

Preventing Recycling Contamination

Residential Recycling Feedback Survey Analysis

City of Lansing, Capital Area Recycling and Trash (CART)
University of Michigan School of Information (UMSI)



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Abstract

The City of Lansing is in need of reducing recycling contamination as they transition to a new materials recovery facility. Previous studies of program participation and contamination audits exclude direct residential feedback. A survey was developed based on previous research and distributed to Lansing residents. Data relating to the following areas of interest was collected: communication methods, disposal habits based on categories of materials and situations, and effects of contamination on the recycling process. Regarding levels of contamination over time, results show estimated averages of contamination occurrences per route in 2017 and 2019 to remain constant. Regarding situational recycling, the observed residential contamination rates do not significantly differ from national residential contamination rates. Regarding disposal of ambiguous items (materials that are possibly recyclable), results are insignificant between proportions of respondents recycling or wasting the item. Each of these results show rates remaining constant. To reduce contamination rates, it is imperative to conduct continuing research on residential experience of informational resources in conjunction with inbound contamination audits in order to accurately assess changes in contamination rates over time. This analysis supplements the Preventing Recycling Contamination Sustainability Report delivered to the city of Lansing¹.

¹ Preventing Recycling Contamination Sustainability Report (excluding appendices) - Appendix L

Background

The city of Lansing's recent partnership with a new, central Michigan based materials recovery facility (MRF) prompted the outsourcing of University of Michigan School of Information graduate students to assist the city in developing solutions for the reduction of recycling contamination rates. Contamination, as defined by The Recycling Partnership, "refers to material that residents include in their recycling collection but is not accepted in their curbside program as well as material that is on the list of accepted materials but has unacceptable amounts of residue" (Mouw, 2020, page 21). For Lansing residents, recycling contamination can cause service interruptions and a repossession of their recycling cart. For the city, recycling contamination can increase recycling processing costs, and, in extreme cases, diversion to a load sent to landfill. Lansing's efforts to examine recycling program participation and address contamination started with a 2014 assessment of materials collected over a two week period to determine levels of participation by route and instances of contamination. According to the Recycling Partnership, this step is essential to improving material quality: "To effectively improve material quality, a community should specifically know its inbound contamination rate, which measures the amount of contamination, or non-commodity material, in loads being delivered to MRF from curbside collection routes" (Mouw, 2020, page 21).

Lansing's 2014 and 2017 Residential Recycling Program Participation

The success of a recycling program is entirely dependent upon a city's capacity to collect and transport materials, and residential participation. Participation in Lansing's recycling program was previously assessed in two separate studies (City of Lansing, 2017, page 1). Baseline data collected in 2014 yielded an average of 64.3% participation among study groups (City of Lansing, 2017, page 2). A second study conducted in 2017 showed an 6.4% increase in participation. Unfortunately, the exact methods of data collection in the 2014 study is unknown. Based on information in the 2017 study, it appears strong efforts were made to replicate the previous study. As recycling pick up occurs on a bi-weekly basis, all existing routes were observed once. Participation was assessed over a two week period based, and marked as participating in the program if residences placed a cart on the curb for pick up (City of Lansing, 2017, page 2). Any instance of contamination was also recorded, reporting a total of 247 occurrences across all routes (City of Lansing, 2017, page 6). Interestingly, resident input was not assessed in either the 2014 or 2017 study.

Lansing's 2019 Contamination Audit Report

This study yielded an overall contamination rate of 16%, with contamination categorized in four areas: wishful recycling, absolutely trash, recyclable elsewhere, and problematic preparation (City of Lansing CART and City of East Lansing, 2019, page 5). This rate aligns with The Recycling Partnership's 2019 State of Curbside Recycling Survey, which "indicate that about 35% of communities know inbound contamination rate, which averages 16.9%" (Lansing CART and East Lansing, 2020, page 23). Lansing's top contaminants (by weight) include absolutely trash, wishful recycling - plastic, problematic preparation - bagged recyclables, wishful recycling - metal, and recyclable elsewhere - electronic waste (Lansing CART and East Lansing, 2019, page 6). The audits conclusions indicated a need for "continued education addressing Wishful REcycling and the negative impacts to the recycling program and sorting process" (Lansing CART and East Lansing, 2019, page 12). The Recycling Partnership emphasizes four anti-contamination strategies: cart tagging ("Oops Tags"), rejecting contaminated carts, direct mailers or bill inserts with information on accepted materials, and general advertising to promote accepted materials (Mouw, 2020, page 23). Lansing is currently employing all of these strategies within their highly motivated and engaged community.

Lansing's Contamination Intervention

An interview with a Michigan Department of Environment, Great Lakes, and Energy (EGLE) representative reinforced the need for "Oops Tags" and its effectiveness, praising Lansing on their strict adherence to refusing and tagging contaminated recycling carts at the curb level. Oops Tags² are an informational tool utilized by the city to communicate to residents a violation of CART's policies, such as the presence of recycling contamination or incorrect placement of carts on the curb. Lansing employs a three-strikes rule, in which residents carts are repossessed after three violations. Currently, only residences with repossession occurrences are tracked, with data managed by the Public Works department. To regain access to their cart, residents must contact the city after the repossession and engage in reeducation of accepted recycling materials. In addition to Oops Tags, Lansing also utilizes infographics on accepted and unaccepted materials in their quarterly *Lansing Living* newsletter, comprehensive informational resources on the CART website, and partnered with EGLE on a hyper local "Know it before you throw it" marketing campaign.

Residential Feedback Survey

Based on background research, a critical component in Lansing's efforts to reduce contamination is missing: assessment of residential contamination habits. Successful

² Oops Tag - Figure 1 - Appendix A

recycling programs are two sided, requiring both government facilitation and management as well as residential participation. In addition to evaluation of inbound contamination rates, it is necessary to evaluate residents' understanding of accepted materials. Where previous participation studies exclude direct residential feedback, this study aims to understand how residents conceptualize recycling. This study evaluates contamination history and residential feedback on informational resources, typical disposal methods of common items and situations, and contamination effects via surveys distributed to Lansing residents.

