloucester (Essex), Fall River (Bristol), and Hyannis (Barnstable).

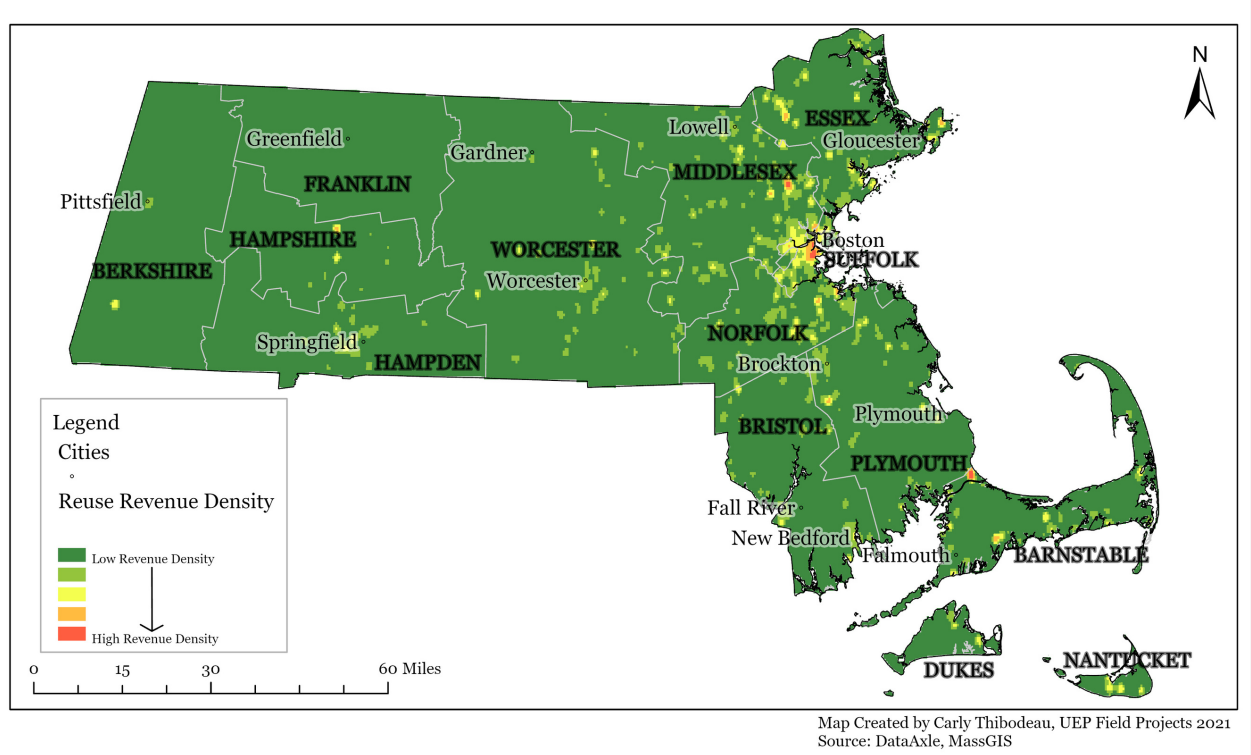

Figure 22: Heat map of total reuse revenue in MA.

Figure 22 shows the distribution of reuse revenue in MA as a heat map. This map has the least smoothed results compared to the heat maps of business density and employment, consisting of a multitude of very small hotspots across the state. The most dense areas of reuse revenue are in Boston and the Greater Boston area (Suffolk, Norfolk, Middlesex, and Essex Counties), and around Springfield (Hampden) and Worcester (Worcester). Notable high heat spots include Boston, Great Barrington in Berkshire County, Hatfield in Hampshire, Woburn in Middlesex, Andover (west) and Rockport (east) in Essex, Sagamore on the Plymouth/Barnstable County border, and Mashpee in Barnstable County.

Population Density

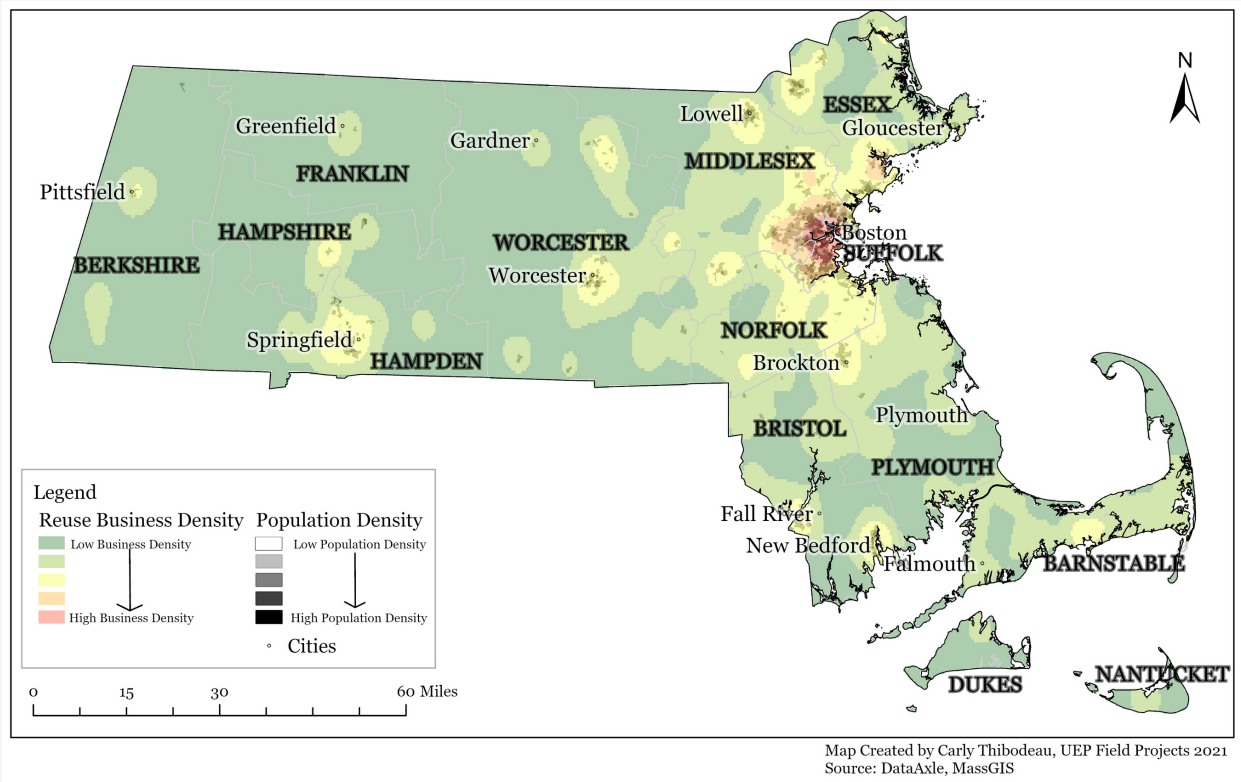

Figure 23: Population density compared to total reuse business density in MA.

Figure 23 displays a visual comparison of population density (grayscale patches) and reuse business density (shown in Figure 16). The areas of highest population density (Boston/Greater Boston area, Pittsfield, Springfield, Worcester, Lowell, Brockton in Plymouth County, Fall River, and New Bedford) also see higher densities of reuse activity. However, there are some relatively higher business densities in areas with lower population densities, such as around Great Barrington in Berkshire County, and areas on Cape Cod and the Islands (Barnstable, Dukes, and Nantucket Counties).