Methodology

Contamination History

Upon request, Lansing's public service department provided cart repossession history from January 2019 to September 2020 including addresses, repossession date, and collection route. Additionally open sourced geographic data, including Lansing wards and neighborhood associations, and CART route boundaries were collected. Data was imported into GoogleMyMaps, and layered based on CART route boundary, neighborhood association, and residences with cart repossession history to create an interactive map³. Repossession order history was evaluated visually, and occurrences organized by route and year. History was compared to contamination occurrences recorded in previous participation studies to examine possible contamination patterns across pickup routes and change over time. Hypothesis testing was used for statistical analysis. Repossession data was imported into RStudio and analyzed using the following R packages: tidyverse, ggplot2, dplyr, and infer. Analysis and results were compiled in Rmarkdown syntax, exported to html format, and uploaded to a Github Repository⁴ for public access.

Residential Recycling Feedback Survey

The residential recycling feedback survey was developed using University of Michigan licensed Qualtrics Software. Six questions were written to evaluate the following areas of interest:

1. Methods of communication between Lansing and its residents: currently receiving and preferred (multiple choice, multiple response)
 - A. Organizations (school, commercial business, and/or place of work)
 - B. Companions (friends, family, and/or neighbors)

³ Contamination Map - Figure 2 - Appendix B

⁴ Github Repository - https://github.com/s-ryanlee/SI538_PRCsurvey

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- C. Paper (mailed pamphlets, flyers, or newsletters)
 - D. Cart (information located on recycling cart)
 - E. Website (CART informational pages)
 - F. Social Media (City of Lansing, Public Works Department, and CART Facebook pages)
 - G. Apps (Recycle Coach and/or Lansing Connect apps)
2. Methods of disposal (trash, recycle, drop off recycling, and other (such as bottle deposit) of common categories of items (multiple choice, multiple response)
- A. Recyclable paper products (such as junk mail, office paper, magazines)
 - B. Non-recyclable paper products
 - C. Recyclable cardboard and boxboard (such as cereal and shipping boxes)
 - D. Recyclable glass (such as beverage bottles and food jars)
 - E. Specialty glass (such as ceramics, window panes, and mirrors)
 - F. Recyclable plastics (such as clean and empty bottles and milk jugs)
 - G. Plastic bags (such as grocery bags and air filled packaging pillows)
 - H. Bulky/rigid plastics (such as buckets and storage containers)
 - I. Polystyrene Foam (such as takeout containers and packing peanuts)
 - J. Recyclable Metals (such as steel canisters and aluminum cans)
 - K. Specialty metals (such as scrap metal, tools, and knives)
 - L. Electronic waste (such as charging cords, circuit boards, and computers)
 - M. Miscellaneous items (such as motor and cooking oil and light bulbs)
4. Likelihood of disposal habits in a variety of situations (5 point Likert scale):
- A. Dispose of an item that is on the accepted recycling list into the trash?
 - B. Dispose of an item that is on the accepted recycling list into the recycling?
 - C. Dispose of an item that is not on the accepted recycling list into the trash?
 - D. Dispose of an item that is not on the accepted recycling list into recycling?
 - E. Dispose of an item that I am unsure about into the trash?
 - F. Dispose of an item that I am unsure about into the recycling?
 - G. Take recyclable specialty items to a drop off recycling center?
5. Resident's understanding of contamination effects (multiple choice)

Responses in the first three survey questions were not mutually exclusive, while the remaining three maintained exclusivity.

A follow-up interview interest form was created using Google forms to recruit residents for virtual follow-up interviews and linked to the completion message of the residential recycling feedback survey. Questions on this interest form included a short answer field for residents to volunteer email addresses, 3 point scales to assess level of interest in

participating in a virtual interview or receiving a copy of final reports, and short answer field for additional information residents wish to share.

The survey was transferred to Lansing officials who distributed through the following channels on October 19, 2020: existing email repository, neighborhood association points of contact with requests to distribute to neighborhood residents, city of Lansing social media pages (general city page, public works, and CART), Lansing Connect and Recycle Coach apps. Lansing officials contacted residents with a reminder request to complete the survey on October 23, 2020, and the survey closed on October 28, 2020⁵.

Responses were collected anonymously (n=540) with the option to continue to a follow-up interest form⁶ to volunteer for a virtual interview (n=80). Residents indicating interest in volunteering for a follow-up interview received the Residential Recycling Follow-Up Selection Form⁷. Data was cleaned and filtered using Python, then transferred to RStudio for analysis in R. Measures of frequency were examined for all areas of interest. Two bootstrapped hypothesis tests were conducted to evaluate the significance of proportions of two different aspects of situational recycling, *dispose of an item I am unsure is recyclable into the recycling*, and *dispose of an item I am unsure is recyclable into the trash*. Results were analyzed in R, compiled, and uploaded as previously described.

Residential Recycling Follow-up Interviews

After the survey closed and prior to analysis, interviewee selection criteria was determined and compiled into a Google Form for distribution to volunteers via email. Name, pronouns, and email were requested, as well as indication of how residents would access the virtual interview (Internet access or phone call) held via Zoom Meeting Software. Selection criteria included the following:

1. Meeting Availability
2. Quantity of Oops Tag(s) received

A follow-up interview selection form was distributed to volunteers via email on November 20, 2020. Responses were collected on a rolling basis (n=16), and residents contacted via email as availability matched with those conducting interviews. Contextual inquiry methods were used to develop interview questions⁸ elaborating on questions from the feedback survey; conduct interviews; and analyze qualitative data. 30 minutes interviews with three Lansing residents were conducted between November 23-25, 2020. Interviews were

⁵ Survey Timeline - Figure 3 - Appendix C

⁶ Improving Recycling in Lansing Follow Up Survey - Figure 4, 5, 6 - Appendix D

⁷ Residential Recycling Follow-Up Selection Form - Figure 7, 8 - Appendix E

⁸ Residential Follow-Up Interview Protocol - Appendix F

facilitated by two team members, one as interviewer and another as note taker. Notes were analyzed after interviews terminated to determine key findings and provide support for the results in the Sustainability Report⁹.

Results

Contamination History

2017 Participation Survey recorded instances of contamination by type (plastic bags, non-recyclable waste, yard waste/wood, polystyrene foam, textiles, miscellaneous, yard waste, e-waste, and bio-hazardous waste) and route (Blue Monday, Blue Tuesday, Blue Wednesday, Blue Thursday, Green Monday, Green Tuesday, Green Wednesday, and Green Thursday)(n=247, m=30.875, sd=12.789). As 2017 data recorded contamination occurrences and 2019 data recorded cart repossession (3 contamination occurrence), 2019 occurrences were multiplied by 3. Residences with instances of repossession work orders were plotted on a map¹⁰ overlaid with route boundaries and categorized by year and route first, then sums multiplied by 3 (2019: n=282, m=35.25, sd=17.25 and 2020: n=162, m=20.25, sd=11.42). A bar plot¹¹ for 2017, 2019, and 2020 occurrences was created to assess visual patterns. Ultimately, repossession history and contamination estimates from 2020 were removed from analysis as only months January through August were recorded.

A two sample, two-sided t-test was performed to determine if a significant difference in quantity of contamination instances from 2017 to 2019 exists. Null hypothesis: there is no difference between contamination occurrence means in 2017 and 2019. Alternative hypothesis: there is a difference between contamination occurrence means in 2017 and 2019.

$$H_0 : \mu_1 - \mu_2 = 0$$

$$H_1 : \mu_1 - \mu_2 \neq 0$$

Welch two sample t-test results are insignificant (t=0, df=12.909, p-value=1, $\alpha=0.05$). There is not enough evidence to reject the null hypothesis in favor of the alternative hypothesis. There is not enough evidence that a difference in average contamination occurrences per route in 2017 and 2019 exist.

Residential Informational Receipt and Preference

⁹ Preventing Recycling Contamination Sustainability Report - Appendix L

¹⁰ Contamination Map - Figure 2 - Appendix B

¹¹ Contamination History Bar Plot - Figure 9 - Appendix G

The residential recycling feedback survey examined current methods of communication residents receive and residents' preferred methods of communication (n=540). Top five currently received communication methods include paper (32.80%), website (27.63%), cart (10.52%), companions (9.54%), and apps (8.56%). Top five preferred methods of communication include paper (34.71%), website (25.37%), apps (13.18%), cart (14.16%), and social media (9.34%). Responses were tabulated based combinations of relationships between current method received and preferred method. Relationship totals were determined based on logical conditions, such as if a respondent is currently receiving paper methods of communication and their preferred communication method is via Lansing's website, then the value results to true (1) and summed. Based on combinations of current and preferred methods, paper and website communication accounts for the majority of residents' receipt and preference of communication. Chi-squared analysis to determine the significance of communication relationships is invalidated, as responses are not mutually exclusive (respondents were capable and encouraged to select all methods that applied).

PREFERRED METHOD	CURRENT METHOD				
	paper	website	cart	companions	apps
paper	308	212	85	308	84
website	188	219	63	219	60
apps	95	100	32	84	84
cart	64	85	64	64	28
social media	69	64	26	36	23

PREFERRED METHOD	CURRENT METHOD				
	paper	website	cart	companions	apps
paper	0.57	0.39	0.16	0.57	0.16
website	0.35	0.41	0.12	0.41	0.11
apps	0.18	0.19	0.06	0.16	0.16
cart	0.12	0.16	0.12	0.12	0.05
social media	0.13	0.12	0.05	0.07	0.04

Common Materials

Lansings 2019 audit identified top five contaminants by volume: wishful recycling¹² plastic (3.68%), absolutely trash¹³ (2.43%), wishful recycling paper (1.62%), problematic

¹² "Wishful recycling: items presumed to be acceptable based on similar product material of conforming item" (City of Lansing CART, 2017, page 4).

¹³ "Absolutely trash: non recyclable waste" (City of Lansing CART, 2017, page 4).

preparation¹⁴ bagged recyclables (1.35%), and wishful recycling metals (0.94%). Top five contaminants by weight: absolutely trash (5%), wishful recycling plastic (2.75%), problematic preparation bagged recyclables (1.59%). Common categories of materials and methods residents typically dispose of them were assessed. Responses are not mutually exclusive, and this evaluation was made based on the proportion of respondents' recycling disposal of common contaminants into the recycling cart. Contaminant proportions follow: specialty metals (17.74%), specialty glass (8.37%), polystyrene foam (4.33%), plastic bags (3.27%), electronic waste (2.49%), non-recyclable paper products (2.21%), and miscellaneous items (1.60%).

Situational Recycling

6% of contaminated recyclables in Lansing's 2019 audit was due to wishful recycling. 8.6% of survey respondents will first wishful recycle and 38.36% of respondents will first properly dispose¹⁵ if they are unsure if an item is an accepted recyclable. 47.17% of respondents indicated they will first search or call for information to find out if the item is in fact an accepted material. 16.91% of respondents indicated they are extremely likely or somewhat likely to wishful recycle when they come across an item they are unsure is recyclable (*Dispose of an item that I am unsure about into the recycling?*). 83.23% of respondents indicated they are extremely likely or somewhat likely to properly dispose when they come across an item they are unsure is recyclable (*Dispose of an item that I am unsure about into the trash?*).

A one-sample, two sided t-test was conducted to determine if the proportion of respondents wishful recycling is significantly different than the national average inbound contamination rate of 16.9%. Null hypothesis: the proportion of Lansing wishful recyclers is equal to the national contamination rate. Alternative hypothesis: the proportion of Lansing wishful recyclers is not equal to the national contamination rate.

$$H_0 : p = 0.169$$

$$H_1 : p \neq 0.169$$

Student one sample t-test results are significant (p-value= 2.2×10^{-16} , $\alpha=0.05$). There is evidence to reject the null hypothesis in favor of the alternative hypothesis. There is evidence that a difference in the proportion of Lansing wishful recyclers and the national inbound

¹⁴ "Problematic preparation: items that if properly prepared would be acceptable" (City of Lansing, CART, 2017, page 4).

¹⁵ Proper disposal: dispose of an item one is unsure if it is on the accepted recycling list into the trash.

contamination rate of 16.9% exists. Proportions were further tested under a bootstrapped one sample t-test¹⁶ using the same hypotheses. Results are insignificant (p-value=0.14, $\alpha=0.05$). There is not enough evidence to reject the null hypothesis in favor of the alternative hypothesis. The probability of the proportions resulting at random is greater than the alpha level of significance.

Two sample, two sided t-test was conducted to determine if the differences in proportions of wishful recyclers and proper disposers. Null hypothesis: there is no difference between the proportion of respondents wishful recycling and proportion of respondents properly disposing. Alternative hypothesis: there is a difference between the proportion of respondents wishful recycling and proportion of respondents properly disposing.

$$H_0 : p_1 - p_2 = 0$$

$$H_1 : p_1 - p_2 \neq 0$$

Two sample t-test results were inconclusive. To further test these hypotheses, a simulated (randomly generated sampling without replacement) two sample, two sided t-test¹⁷ was conducted to determine the probability of the proportion of respondents wishful recycling significantly differing from the proportion of respondents properly disposing. Simulation based t-test results are insignificant (p-value= 0.054, $\alpha=0.05$). There is not enough evidence to reject the null hypothesis in favor of the alternative hypothesis. There is not enough evidence to suggest a difference between proportions of wishful recyclers and proper disposers.