Environmental Justice Populations

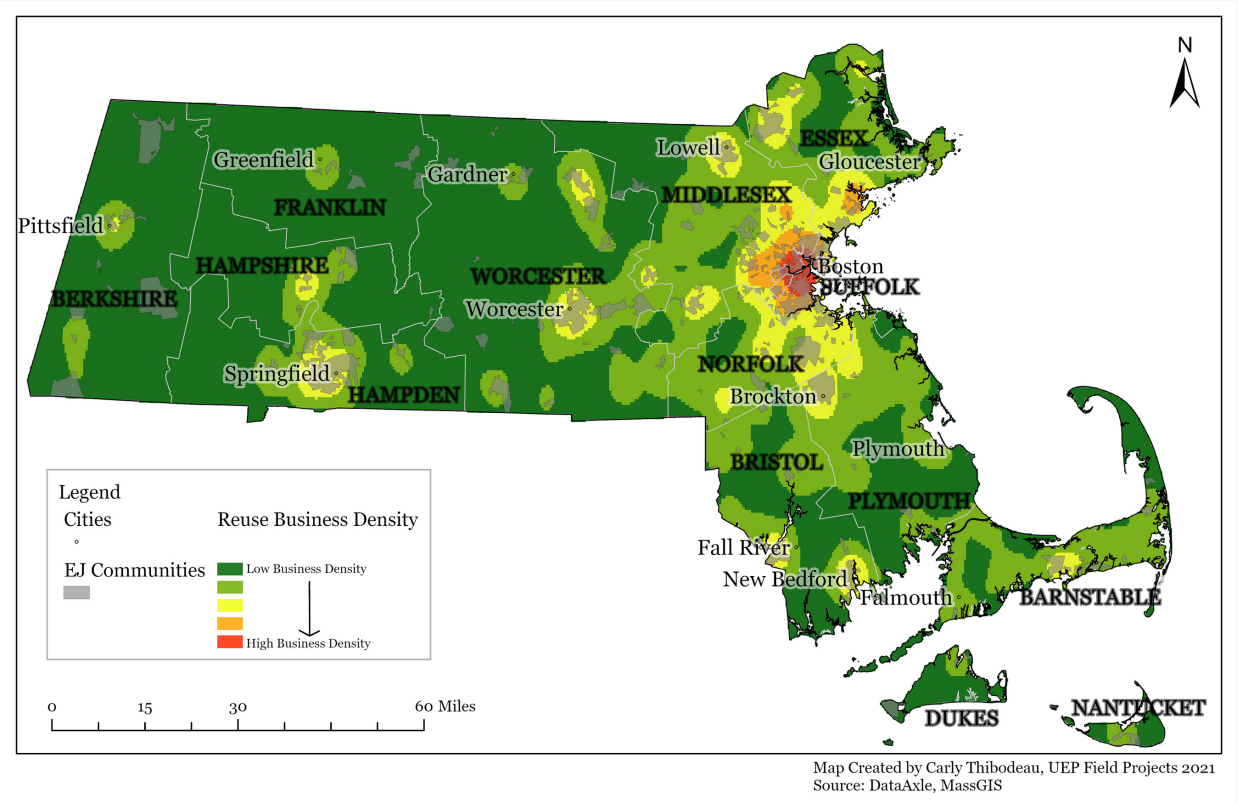

Figure 24: Locations of EJ Communities (as defined by MassDEP) compared to total reuse business density in MA.

Figure 24 shows the locations of EJ communities, using GIS data from MassDEP, and the reuse business density heat map from Figure 16. Again, EJ communities are those defined by MassDEP as having high percentages of low income, minority, or English-isolated populations. EJ communities are represented by gray patches. A majority of EJ communities are located within reuse activity hotspots which are also areas of high population density, such as Pittsfield, Springfield, Northampton, Worcester, Lowell, the Greater Boston area, Brockton, Fall River, and New Bedford. However, there are also quite a few EJ communities in the least or second least reuse dense areas in mostly the Berkshire, Franklin, and Worcester Counties.

QUALITATIVE ANALYSIS RESULTS

Photo source: Joann Lai

ACADEMIC AND PROFESSIONAL REUSE EXPERTS

University of Maine

We had a brief email correspondence with a few researchers that conducted the reuse economy study in Maine. They were unable to commit to a formal interview and reiterated that their study was still underway. We reached out to them at the beginning stages of our research process in hopes they could answer a few questions about developing our methodology. They confirmed that they had not yet created a methodology to successfully quantify the informal reuse economy (PTP exchanges, eBay, Craigslist, and Facebook Marketplace). This confirmed our decision that including the informal reuse economy in our analysis would not be possible given our time and resource constraints.

ReUSE Minnesota

We interviewed Jennifer Kedword, an Environmental Specialist who was a part of the ReUSE Minnesota study. We hoped that by talking with her we would gain a deeper understanding of how the research team developed their methodology and that we would uncover the rationale behind them utilizing the D&B Business Directory to collect their economic data. One main takeaway from this meeting was that ReUSE MN contracted Brio Marketing to conduct the environmental, economic, and social analysis because it proved to be rather complicated and time consuming. They chose to utilize the D&B dataset as opposed to simply using Census data because the D&B dataset contained more information that they found valuable. By analyzing the D&B dataset the researchers were able to aggregate employment numbers, tax revenue, and gross sales of the reuse economy. However, similar to our team, they were also unable to collect wage data.

Another important takeaway from this interview was the research team's methods for conducting a spatial analysis of the reuse sector. They created heat maps of Minnesota to show where the reuse economy was most prevalent. We developed some of our methodology for our spatial analysis based on the recommendations of the ReUSE Minnesota researchers. Finally, we discussed possible methods for conducting an analysis of the informal reuse economy. The ReUSE Minnesota team also decided to exclude this in their analysis. They mentioned that there would need to be an accurate way to track postings and sales on websites such as eBay or Craigslist.

Oregon DEQ

Our Project Partners at MassDEP had originally offered to put our team in contact with a member of the Oregon DEQ Material Management Program. Our original plan was to connect with Oregon DEQ and/or their contacts at the City of Portland Bureau of Planning and Sustainability and at the City of Eugene once we started to develop our recommendations section of the report. However, since MassDEP has already created its Strategic Reduce and Reuse Plan, we did not feel it was necessary to develop a separate

set of recommendations that may be repetitive with that work. Rather than developing strategic planning efforts, we included a Recommendations for Further Study section to suggest further avenues of study that would support the planning efforts that MassDEP already has in place. While we did not speak to the Oregon DEQ team, the review of their strategic plan sparked our thinking as to how we could develop our own future avenues for study.

REUSE BUSINESS OWNERS

We were able to meet our original goal of gathering information from at least one business owner per county and from a mixture of business types (reuse, rental, and repair). We contacted a total of 591 reuse, rental, or repair business owners in Massachusetts. We received 24 responses in which some or all of our interview questions were answered. Most business owners chose to answer via email (most likely for convenience), 3 business owners preferred to speak to a member of the research team and answer the questions over the phone.

Table 10: Number of emails sent to reuse businesses in Massachusetts and number of responses received[25]

County	Number of Emails Sent	Responses
Barnstable	66	1
Berkshire	33	2
Bristol	39	2
Dukes	24	1
Essex	41	2
Franklin	40	3
Hampden	42	1
Hampshire	44	1
Middlesex	48	3
Nantucket	21	1
Norfolk	51	2
Plymouth	52	2
Suffolk	48	1
Worcester	42	2
Total	**591**	**24**

Table created by Joann Lai

[25]This count does not include responses that were declining participation or responses from business owners that felt that their business did not fit the study.