Due to the level of significance ($\alpha=0.05$), the probability of committing type I error, or rejecting the null hypothesis when it is in fact true, is low. Power analysis yields the probability of committing type II error with the testing performed is extremely low (n=540, d=0.3, power=0.998). The probability of rejecting the null hypothesis when it is in fact false is extremely low. This supports the validity of the results of the t-tests performed in this analysis.

Residential Understanding of Contamination Effects

Two questions asked aimed to assess how respondents understand the effects of improperly prepared materials on end-recycling processes. Regarding unwashed materials, 52.62% of respondents reported being unsure what happens to unwashed items. Additionally, 40.67% reported MRF wasting items, 3.77% reported the MRF cleaning the

¹⁶ Simulation-Based Bootstrap Distribution - Figure 10 - Appendix H

¹⁷ Simulation-Based Null Distribution - Figure 11 - Appendix I

items, and 2.94% reported rejection at the curb level. Regarding recyclable items contained in plastic bags inside the cart, 49.06% reported being unsure what happens to the bagged items. Additionally, 30.19% reported disposal by the MRF, 16.82% reported rejection at the curb level, and 6.92% reported items are removed from the bags at the MRF.

Conclusion

This study aimed to evaluate Lansing residential recycling habits to provide context for previous participation and contamination studies conducted by Lansing, as well as provide feedback to the city regarding communication of informational recycling resources. A six question survey was distributed to residents through a variety of channels including email lists, social media and apps, and neighborhood association points of contact. Selection bias exists as, generally speaking, the majority of methods of distribution reach those who are already invested in recycling. For example, only those residents who are interested in recycling will have the Recycle Coach app downloaded. Additionally, residential verification and demographics were not addressed in this survey. The possibility of non-Lansing residents responding to this survey is likely. Future surveys should include residential verification such as a question of which zip code the respondent belongs to, as well as demographic questions to address age, gender, race, and number of children in the household. Finally, future studies should ensure random distribution of surveys by incorporating mailed paper surveys to reach those that do not have access to previous distribution methods. Unfortunately, due to the 2020 pandemic, direct contact with residents was not possible.

This study analyzes previous baseline contamination data with current residential conceptualization of recyclable materials. Results show no significant differences in average contamination occurrences per route in 2017 and average estimated contamination occurrences per route in 2019. These results imply constancy to recycling contamination and plateau in contamination reduction in Lansing. As there are no significant differences between previous years average contamination rates, it is likely that current anti-contamination strategies are not effective in changing the average number of contaminations per collection route. However, there are limitations. For instance, “Oops Tags” are not always distributed solely for recycling contamination. One interviewee described an instance in which they received an Oops Tag because their recycling and trash cart were positioned too close together. This prevented the machinery used to empty the cart from accessing it. If a resident received three Oops Tags in 2019 for violations similar to the one experienced by this Lansing resident, the estimated number of contaminations calculated in this study is inaccurate. Future studies should analyze anti-contamination

strategies and their effect on reducing average contamination occurrences per route by examining carts at the curb level prior to collection in addition to surveying residents on how well received and understood improved marketing materials¹⁸.

Relationships of current communication methods and preferred communication methods show the majority of respondents that currently receive information via paper and website methods also prefer these methods. Some slight increases in preference for app and social media exist. As these variables are not mutually exclusive, the significance of their relationship is indeterminate. City of Lansing stakeholders showed marked interest in these relationships. Further research should address the significance of these variables through statistical analysis. One possible method might include surveying residents on these questions again, with only one response collected instead of allowing respondents to select all that apply. Additionally, future research might move beyond current receipt and preference of communication methods to assess how city residents experience different types of informational resources deployed by Lansing, such as accepted recycling material infographics¹⁹. An opportunity for heuristic evaluation of informational resources through the use of mutually exclusive variables to determine significance of factors exists here.

Regarding wishful recycling, there is no evidence that the proportion of respondents wishful recycling when unsure if an item is in fact recyclable is different from the national rate of 16.9%. This implies that, in terms of resident's conceptualization of recyclable and non-recyclable materials, Lansing's inbound contamination rates are neither greater or less than 2020's average. Additionally, there is not enough evidence to suggest a significant difference in the proportion of residents that are wishfully recycling and those that are wasting materials they are unsure about. This adds a layer of complexity to the wishful recycling phenomenon, as those who are wishfully recycling are not significantly different than those individuals disposing of items they are unsure about. There is also an opportunity for contamination intervention here. Educating residents on the harmfulness of wishful recycling to the recycling process and emphasizing the idea behind properly disposing of materials with ambiguous recycling connotations may reduce contamination instances. To improve validity of this conjecture, it is important to analyze actual inbound contamination rates through audit or examination at the curb prior to collection, in conjunction with reassessment of residential feedback in the near future. It is important to perform waste audits, for both trash and recycling, to determine the amount of wishful recycling existing in inbound trash and recycling to verify if differences exist.

¹⁸ Recycling Guide Magnet distributed to residents - Figure 12 - Appendix J

¹⁹ Recycling Guide - Figure 13 - Appendix K

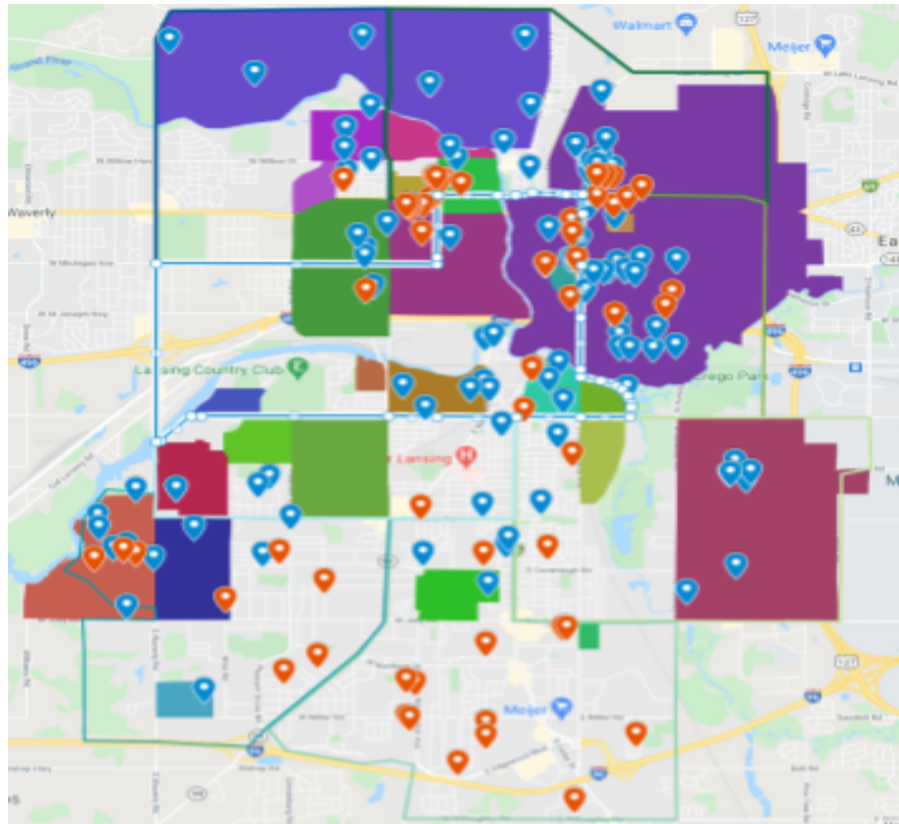
The UMSI Preventing Recycling Contamination Sustainability report highlights some improvements to current strategies, including emphasizing wasting materials residents are unsure about, timelines and updates for the next iteration of feedback surveys, and additional opportunities to engage with residents in interviews to collect targeted qualitative data to understand how they experience informational resources distributed by the city. In general, Lansing's residents appear eager to engage with recycling initiatives. Collecting feedback, analyzing how this feedback relates to current contamination rates and anti-contamination strategies, and reevaluating and updating resources accordingly is crucial for the improvement of contaminated materials in Lansing's recycling program.

Appendix A



Figure 1: Oops Tag

Appendix B



*Figure 2:
Recycling cart
repossession
instances January
2019 to
September 2020.*

Filled boundaries
indicate
neighborhood
associations

Outlined
boundaries
indicate CART
pick up routes

Blue points
indicate
residences with
recycling cart
repossessions in
2019 (excluding
duplicate
instances)

Orange points

Appendix C

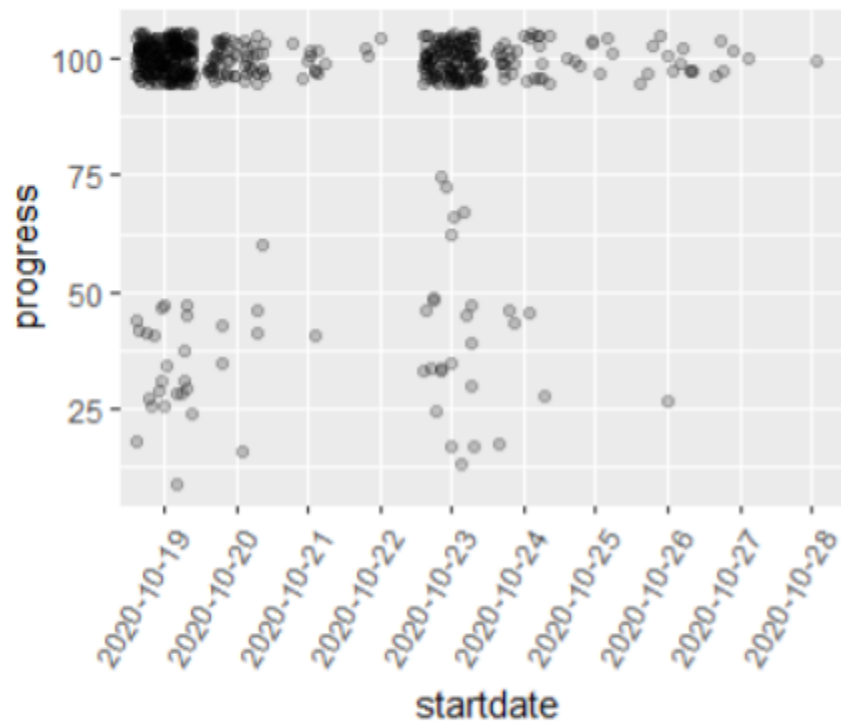


Figure 3: Survey Distribution Timeline and Completion Rate

Appendix D

Section 1 of 3

Improving Recycling in Lansing Follow Up Survey

Please include any additional information you would like us to consider to help improve and support Lansing Recycling. All responses are confidential and will only be recorded if you express interest in following up with our team. You may withdraw or edit your responses at any point in time after submission.

Where did you access our "Improving Recycling in Lansing" survey?

☐ Recycle Coach

☐ Lansing Connect

☐ City of Lansing Facebook Pages

☐ Friend, Family, Coworker, and/or Neighbor

☐ Other...

Is there any additional information you would like us to know about you and/or your recycling habits?

Long answer text

Figure 4: Survey to recruit volunteers for virtual interviews, Section 1 of 3

Interest in Follow Up Interview



Please use this form to indicate your level of interest in participating in a follow up interview so we may learn more about Lansing resident's recycling habits.

Any contact information you volunteer will be kept confidential and only be used to contact those interested in participating in a follow up interview with our team. You may withdraw or edit your responses at any point in time after submission.

Please indicate your level of interest in participating in a follow up interview regarding resident's recycling habits

	1	2	3	
Highly Interested	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	No Interest

If you are interested in participating in a short phone or virtual follow up interview with our team please include your email below

Short answer text

Figure 5: Survey to recruit volunteers for virtual interviews, Section 2 of 3

Final Report Interest Form



Please use this form to indicate your level of interest in receiving a copy of our final report upon the completion of the Fall 2020 semester.

Any contact information you volunteer will be kept confidential and only be used to contact those interested in receiving a copy of our team's final report at the end of the Fall 2020 semester. You may withdraw or edit your responses at any point in time after submission.

Please indicate your level of interest in receiving a copy of our final report at the end of the Fall 2020 semester

	1	2	3	
Highly Interested	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	No Interest

If you are interested in receiving an electronic copy of our final report, please include your email address below

Short answer text

.....