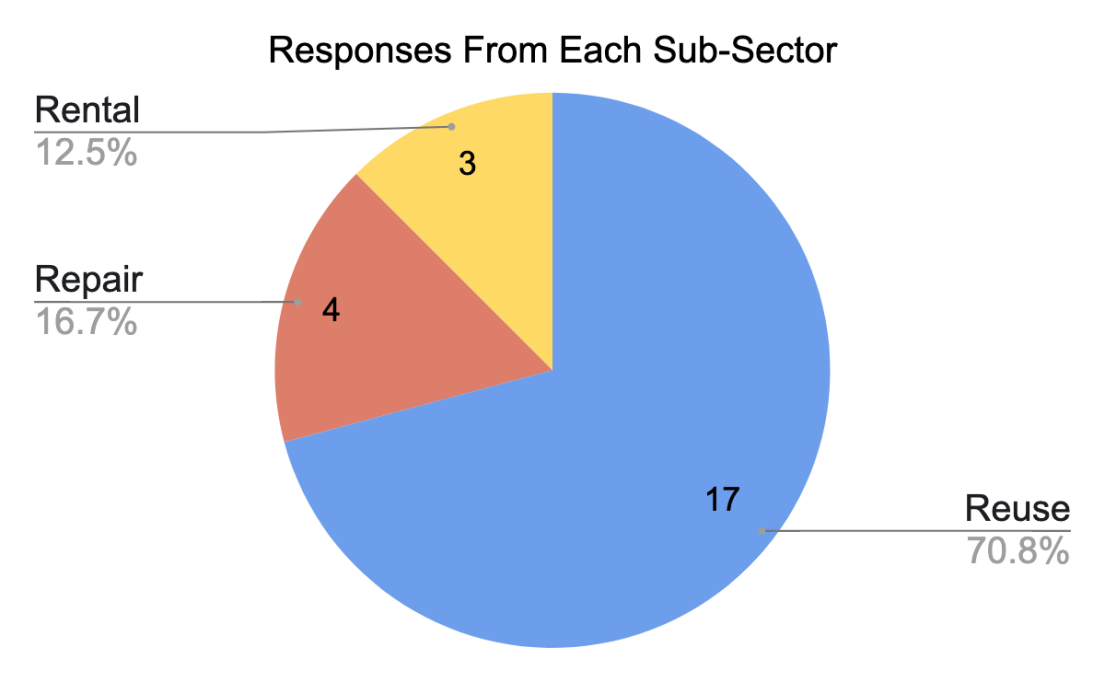

Figure 24: Percentage of respondents from each sub-sector of the reuse economy (reuse, rental, or repair). Chart created by Brianna Eassa.

Interview Results

We interviewed reuse business owners across the state of Massachusetts about the biggest challenges that they face as a part of the industry, as well as possible ways that the state could support reuse businesses. The types of businesses we contacted varied. Some examples include used book stores, antique stores, flea markets, bike and vacation home rentals, and computer repair businesses. From these interviews, we were able to identify the major themes that were common across business owner's responses.

Firstly, MassDEP was interested in gaining insight into what demographics reuse businesses tend to serve. We asked business owners if they had any observations about the population that their business serves and the responses varied greatly. At this time it does not seem appropriate to report on this data since it is subjective and required business owners to make assumptions. If MassDEP is still interested in this question, then further research should be done with clear methodology as to how demographics ought to be categorized and analyzed.

We also asked respondents to discuss some of the biggest challenges that they face as part of the reuse industry. Many noted that the COVID-19 pandemic has had a significantly negative impact on their business. The data that was used for the economic and spatial analyses does not account for the effects of the pandemic on reuse businesses. Since the interviews were conducted during April 2021, it was a topic that

was frequently brought up. Another major challenge that reuse business owners are facing are taxes and fees. Since many of the respondents are small business owners, the taxes and fees that they are required to pay have a major impact on their business's success. For example, one business owner discussed that they have to pay $500 per year to file an annual LLC report, $150 for their HIC (Home Improvement Contractor) license, as well as taxes on top of those fees. Another challenge for reuse business owners in the state is that people are tending to buy new, cheaper, and more disposable items instead of refurbishing or buying used items. Many business owners discussed their frustration with this trend and suggested that one way the state could help is to increase promotional and advertising campaigns for people to buy used items or have their old items refurbished or repaired. Additionally, several business owners recommended that the state eliminate the sales tax on used goods. Respondents thought this could be an impactful way to encourage people to buy used items. Since the COVID-19 pandemic was on many business owners' minds, several recommendations as to how the state government could help reuse businesses had to do with financial aid. Many respondents recommended that the state find a way to approve more direct financial aid for small, reuse businesses and cut down on taxes and fees so that businesses can make improvements and better promote themselves. One business owner mentioned that the state could provide better tools and assistance (such as workshops) that would help businesses open their own store front as opposed to renting a booth at a flea market.

> "The biggest challenge we face at the moment is just keeping the doors open."
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

> "We need stimulus money that we actually qualify for. It would be helpful to see acknowledgment of that from local, state, and federal governments in the form of financial assistance, grants to help improve our exterior and update our space. Any local support is going to the bar/restaurant industry."
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

Finally, we asked reuse business owners what they considered to be the most important benefit that their business provides. Several respondents said that they were most proud that their business provides a strong sense of community and a place for people to gather (when there is not a global pandemic). Many of the antique dealers that were interviewed felt their most important contribution was that they were preserving history. Other reuse business owners felt that their most important contribution was that they prevent more waste from going into landfills.

Overall, most reuse business owners were happy and enthusiastic about participating in the study. We did receive some responses from business owners who were not interested in participating. The reasons for that were not made clear and we did not ask for more information. Some respondents were appreciative of the work that was being done and that the state had an interest in helping the reuse economy. However, there were others that seemed rather pessimistic about the notion of the state offering help, which may be coming from a place of feeling that the interview was just an exercise that would not lead to real results.

DISCUSSION AND CONCLUSIONS

Photo source: Carly Thibodeau

The reuse economy represents almost 2 percent of Massachusetts' businesses and employs about 1 percent of its workforce. That the percentage of the workforce is half the percentage of businesses indicates that, as is the case with other states, most reuse businesses are small and consist of only a few employees. About half of the reuse businesses we identified characterized themselves as "small businesses" in the DataAxle database, and on average MA reuse businesses have less than six employees. Although 1 percent of employment and 2 percent of businesses are small percentages, they represent quite large values; 6,438 businesses and 32,828 employees, respectively. This juxtaposition suggests two insights. Firstly, there is an opportunity to grow the reuse economy's share of the overall MA state economy. Other states' reuse economies represented a larger percentage of statewide employees than MA's reuse economy (namely Minnesota and Maine), so expanding reuse's share of the economy is certainly possible. Secondly, the MA reuse economy as it currently exists represents a relatively large number of employees and businesses, and as such it merits further study. **The MA reuse economy also represents significant economic activity; statewide, it is a 7.3 billion dollar industry with $1,067 of spending per capita.**

The reuse economy is not monolithic. There is significant variation among its three sub-sectors in terms of their share of the reuse economy and in terms of the revenues incurred in each sector. Repair sector services represent almost half of all businesses in the reuse economy, with reuse sector and rental sector businesses each representing about a quarter of businesses. Importantly, though, the proportion of businesses in each sector is different than the proportion of business *revenue* in each sector: reuse businesses and rental businesses represent 35 and 39 percent of total business revenue, respectively, with repair businesses representing only 26 percent of total reuse economy revenue. Thus, while repair businesses are much more numerous than either reuse or rental businesses, they represent a much lower share of the reuse economy's business revenue. This is not to say that repair business owners make less money from their businesses than reuse or rental businesses; the revenue data we used in this study does not tell us anything about the costs associated with running these businesses. Presumably, though, the costs of running repair businesses (aside from businesses that require special facilities, such as boat repairs) are typically higher in terms of the time investment needed to gain trade skills (and the cost of paying employees with these specialized skills) and lower in terms of the physical capital needed to carry out repairs. Reuse and rental businesses,

> "In terms of state support, honestly just direct grants or forgivable loans make the most sense for us."
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

meanwhile, have to acquire the goods they provide and establish mechanisms for ensuring their safe return (in the case of rental) and, if the business model is donation-based like Goodwill, ensure a steady supply of donations. Goodwill-model businesses in particular often rely heavily on volunteer employees, which would also lower labor costs compared to the repair sector, which relies on skilled labor.

In addition to the differences between the three sectors of the reuse economy, there also exists significant variation within each of the three sub-sectors. A thorough assessment of the proportions of different business types in each sector was beyond the scope of this study (such an analysis is made difficult owing to the NAICS and SIC codes not differentiating very much between the types of reuse businesses), but over the course of our research and review of the data it became clear that each of the sectors is comprised of many different types of firms. The repair sector includes businesses that range from plumbing, home repair, and boat repair to small or even employee-owned watch, clothing and jewelry repair businesses. Rental businesses are various and provide everything from jet ski rental services to vacation home rentals, to sound system rentals and even bouncy-house rentals. The reuse sector, excluding the automotive sector, is slightly more homogenous in that most of the stores are generalists that provide a range of used goods. Still, some operate on a donation-based model while others purchase used goods, some do most of their business online while others operate exclusively through a physical establishment and others specialize in a specific type of used goods (e.g. furniture, name brand clothing, and jewelry). Furthermore, from our interviews we noticed that the clientele served by different business types was extremely varied.