Figure 6: Survey to recruit volunteers for virtual interviews, Section 3 of 3

Appendix E

The image shows a digital form titled "Follow-Up Interviews: Residential Trash and Recycling Disposal Habits Among Lansing Residents Survey". The form is divided into several sections. The first section contains the title and a brief description: "Join a 30-minute interview with the University of Michigan graduate students working on behalf of the City of Lansing. We aim to understand Lansing residents' experiences with the City's recycling program." The second section is a thank-you message: "Thank you for your interest to participate in a follow-up interview. Will will conduct interviews with as many residents as time will allow. Please inform us of when you are available to meet with us before 5:00 pm EST Saturday November 21." Below this is a label "Description (optional)". The third section is a required question: "What is your name and pronouns? *" with a "Short answer text" input field. The fourth section is another required question: "What is your email address? *" with a "Short answer text" input field. The form has a purple header bar and a light purple border.

Follow-Up Interviews: Residential Trash and Recycling Disposal Habits Among Lansing Residents Survey

Join a 30-minute interview with the University of Michigan graduate students working on behalf of the City of Lansing. We aim to understand Lansing residents' experiences with the City's recycling program.

Thank you for your interest to participate in a follow-up interview. Will will conduct interviews with as many residents as time will allow. Please inform us of when you are available to meet with us before 5:00 pm EST Saturday November 21.

Description (optional)

What is your name and pronouns? *

Short answer text

What is your email address? *

Short answer text

Figure 7: Selection Form for Residential Follow-Up Interviews, 1 of 2

...

We will be conducting interviews via Zoom meeting software. A Zoom account is not necessary *
to access the meeting invite. Once a date and time is confirmed, a meeting invite will be emailed
to you directly. Please indicate if you will be accessing the meeting via internet or phone call.

☐ Internet

☐ Phone call

Please select which dates you are available for an interview between 9:00am - 5:00pm. *

☐ Monday November 23

☐ Tuesday November 24

☐ Wednesday November 25

Have you ever had an orange "Oops" tag placed on your recycling bin? *

☐ No

☐ Once

☐ Twice

☐ Three times

☐ My Recycling Cart has been repossessed previously

Figure 8: Selection Form for Residential Follow-Up Interviews, 2 of 2

Appendix F

Residential Trash and Recycling Disposal Habits Among Lansing Residents Follow-up Questions

1. Wondering if you can tell me a bit of background information about yourself, and your role within the Lansing community?
2. Are there any difficult or annoying parts of the recycling process for you? How could we make things better?
3. Has there ever been a time when you had questions or needed to get information about the recycling process? What was that like for you?
4. Have you encountered an “Oops” Tag?
5. What information do you wish you knew about the recycling process, but don't?
6. Anything else you would like to share?

Question to ask in future interviews: What do you do when you are unsure whether to put something in the recycling bin? Please walk me through the last time this happened.

Appendix G

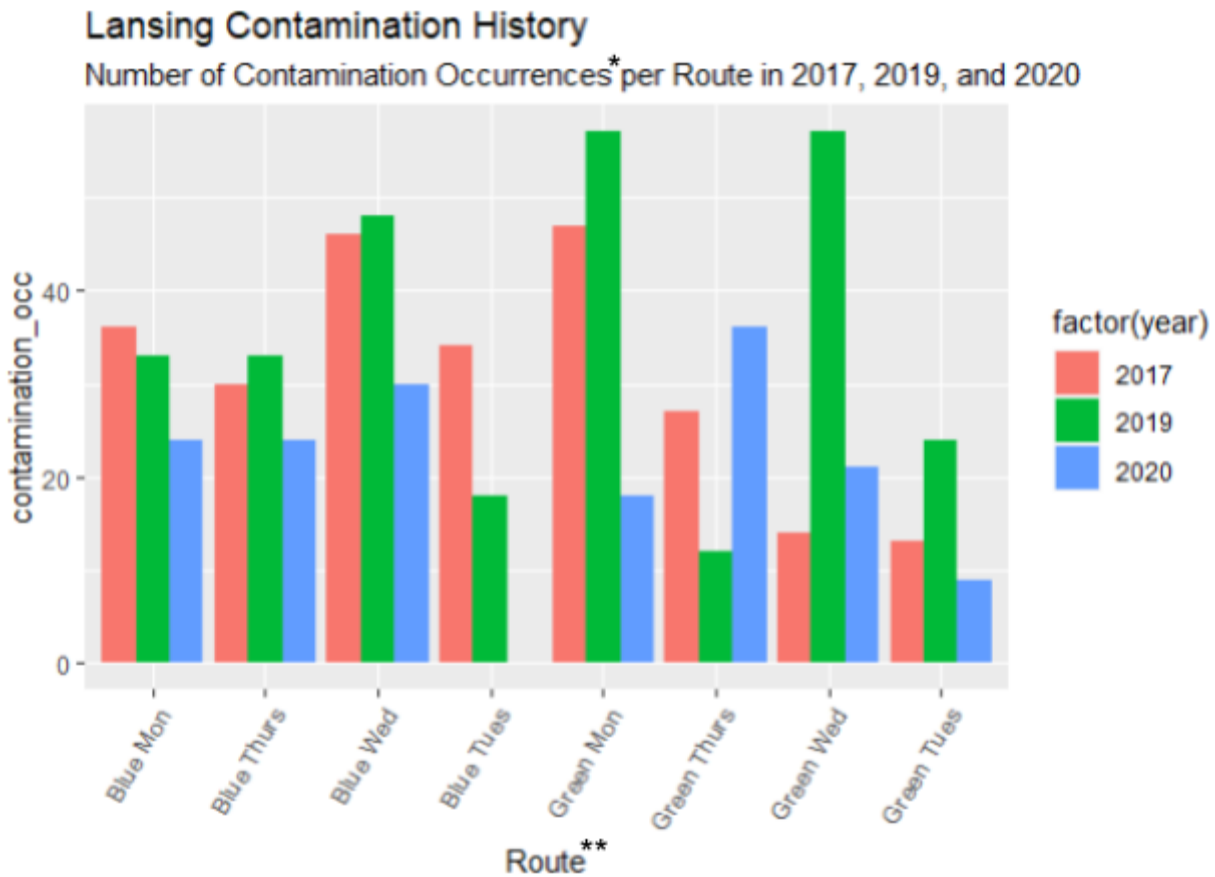


Figure 9: Lansing contamination occurrences by route according to 2017 participation study and residential cart repossession history