Perhaps owing to this variation, many of the business owners we reached out to did not associate the business they conducted with the reuse economy. In response to emailed interview requests many business owners would decline the interview, explaining how their business did not operate as part of the reuse economy. For example, some repair businesses and several used book stores did not feel that they fit into this study. It may be the case that business owners identify more with the type of products they sell and the clients they serve than with its location in the supply chain of goods. The reuse economy is clearly not a single, cohesive set of businesses like the housing market or food industry, for example. The products and services reuse businesses provide are various and connected only in that they all directly or indirectly extend the lifetimes of goods that would otherwise end up as waste. This is a rather abstract, academic idea, and is not overly surprising that many reuse business owners do not identify strongly with the reuse economy (although some were proud of preventing waste from entering the landfill). We offer no opinion here on whether a stronger sense of belonging and identity would be beneficial for the proliferation of the reuse economy in MA, and instead offer several observations:

- Firstly, the case study on Maine’s reuse economy noted how reuse was a firm part of

Maine's identity. The sense of belonging to a community that valued reuse encompassed, not only reuse business owners, but the customers of those stores and the citizens of the state on the whole.

- Secondly, given that this sense of identity does not seem present in the MA reuse economy, it may be beneficial to conduct outreach more directly to rental or repair businesses as their own entities, rather than as a part of the reuse economy. Honoring the business owners' conception of what their business does and its place in the economy as a whole may be a necessary prerequisite for introducing the idea of the reuse economy down the line.
- Finally, MassDEP may choose to develop campaigns to increase public awareness of the importance of reuse and the existence of the reuse economy. A public awareness campaign of this sort may grant the reuse economy a place of residence in the public consciousness.

Our team's study assessed two demographic variables within the reuse economy, the first of which is female-ownership of businesses as identified in the DataAxle database. In Massachusetts, approximately 33% of businesses are owned by women (NAWBO 2019). This is already lower than the national average of 39% (id.), but we determined that in MA's reuse economy only about 2% of businesses are female-owned. This figure for the percentage of female-owned reuse businesses may be underreported; according to their 2020 data only about 8% of MA businesses for the whole economy are owned by women. This is four times lower than the known 33% figure, so it seems likely that the 2% female-owned reuse businesses value derived from the DataAxle database underreports female reuse business ownership in MA. Assuming DataAxle missed the same proportion of female-owned reuse businesses as they missed for the state on a whole, that would still mean only 8% of reuse businesses are owned by women. The reason for this enormous gender disparity is unclear, and has not been assessed in the case studies on the reuse economies of other states to date. MassDEP may want to consider reaching out to women who own reuse businesses to learn more about why the gender gap is so large in the reuse economy.

The second demographic variable we assessed was whether the businesses in the DataAxle database self-identified as "small businesses." DataAxle's method of identifying small businesses relies on the subjective perspectives of each business owner, and as such is not standardized. As previously stated, roughly half of businesses qualify as "small" according to this measure. To determine the number of small businesses from a more objective standpoint, we referred to the U.S. Small Business Administration which defines a small business as a a business with fewer than 1,500 employees and a maximum of $38.5 million in average annual receipts (McIntyre, n.d.). Selecting businesses by this definition, 6,087 of 6,424 reuse businesses definitively qualified as "small." Almost all of the remaining 337 businesses did not have sufficient sales volume and/or employee information to determine whether they qualified as

small businesses. Only one MA reuse economy business, Lease & Rental Management Corp, had had more than 1,500 employees *and* more than $38.5 million in annual receipts (they took in roughly $68 million according to the DataAxle data). One business, MT Uni Repair, did employ more than 1,500 people and its total sales volume was quite close to the cutoff at $38.3 million. Looking at reuse businesses that are still technically "small" but are larger than the average 6 employee business, about 100 reuse economy businesses accrued more than $10 million in sales volume according to the DataAxle database. Of the remaining 6,324 reuse businesses that have less than $10 million in sales volume, the average number of employees is slightly over 4 and the average sales volume for these businesses is $896,000. Slimming the list to businesses with less than $1 million in sales volume gives us 4,589 reuse businesses that average between 2 and 3 employees and take in $350,000 in sales volume. Cumulatively, the 6,324 reuse businesses making less than $10 million annually make $5.4 billion in sales volume and the 4,589 reuse businesses that make less than $1 million annually account for $1.6 billion of the reuse economy's sales volume.

> "The state could provide workshops or seminars for people who want to open a small business in their own retail location. Many people do not have the tools to do so, but want to."
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

Table 11: Reuse economy businesses split into three ranges of sales volumes, the number of businesses in each range, and the sum of the sales volumes for all of the businesses that belong to each range.

Sales Volume Ranges for Reuse Economy Businesses		
Sales Volume Per Business (USD)	**Number of Businesses**	**Total Sales Volume (USD)**
< 1 $Million	4,589	$1.6 billion
$1 Million - $10 Million	1,735	$3.8 billion
> $10 million	100	$2 billion

Table created by Max Dorman.

Although the U.S. Small Business Administration's definition classifies almost the entire MA reuse economy as small businesses, the top 100 businesses make almost $2 billion in sales, the 1,735 businesses that make between $1 and $10 million account for $3.8 billion in sales, and the 4,589 businesses that make less than $1 million in sales (71% of the reuse economy's businesses) account for only $1.6 billion in sales volume. Stated another way, 19% of reuse businesses make 78% of sales revenue and the remaining 71% make 22% of sales revenue. The MA reuse economy may be made up of entirely "small businesses," but a small portion of those businesses carry out the majority of its economic activity. It may be beneficial to distinguish the minority of "larger" small businesses from

the multitude of small, 2-3 employee businesses when identifying strategies for growing and supporting reuse activity. Another area for future study is identifying the sectoral makeup of the top 19% of reuse economy businesses (i.e. all of those with over $1 million in sales volume).

In interviews, owners of the smaller range of reuse businesses (who were the only type of business owners who responded to interview requests) expressed difficulties associated with opening and running reuse businesses and offered ideas on how MassDEP might support them and grow the reuse economy. The main issue was money. Businesses in general and reuse businesses in particular are expensive to open and there is a lot of overhead associated with running them. Some owners recommended providing grants or forgivable loans to reuse business owners. **Some business owners encouraged MA to exempt pre-owned and reused goods from sales tax to increase the incentive for customers to buy them.** One repair business owner emphasized that, because their business runs on small margins, government fees can "make or break a business." Exempting reuse businesses from these fees would give the businesses financial security and potentially allow them to grow. One owner of a reuse business emphasized that knowledge is a key component to opening a reuse business, and suggested that the state provide seminars or workshops for people who want to run their own small operation. Many reuse owners operate solely out of flea markets, and in one interview a flea market owner explained how her vendors do not have the funds or necessary knowledge to open their own store front. Providing these funds (either directly through grants or implicitly through tax breaks) and setting up workshops or seminars would provide reuse business owners with the financial and intellectual capital necessary to open a successful, independent reuse business.

> "Massachusetts only needs to do one thing: do not charge sales tax on pre-owned goods. This would provide an incentive for people to look to the resale economy."
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

Although our economic data was collected before the COVID-19 pandemic, our interviews were exclusively conducted in the second quarter of 2021 and showed that the pandemic has deepened and added to the financial stress reuse businesses often experience. Business owners emphasized that keeping their doors open is growing increasingly difficult, and pleaded for the state (as well as local and federal government) to provide stimulus money in which they actually qualify. One business owner noted that they could use grant or stimulus money to upgrade their facilities, which would increase the attractiveness of their business and (hopefully) provide a more steady stream of customers. They lamented that all help is currently directed towards the bar and restaurant industry, which leaves them wanting for financial assistance. While federal

COVID relief funds do in fact exist outside the restaurant industry, they are only helpful to reuse businesses if their owners are aware that they exist. The state of Massachusetts could promote awareness of these loans and grants in the reuse economy to support it through this difficult time.