**contamination occurrences for 2019 and 2020 estimated based on cart repossession history*

***please note that routes are not displayed in any particular order*

Appendix H

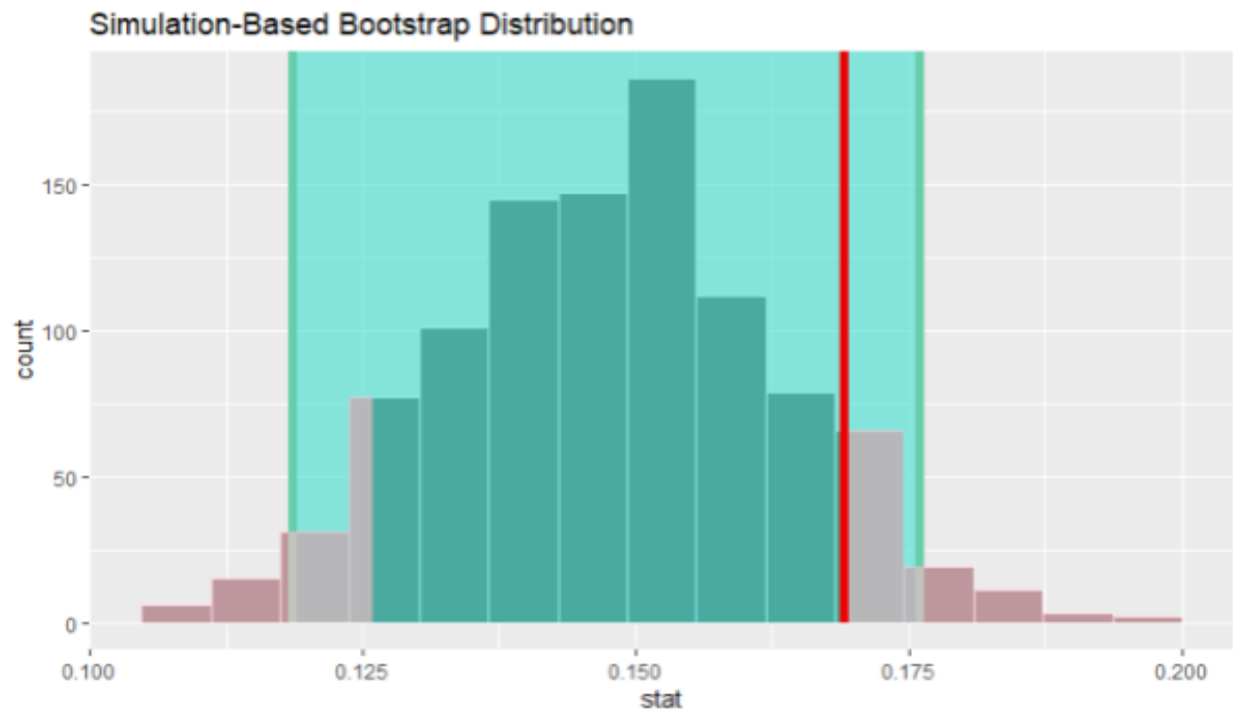


Figure 10: Random simulation of proportion of wishful recyclers (1000 replicates) tested against national inbound contamination rate (16.9%). Red line indicates 16.9%. Results are insignificant (p -value 0.14 > alpha 0.05)

Appendix I

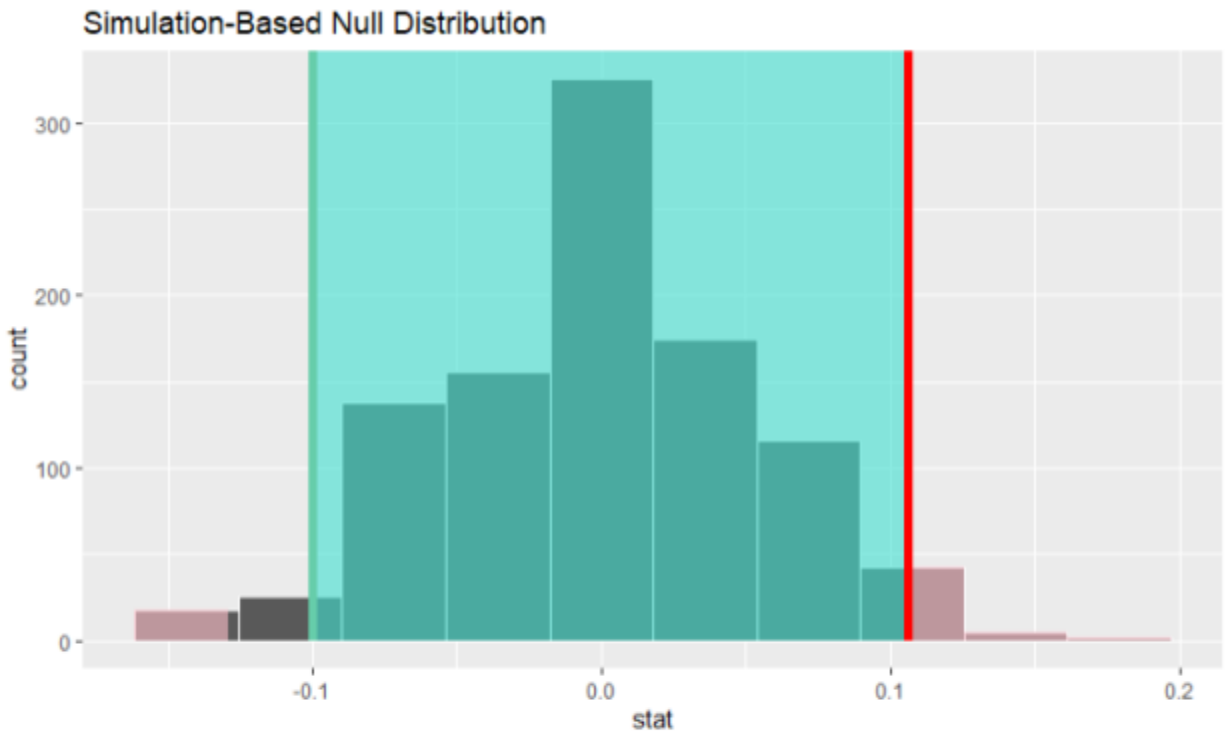


Figure 11: Random simulation of difference in proportions of wishful recyclers and proper disposers (1000 replicates). Red line indicates observed difference in proportions 10.6%. Results are insignificant (p -value 0.054 > alpha 0.05)

Appendix J



Figure 12: Magnet created by new marketing partners and distributed to residents

Appendix K



Figure 13: Recently improved recycling guide distributed to Lansing residents

Appendix L

Problem Addressed: Curbside Recycling Contamination

Residents of the city of Lansing, Michigan sometimes put items in their recycling bins that don't belong there. This can contaminate entire batches of recycling, so it's important that Lansing reduce contamination rates from 14% to below 5%. To understand and solve this problem, we strongly suggest orientating the Lansing recycler in the center of the process.