In addition to statewide trends and variations, the MA reuse economy exhibits noticeable spatial variation. One major finding is that the reuse and repair sectors of the reuse economy may not grow proportionally with the rest of the economy in densely populated areas[26]. The number of reuse businesses is much higher in metropolitan areas like Boston and Worcester, but the location quotients for the counties these cities reside in (Suffolk and Worcester, respectively) are lower than the state average. So, while the number of businesses per unit area is higher, the proportion of jobs these businesses provide compared to the state as a whole is lower in these counties (for both the reuse economy as a whole and the reuse and repair sectors). This is an especially pertinent and accurate observation for Suffolk, which comprises Boston and the greater Boston area. It is of course possible that this trend is only true of Boston or MA as a whole and deserves more study. But it may make sense that this relationship exists for cities in general; larger businesses, corporate headquarters, and tech companies are located more often than not in cities rather than towns and rural areas. It makes sense, then, that the reuse economy makes up a smaller proportion of city employment; there are simply more (and plentiful) forms of employment in cities that do not exist to the same degree in more rural areas. Interestingly, the rental sector does not follow this trend; rental LQs are higher in Suffolk and Worcester, suggesting that the rental sector may do better in densely populated areas than in more rural ones. To a certain degree, this is intuitive; one generally has less space for their belongings in cities (real estate is more expensive and more people live in apartments in cities), and so people may rent more on an as-needed basis. Tourism is also a larger part of cities' economies, and tourists tend to rent more items than permanent residents (after all, you can't bring everything with you!)

To date, only the Maine study has used location quotients as a means for studying reuse activity, and they did so in order to compare the proportion of the number of businesses at a state level (LQs are typically used at the national scale). Notably, the variation in LQs across counties in MA is much more extreme than the variation across states in the US as a whole. Exploring the reasons for this higher in-state variation in proportion of reuse employment, and determining whether that variation occurs within other states as well, is an area for future study. It may be the case that tailoring policy interventions to specific counties (or rural/urban areas, richer and poorer areas, etc.) is an effective way to target and catalyze growth in the reuse economy.

[26] Another spatial relationship, which we did not have time to thoroughly explore in this study, is the possible association between waste we did not have time to thoroughly explore in this study, is the possible association between waste disposal sites and reuse activity. We noticed that two reuse sales revenue hotspots in the greater Boston area (Sagaus and Haverhill) were also the sites of major waste incinerators. It is worth exploring whether large quantities of disposed-of goods are collected and resold at these sites.

Our spatial analysis also shows a large overlap between EJ areas (as defined by MassDEP) and reuse business density. While this is an interesting correlation, confounding variables are almost certainly at play; most EJ communities reside in densely populated areas, and more densely populated areas intuitively have a higher density of reuse businesses. It may be the case that EJ communities and areas of high reuse activity simply coincide in areas of high population density, as opposed to there being a causal relationship between the two several large EJ areas in Berkshire County and others in Franklin and Worcester Counties reside in areas where reuse business density is low. Here, we do not mean to imply that a higher prevalence of reuse businesses is desirable in EJ areas. It would make sense that widespread availability of reuse and repair services in EJ areas would alleviate some of the justice issues associated with these locations by providing and maintaining peoples' assets for a lower cost than purchasing firsthand, but we did not research this connection directly and will leave the question of whether reuse activity should be targeted to EJ areas for future study. This question deserves an entire analysis in and of itself.

Even when one takes population and economic variables into account, reuse activity varies to an extreme degree across the counties of MA. For instance, per capita sales revenue for the reuse economy was over $10,000 in Nantucket and only $408 in Franklin—that's over a 2000% difference! Indeed, per capita sales revenue was at least three times the state average of $1,067 per capita in each of the districts of Barnstable, Dukes, and Nantucket. For Nantucket, 70% of the $10,000 per capita revenue comes from the rental sector, with the reuse sector making up the bulk of the remaining 30%. Dukes has a similarly extreme proportion of reuse economy revenue coming from the rental sector, with Barnstable exhibiting the same relationship to a slightly lesser degree. This higher amount of reuse activity is also represented in the proportion of reuse employment for these counties relative to the state as a whole; all three counties have above to well above average LQs for the reuse and rental sectors. That the reuse economy is much larger than average in these areas, and that the rental and reuse sectors in particular are extremely prosperous, is likely tied to the makeup of these counties' economies. All three counties attract flocks of tourists every year as they travel to Cape Cod, Martha's Vineyard, Nantucket and other luxurious summer vacation destinations. Reuse business revenue in this southeastern region of the state clusters around cities, which are major tourist destinations—people rent houses, boats, party supplies, and more on their stays and visit the local thrift stores to acquire unique vintage goods. Because the Barnstable, Dukes, and Nantucket economies are tourism-based and the other MA counties rely more heavily on other industries, it may not be realistic to mimic the storefronts and business models of the Cape in other areas of the state. The clientele is fundamentally different in these counties than the rest of the state, not only because the economies are tourism-based, but also because the residential population in this area is more affluent and so can afford a different set of goods and services. The Berkshires, located in Western MA, are

also popular tourism locations and could explain the hotspots in this area as well (Figure 16).

We close with some notes on each of the three sectors of the reuse economy and then for the economy as a whole. Firstly, reuse sector businesses are associated with run down, tired, often-smelly stores in the minds of the general public. Owners themselves noted how their businesses look run down and could use a face lift. Supporting these businesses with both direct financial support and workshops, seminars, or guides on opening and running successful reuse businesses may help change the face of the reuse sector, both in MA and more generally. In 2013-2014, thrift shopping became (and has since remained) a cool, even stylish activity for Millennials and Gen Z. Many reuse business owners we interviewed noted the demographic shift towards a younger customer base. Determining what appeals most to this young crowd would go a long way towards branding reuse as a mainstream activity and growing the reuse sector in the future.

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> "The younger crowd also seems more engaged in the shop local movement now than they were a few years ago."
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

> "We have found that our demographics are changing. With the popularity of social media bloggers we are finding younger people, 20+, coming in to buy vintage and unique items."
>
> REUSE BUSINESS OWNER IN MASSACHUSETTS

For the repair sector, we emphasize the diversity of services offered. Each type of repair, from fence repair to watch repair, requires learning an entire trade. Repair business owners we interviewed often did not see themselves as "reuse" businesses, and so approaching this sector as a unique and separate portion of the reuse economy may be imperative for learning more about and developing it further. In the future, the development of repair sector jobs could be strengthened by a connection

entire trade. Repair business owners we interviewed often did not see themselves as “reuse” businesses, and so approaching this sector as a unique and separate portion of the reuse economy may be imperative for learning more about and developing it further. In the future, the development of repair sector jobs could be strengthened by a connection with regional vocational-technical and specialized trade schools. Concerning the rental sector, we note that this sector is the least isolated of the three sectors of the reuse economy, meaning that it overlaps with other markets such as real estate, the wedding industry, and many more areas. Because rental customers only see the product for a defined window of time, they don’t generally consider the fact that the product they are using will go on to be used by many other customers. However, it is for exactly this reason that the rental economy has so much potential to reduce waste; instead of a hundred people each buying a microphone for their wedding ceremony, they can all use the same one in turn. We also note the synergies between supporting the rental economy and supporting the repair economy; that same microphone could be made to serve thousands more customers if it is repaired properly and affordably. Lastly, we emphasize that developing the reuse economy goes hand-in-hand with eliminating waste culture. Addressing both sides of the issue in tandem, and perhaps even collectively, will make both efforts that much more effective.

RECOMMENDATIONS FOR FUTURE STUDIES

Photo source: Canva

Throughout this project, the team looked into many avenues of research to achieve our project goals and objectives. However, due to time constraints and other limitations, the team was unable to explore all research possibilities. In this section we discuss both some of the limitations of what we were able to accomplish, as well as areas that future research teams could investigate to gain a deeper understanding of the reuse economy in Massachusetts. These recommendations come from benchmarking, or reviewing, the reuse economy studies from other states, as well as our own research experience.

This study's economic analysis was limited by our lack of access to wage and tax data, as well as time constraints. Given our results, we believe there is sufficient motivation and rationale for an extended investigation into these variables to take place. Because this data was not available for MA on a business-by-business basis (as it was for Minnesota), future investigators may want to work directly with Bureau of Labor Statistics or a MA state agency to obtain business-level data on these two important variables.

Another important subtopic of reuse economy research is the environmental impact of reuse in MA. A brief analysis of this was conducted in the MPCA study, followed by a deeper investigation including metrics on GHG emissions and water withdrawals avoided as a result of reuse by ReUSE MN. This type of information in the context of MA would be helpful for better understanding reuse and its planning efforts. While assessing the economic impact of reuse activities has huge importance to be able to quantify and educate the public on the benefits of reuse in a common language, not all benefits are captured by the economic data. Judging by the significant environmental impact results of the ReUSE MN study, environmental impact should be an important part of the conversation as well.

The same can be said for social benefits, as both the Maine and ReUSE MN studies indicated that reuse also has a variety of social benefits. While our study did explore social impacts through interviewing reuse business owners, we focused primarily on obstacles and challenges faced by reuse business owners and had limited responses concerning the perceived social benefits. A large part of this is likely because of the small sample size. Time was a constricting factor in this regard, both because of the tight timeline the research team had to recruit participants and gather data, as well as the time spent by business owners to participate in the study. Reuse owners may not have wanted to devote time to an interview, which could account for the large amount of non-response. One recommendation to get more responses from reuse businesses is to create and send out an online survey rather than conducting interviews, in order to make the process as simple and time-efficient as possible for reuse business owners. Additionally, the interviewers may want to present more concrete ideas (such as some of the initiatives outlined in the Strategic Reuse and Reduce Action Plan) during interviews/survey so that business owners feel that their time will contribute to progress being made, rather than

feeling it is just an exercise that will not lead to real results. Although there is a Reduce and Reuse Working Group with stakeholders across the state, it may be more beneficial to put additional effort into speaking with small, reuse business owners firsthand to receive more information about how the state can help the reuse economy, and what the owners perceive are social benefits of reuse. This is especially true among those that don't categorize themselves as reuse businesses, and therefore are unlikely to self-select into the R&R working group.

Regardless, further research on social benefits as well as an environmental impact analysis of reuse should be conducted to have a holistic assessment of all the benefits of reuse in Massachusetts. This research would mean that all three components of sustainability- economy, environment, and equity- in terms of reuse have been studied in MA.

Finally, research needs to be conducted on the PTP or informal reuse economy, which no reuse impact study has yet been able to realistically tackle. The MPCA study made a brief attempt by counting the number of postings within a 24 hour period on online exchange sites like Craigslist and eBay. However, the study acknowledged that its investigation was "unscientific," due to it being likely that many posted listings go unsold, and also that it was not possible to obtain total sales for an area from these pages. As mentioned by the MPCA, this would be critical information to estimate economic activity concerning PTP transactions. Additionally, the PTP economy through online exchange sites has seen huge growth since when MCPA made this foray into studying it in 2011. Now, in addition to Craigslist and eBay, online exchanges are common through other avenues such as Facebook, which sees reuse activity through Facebook Marketplace, buy/trade/sell community groups, and even "Everything is Free" pages. Poshmark and other social marketplaces for used items are also becoming common. All of these sites allow people to easily contribute to the reuse economy from the comfort of their own homes and neighborhoods, and money is not always exchanged for the items (ex. Buy Nothing and Everything is Free groups, where transactions are part of the "gifting economy"). From personal experiences of the researchers who have unscientifically observed or even participated in PTP exchanges, many of these transactions happen on a relatively local scale, which has significant implications in terms of building strong communities and networks, and eliminating emissions from transport and associated processes of bringing new items home. The informal reuse economy could have an economic impact just as large, or larger, than brick and mortar reuse businesses. Therefore, this study's strongest recommendation for future research is to develop methodology to study the impact of the informal reuse economy.

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APPENDICES

A. GLOSSARY

Dun & Bradstreet (D&B): Business directory data source that includes business records from all industries

Environmental justice (EJ) community: According to MassDEP, an environmental justice community in Massachusetts is a neighborhood where any of the following are true:

(1) block group whose annual median household income is equal to or less than 65 percent of the statewide median ($62,072 in 2010);
or (2) 25% or more of the residents identify as a race other than white;
or (3) 25% or more of households have no one over the age of 14 who speaks English only or very well (English Isolation)

Freecycle: A system for items that are given away (something used or unwanted), as opposed to selling it or throwing it away, especially in an arrangement made via the internet

Heteroscedasticity: Heteroscedasticity refers to the condition that the variability of the values of a variable are not random across the range of values of a second variable that predicts it

Instrumental variables (IV): Instrumental variables are applied to estimate the casual relationship when independent variables are correlated with error term

Location Quotient (LQ): A comparison of a characteristic across areas of varying sizes

Natural logarithm (Ln): A logarithm to the base e

North American Industry Classification System (NAICS): Codes which are used by businesses and governments within the US and Canada to identify and sort businesses based on what services they perform

Reuse economy: Measured by number of jobs and business revenue that are a direct result of reuse businesses in Massachusetts

Reuse sectors: Any business in Massachusetts that conducts repair, second hand retail (reuse), and share or rental services (both of which we classify as rental)

Small businesses: According to the U.S. Small Business Administration, small business is one that has fewer than 1,500 employees and a maximum of $38.5 million in average annual receipts. For wholesale trade, the maximum number of employees ranges from 100 to 250. For retail trade, for one-third of all retail trade sub-industries, size standards are set at $7.5 million in average annual receipts; other industries are defined by 100 to 500 employee maximums.

Robust regression: Robust regression is the regression analysis which is designed to overcome measurement errors and heteroskedasticity.

T-test: T-test is a statistical tool. It is often used in a hypothesis testing to determine whether a process or treatment actually has an effect on the population of interest.

Two-way causality: Two way causality exists when the predictive variable is dependent on the variable of prediction.

B. DETAILED METHODOLOGY

Location Quotient Calculations:
[See PDF]

NAICS & SIC Codes:
All Codes are 2017 NAICS unless otherwise specified

Reuse NAICS:
441222 Boat Dealers (used)
441229 ATV, Snowmobile, etc. Dealers
453310 Used Merchandise Stores
522298 Pawnshops

Reuse SIC:
5932 Used Merchandise Stores

Rental NAICS:
532210 Consumer Electronics & Appliance Rental
532281 Formal Wear & Costume Rental
532282 Video Tape & Disc Rental
532283 Home Health Equipment Rental
532284 Recreational Goods Rental
532289 All Other Consumer Goods Rental
532310 General Rental Centers
532490 Other Commercial and Industrial Machinery and Equipment Rental and Leasing
532230 Video Tape and Disc Rental **(2012 NAICS)**
532291 Home Health Equipment Rental **(2012 NAICS)**
532292 Recreational Goods Rental **(2012 NAICS)**
532299 All Other Consumer Goods Rental **(2012 NAICS)**
532420 Office Machinery and Equipment Rental and Leasing

(No Rental SIC codes)

Repair NAICS:
811211 Consumer Electronics Repair and Maintenance
811212 Computer and Office Machine Repair and Maintenance
811213 Communication Equipment Repair and Maintenance
811219 Other Electronic and Precision Equipment Repair and Maintenance

811310 Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
811411 Home and Garden Equipment Repair and Maintenance
811412 Appliance Repair and Maintenance
811420 Reupholstery and Furniture Repair
811430 Footwear and Leather Goods Repair
811490 Other Personal and Household Goods Repair and Maintenance

Repair SIC (DataAxle-Specific Codes: These are not universal)
154206 Gate & Fence Repair
179303 Glass Repairing
179305 Storm Windows & Doors Repairing
179304 Windows Repairing
753401 Tire Re-Treading & Repairing
769404 Generators-Electric-Repair
769403 Outboard Motors-Repairing
399917 Furniture Repairing
504427 Cash Registers & Supplies Repairing
504513 Laser Printer Supplies Repair
508469 Machine Tools Repair & Rebuilding
594802 Luggage Repair
769974 Bicycle Repair
594132 Fishing Tackle Repair
769948 Golf Equipment Repair
769946 Skiing Equipment Repair
769933 Sporting Goods Repair
721304 Uniform Maintenance & Repair
721806 Gloves Cleaning & Repair

Keywords:
Excluded businesses with the following words (or parts of words) in business name:
car, auto, vehicle, automotive

Included businesses with the following words (or parts of words) in business name, as appropriate for each sector:
goodwill, 'salvation army', repair, thrift, vintage, consignment, reuse, 'Music Go Round', 'Play It Again Sports', 'Once Upon a Child', 'Style Encore', 'used book', Savers, rent

DataAxle Methodology:

SQL Scripts:

The syntax used in these scripts can be used in Microsoft Access to extract the reuse businesses from any DataAxle database. If they run correctly, the names of the tables must be identical to those in the scripts below (ex. 1_InfoUSA, Filt_NAICS, Filt_SIC, etc.). If the table names are not the same as below, paste the SQL into Word and use "Find and Replace" to change all of the table names to your table names.

1. Choosing only the variables we were considering analyzing out of all the variables in the original DataAxle database:

```
SELECT [1_InfoUSA].Company_Name, [1_InfoUSA].Primary_Address, [1_InfoUSA].Primary_City,
[1_InfoUSA].Primary_Zip_Code, [1_InfoUSA].Primary_Zip4, [1_InfoUSA].County_Code, [1_InfoUSA].County_Name,
[1_InfoUSA].CBSA_Code, [1_InfoUSA].Metro_Micro_Indicator, [1_InfoUSA].CSA_Code, [1_InfoUSA].Census_Tract,
[1_InfoUSA].Census_Block_Group, [1_InfoUSA].Latitude, [1_InfoUSA].Longitude, [1_InfoUSA].Match_Level_Code,
[1_InfoUSA].Secondary_Address, [1_InfoUSA].Secondary_City, [1_InfoUSA].Secondary_State,
[1_InfoUSA].Secondary_State_Code, [1_InfoUSA].Secondary_Zip_Code, [1_InfoUSA].Secondary_Zip4, [1_InfoUSA].Phone,
[1_InfoUSA].Toll_Free_Number, [1_InfoUSA].Web_Site, [1_InfoUSA].Selected_SIC_code, [1_InfoUSA].Primary_SIC_Code,
[1_InfoUSA].Secondary_SIC_Code_1, [1_InfoUSA].Secondary_SIC_Code_2, [1_InfoUSA].Secondary_SIC_Code_3,
[1_InfoUSA].Secondary_SIC_Code_4, [1_InfoUSA].NAICS_Code, [1_InfoUSA].Location_Employment_Size_Code,
[1_InfoUSA].Location_Employment_Size_Desc, [1_InfoUSA].Actual_Location_Employment_Size,
[1_InfoUSA].Corporate_Employment_Size_Code, [1_InfoUSA].Actual_Corporate_Employment_Size,
[1_InfoUSA].Modeled_Employment_Size, [1_InfoUSA].Location_Sales_Volume_Code,
[1_InfoUSA].Actual_Location_Sales_Volume, [1_InfoUSA].Corporate_Sales_Volume_Code,
[1_InfoUSA].Actual_Corporate_Sales_Volume, [1_InfoUSA].Asset_Size, [1_InfoUSA].Last_Name, [1_InfoUSA].First_Name,
[1_InfoUSA].Salutation, [1_InfoUSA].Gender, [1_InfoUSA].Professional_Title, [1_InfoUSA].INFOUSA_ID,
[1_InfoUSA].INFOUSA_PARENT_ID, 'INFOUSA_Subsidiary id', [1_InfoUSA].SITE_NUMBER, [1_InfoUSA].HQ_Branch_Code,
[1_InfoUSA].HQ_Branch_Desc, [1_InfoUSA].Year_First_Appeared_In_Yellow_Pages, [1_InfoUSA].Office_Size_Code,
[1_InfoUSA].Actual_Credit_Score, [1_InfoUSA].Population_Code, [1_InfoUSA].Work_At_Home_Business,
[1_InfoUSA].Own_Lease_Code, [1_InfoUSA].Square_Footage_Code, [1_InfoUSA].Affluent_Neighborhood_Location,
[1_InfoUSA].Big_Business, [1_InfoUSA].Female_Owner_Exec, [1_InfoUSA].Business_Size_Change,
[1_InfoUSA].Medium_Size_Business_Entrepreneur, [1_InfoUSA].Small_Business_Entrepreneur INTO
InfoUSA_Filtered_Variables
FROM 1_InfoUSA;
```

2. Cleaning DataAxle's NAICS codes to convert them to the universal NAICS codes (this process, as well as the script that follows this one, were necessary because DataAxle adds 2 more digits to their NAICS & SIC codes in order to further differentiate the categories the universal NAICS codes represent):

```
SELECT LEFT (NAICS_Code, len(NAICS_Code)-2) AS NAICS_Cleaned, * INTO
4_InfoUSA_NAICS_Cleaned
FROM 3_InfoUSA_Redefine_Data;
```

3. Cleaning Data Axle's Selected_SIC_Codes:

```
SELECT LEFT (NAICS_Code, len(NAICS_Code)-2) AS NAICS_Cleaned, * INTO
4_InfoUSA_NAICS_Cleaned
FROM 3_InfoUSA_Redefine_Data;
```

4. Confirming that we are only analyzing the businesses incorporated in MA that have their physical business location within MA (they all did):

```
SELECT* INTO InfoUSA_WithinState
FROM 5_InfoUSA_Sel_SIC_Cleaned
WHERE Secondary_State = 'MA'
ORDER BY County_Name;
```

5. Selecting all rental businesses:

```
SELECT *
FROM 5_InfoUSA_Sel_SIC_Cleaned
WHERE (COMPANY_NAME LIKE '*RENT*'
OR (NAICS_Cleaned='532120'
OR NAICS_Cleaned='532210'
OR NAICS_Cleaned='532281'
OR NAICS_Cleaned='532282'
OR NAICS_Cleaned='532283'
OR NAICS_Cleaned='532284'
OR NAICS_Cleaned='532289'
OR NAICS_Cleaned='532310'
OR NAICS_Cleaned='532490'
OR NAICS_Cleaned='532220'
OR NAICS_Cleaned='532230'
OR NAICS_Cleaned='532291'
OR NAICS_Cleaned='532292'
OR NAICS_Cleaned='532299'
OR NAICS_Cleaned='532310'
OR NAICS_Cleaned='532420'
OR NAICS_Cleaned='532490'))
AND COMPANY_NAME NOT LIKE '*car*'
AND COMPANY_NAME NOT LIKE '*auto*'
AND COMPANY_NAME NOT LIKE '*vehicle*'
AND Secondary_State = 'MA'
ORDER BY County_Name;
```

6. Selecting all repair businesses:

```
SELECT *
FROM 5_InfoUSA_Sel_SIC_Cleaned
WHERE (Company_name LIKE '*Repair*'
OR (NAICS_Cleaned='811211'
OR NAICS_Cleaned='811212'
OR NAICS_Cleaned='811213'
OR NAICS_Cleaned='811219'
OR NAICS_Cleaned='811310'
OR NAICS_Cleaned='811411'
OR NAICS_Cleaned='811412'
OR NAICS_Cleaned='811420'
OR NAICS_Cleaned='811430'
OR NAICS_Cleaned='811490'
OR Selected_SIC_Code = 154206
OR Selected_SIC_Code = 179303
OR Selected_SIC_Code = 179305
OR Selected_SIC_Code = 179304
OR Selected_SIC_Code = 753401
OR Selected_SIC_Code = 769404
OR Selected_SIC_Code = 769403
OR Selected_SIC_Code = 399917
OR Selected_SIC_Code = 504427
OR Selected_SIC_Code = 504513
OR Selected_SIC_Code = 508469
OR Selected_SIC_Code = 594802
OR Selected_SIC_Code = 769974
OR Selected_SIC_Code = 594132
OR Selected_SIC_Code = 769948
OR Selected_SIC_Code = 769946
OR Selected_SIC_Code = 769933
OR Selected_SIC_Code = 721304
OR Selected_SIC_Code = 721806))
AND Company_Name NOT LIKE '*car*'
```

```
AND COMPANY_NAME NOT LIKE '*automotive*'
AND COMPANY_NAME NOT LIKE '*AUTO*'
AND COMPANY_NAME NOT LIKE '*vehicle*'
AND Secondary_State = 'MA'
ORDER BY County_Name;
```

7. Selecting all reuse businesses:

```
SELECT *
FROM 5_InfoUSA_Sel_SIC_Cleaned
WHERE ((COMPANY_NAME LIKE '*Thrift*'
OR COMPANY_NAME LIKE '*Vintage*'
OR COMPANY_NAME LIKE '*Consignment*'
OR COMPANY_NAME LIKE '*Reuse*'
OR COMPANY_NAME LIKE '*Goodwill*'
OR COMPANY_NAME LIKE '*Music Go Round*'
OR COMPANY_NAME LIKE '*Play It Again Sports*'
OR COMPANY_NAME LIKE '*Once Upon A Child*'
OR COMPANY_NAME LIKE '*Style Encore*'
OR COMPANY_NAME LIKE '*used book*'
OR COMPANY_NAME LIKE 'SAVERS*'
OR COMPANY_NAME LIKE '*salvation army*')
OR (NAICS_Cleaned='441210'
OR NAICS_Cleaned='441222'
OR NAICS_Cleaned='441229'
OR NAICS_Cleaned='453310'
OR Selected_SIC_Cleaned = '593200'
OR Selected_SIC_Cleaned='593201'
OR Selected_SIC_Cleaned='593203'
OR Selected_SIC_Cleaned='593204'
OR Selected_SIC_Cleaned='593205'
OR Selected_SIC_Cleaned='593299' ))
AND Company_Name NOT LIKE '*car*'
AND COMPANY_NAME NOT LIKE '*automotive*'
AND COMPANY_NAME NOT LIKE '*vehicle*'
AND Secondary_State = 'MA'
ORDER BY County_Name;
```

8. Selecting all secondary reuse businesses (excluding primary reuse businesses):

```
SELECT *
FROM 5_InfoUSA_Sel_SIC_Cleaned
WHERE (Secondary_SIC_Code_1 LIKE '5932*')
AND NOT ((COMPANY_NAME LIKE '*Thrift*'
OR COMPANY_NAME LIKE '*Vintage*'
OR COMPANY_NAME LIKE '*Consignment*'
OR COMPANY_NAME LIKE '*Reuse*'
OR COMPANY_NAME LIKE '*Goodwill*'
OR COMPANY_NAME LIKE '*Music Go Round*'
OR COMPANY_NAME LIKE '*Play It Again Sports*'
OR COMPANY_NAME LIKE '*Once Upon A Child*'
OR COMPANY_NAME LIKE '*Style Encore*'
OR COMPANY_NAME LIKE '*used book*'
OR COMPANY_NAME LIKE 'SAVERS*'
OR COMPANY_NAME LIKE '*salvation army*')
OR (NAICS_Cleaned='441210'
OR NAICS_Cleaned='441222'
OR NAICS_Cleaned='441229'
OR NAICS_Cleaned='453310'
OR Selected_SIC_Cleaned = '593200'
OR Selected_SIC_Cleaned='593201'
OR Selected_SIC_Cleaned='593203'
OR Selected_SIC_Cleaned='593204'
```

```
OR Selected_SIC_Cleaned='593205'
OR Selected_SIC_Cleaned='593299' ))
AND Company_Name NOT LIKE '*car*'
AND COMPANY_NAME NOT LIKE '*automotive*'
AND COMPANY_NAME NOT LIKE '*vehicle*'
AND Secondary_State = 'MA'
ORDER BY County_Name;
```

9. Selecting all secondary repair businesses (excluding primary repair businesses):

```
SELECT *
FROM 5_InfoUSA_Sel_SIC_Cleaned
WHERE (Secondary_SIC_Code_1 = '154206'
OR Secondary_SIC_Code_1 = '179303'
OR Secondary_SIC_Code_1 = '179305'
OR Secondary_SIC_Code_1 = '179304'
OR Secondary_SIC_Code_1 = '753401'
OR Secondary_SIC_Code_1 = '769404'
OR Secondary_SIC_Code_1 = '769403'
OR Secondary_SIC_Code_1 = '399917'
OR Secondary_SIC_Code_1 = '504427'
OR Secondary_SIC_Code_1 = '504513'
OR Secondary_SIC_Code_1 = '508469'
OR Secondary_SIC_Code_1 = '594802'
OR Secondary_SIC_Code_1 = '769974'
OR Secondary_SIC_Code_1 = '594132'
OR Secondary_SIC_Code_1 = '769948'
OR Secondary_SIC_Code_1 = '769946'
OR Secondary_SIC_Code_1 = '769933'
OR Secondary_SIC_Code_1 = '721304'
OR Secondary_SIC_Code_1 = '721806')
AND NOT (Company_name LIKE '*Repair*'
OR (NAICS_Cleaned='811211'
OR NAICS_Cleaned='811212'
OR NAICS_Cleaned='811213'
OR NAICS_Cleaned='811219'
OR NAICS_Cleaned='811310'
OR NAICS_Cleaned='811411'
OR NAICS_Cleaned='811412'
OR NAICS_Cleaned='811420'
OR NAICS_Cleaned='811430'
OR NAICS_Cleaned='811490'
OR Selected_SIC_Code = 154206
OR Selected_SIC_Code = 179303
OR Selected_SIC_Code = 179305
OR Selected_SIC_Code = 179304
OR Selected_SIC_Code = 753401
OR Selected_SIC_Code = 769404
OR Selected_SIC_Code = 769403
OR Selected_SIC_Code = 399917
OR Selected_SIC_Code = 504427
OR Selected_SIC_Code = 504513
OR Selected_SIC_Code = 508469
OR Selected_SIC_Code = 594802
OR Selected_SIC_Code = 769974
OR Selected_SIC_Code = 594132
OR Selected_SIC_Code = 769948
OR Selected_SIC_Code = 769946
OR Selected_SIC_Code = 769933
OR Selected_SIC_Code = 721304
OR Selected_SIC_Code = 721806))
AND Company_Name NOT LIKE '*car*'
```

```
AND COMPANY_NAME NOT LIKE '*automotive*'
AND COMPANY_NAME NOT LIKE '*AUTO*'
AND COMPANY_NAME NOT LIKE '*vehicle*'
AND Secondary_State = 'MA'
ORDER BY County_Name;
```

10. Calculating total MA employment:

```
SELECT Sum(Actual_Location_Employment_Size)
FROM All_MA;
```

11. Calculating total employment for each county:

```
SELECT County_Name, SUM(Actual_Location_Employment_Size)
FROM All_MA
GROUP BY County_Name;
```

12. Calculating total employment for repair, reuse & rental sectors by county (simply replace the word “repair” here with “reuse” and “rental” to identify those spreadsheets)

```
SELECT County_Name, SUM(Actual_Location_Employment_Size)
FROM All_Repair_Business
GROUP BY County_Name;
```

13. Calculating female owned businesses by county (“Combined” is the tabel with all reuse businesses):

```
SELECT County_Name, Count(combined.female_owner_exec) AS CountofFemale
FROM combined
WHERE (combined.female_owner_exec='Y')
GROUP BY combined.County_Name;
```

14. Calculating total small businesses by county:

```
SELECT County_Name, Count(combined.small_business_entrepreneur) AS CountofSmall
FROM combined
WHERE (combined.small_business_entrepreneur='Y')
GROUP BY combined.County_Name;
```

C. INTERVIEW GUIDES

Interview Questions for Academic and Professional Reuse Experts

1. Can you go over the general methodology of your work?
2. Which data set(s) and software were used in the analysis?
3. How did the team come to decide which data set to use and which attributes were important?
4. How did the team get access to the data (ie. cost)?
5. Did the team conduct any spatial analysis?

Interview Questions for Reuse Business Owners

1. If it is a retail business, how do you source your items (ex. donations)?
2. What observations do you have about the population that your business serves?
3. As a part of the reuse sector, what do you think are the biggest challenges facing your business?
4. How can the state government help reuse businesses in Massachusetts?
5. What would you consider to be the most important benefit your business provides to your community?

Tufts UNIVERSITY
GRADUATE SCHOOL OF ARTS AND SCIENCES
Urban and Environmental Policy and Planning

MassDEP
Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs
Department of Environmental Protection