Research Insights:

"Wishful Recycling" Phenomena
Residents Contaminate Unknowingly
Curbside has limitations of pick-up service
Lansing Recycling Process is a Mystery to roughly 50% of residents

Solution Overview:

Feedback:

Ask questions about the experiences of Lansing residents
Utilize surveys (such as Google Forms, Qualtrics) and interviews (qualitative questions about residents' experiences)

Analysis:

Learn about residents' recycling habits and identify how the City of Lansing could improve resident engagement. Qualitative and quantitative data collected from feedback surveys and resident interviews identify trends, patterns, and outliers.

Response:

Implement identified changes needed in contamination communication (i.e. update resident-facing materials).
(For Model of solution, See Appendix A.)

Suggestions from our research

"When in doubt, throw it out" (for slogan sticker prototype, see Appendix B.)

Well-intentioned Lansing residents often mis-sort recyclables in their recycling bins, which contaminate the entire recyclables materials. Our purpose is to attempt to proactively intervene in contamination by disposing of one item rather than wishful recycling and wasting an entire cart due to contamination. We believe nobody throw trash into recycling bin on purpose, they just not sure about the recycling items, besides some easy to identify recycling items, like yogurt box, bottles and cartons. Based on our data analysis from the 2017 CART Waste Audit Report, we observed that plastic bag and plastic film waste was significant. To better prevent recycling contamination, we recommend residents only throw the 100% sure recyclable items into the recycling bin, and remember the slogan "When in doubt, throw it out".

We think updating Lansing resident-facing materials from three perspectives:

- Digital and paper communication to include infographics of data analysis**
Currently, digital materials including social media, official website, app, and paper materials including newsletter, "Oops tag," are the main resident-facing contents. Add infographics of data analysis to give residents a better understanding of the Lansing recycling process, and become aware of the significant contamination rate of recycling, in order to nudge Lansing residents to take action in reducing recycling contamination.
- Use QR codes to informational videos in paper communications**
The quickest way to deliver visual contents by paper is using the QR code. Due to the limited space available in paper communications, QR codes provide more information than the printed materials, as well as the extensions. Residents could discover more Lansing recycling processes by themselves, in order to achieve the learning process. We redesigned the "Oops" tag and added a QR code to it. (See Appendix F.)
- Video of MRF facility, other videos shared in digital space**
Video is the most easy and efficient way to let a huge amount of audience receive the recycling process information. Graphics is always more intuitively expressing the contents than the text. Especially during the quarantine, and for some respiratory system diseases, or disability people, video tour is a very double and practical way to educate Lansing residents about Lansing recycling process.

Reminders of top 3 contaminants

Based on the 2019 Recyclables Contamination Audit Report and our data analysis, the top contaminants (excluding waste) in 2019 are **plastic and plastic bags, metals, and electrical waste**. According to residential feedback, the top contaminants are **specialty metals and glass, plastic bags, polystyrene foam, and electrical waste**. In both cases, contaminants include items that have the potential to be recycled if taken to a drop-off center. To better remind Lansing residents about these high rate recycling contaminants, besides highlighting these in the resident-facing materials and in the education process, providing the correct drop-off centers to the residents is important. For example, Styrofoam Drop-off centers includes MSU/Recycling Public Drop-off, Granger recycling center and DART foam recycling - EL public works in Lansing, etc., and using QR code to spread these information quickly and easily in order to prevent Lansing resident putting these in to their recycling bin and will contaminate an entire batch of recycling, include their neighbors.

Educate residents on the Lansing recycling process

To educate Lansing residents about the recycling information and the result of not doing recycling correctly. Based on the resident interviews, we noticed that many Lansing residents are not familiar with the recycling process but are willing to learn.

- Relationships between current methods of communication received and preferences were examined based on survey data. In general, the majority of residents' preferences and current receipt of information align (about 57%). Of particular note is the relationship between mailed resources, website resources, and app/social media resources.
 - Mailed contact with residents**
About 40% of residents are currently receiving website resources and prefer mailed resources (however, about 35% of residents are currently receiving mailed resources and prefer website resources). To comply with residents' preferences, sending annual mailers to residents, with reminders of general recycling rules. Each year include the most recent percentage of recycling contamination and tips to reduce it.
 - Social Media Engagement** (See Appendix C)
About 30% of residents are currently receiving mailed resources and prefer social media or app communication.
 - Opportunity for engagement on recent Facebook post: "tell us about or show us your recycling set up in the comments below"
 - Example of longer post: "Nationally, 32% of recycling includes contaminated materials like plastic bags, unwashed plastic food containers, and scrap metal. In 2019, Lansing's contamination rates were around 25%. To Lansing, one recycling cart containing contaminated items means the entire batch of recycling must be wasted and sent to landfill. To reduce this instance, carts are tagged if they contain contaminants. What does recycling contamination mean to you?"
 - Develop a Neighborhood Recycling Ambassador Program for the Recycling program.**
This may help with distributing the information about any judge incentives for the recycling program. May help with on-the-ground content. (See Appendix D)
- 52.62% of respondents reported being unsure of what happens to unwashed recyclables.
 - 47% of respondents are misinformed regarding unwashed recyclables.
- 49.08% of respondents reported being unsure of what happens to recyclable items contained in plastic bags inside the recycling cart.
 - 37% of respondents are misinformed regarding recycled items contained in bags.

(See Survey Analysis Report, Abstract and Conclusion included at Appendix E)

Suggested Next Steps

Run surveys on a bi-annual basis

We suggest sending feedback from residents via surveys on a schedule basis. The "Residential Trash and Recycling Disposal Habits Among Lansing Residents" survey proved to be a useful way of getting quantitative feedback from 564 residents about their recycling knowledge and habits (see Appendix G). In hindsight, we believe this survey was successful because it was distributed by our partners at the City through their strong communication channels (the RecyclingCoach app, community newsletter email list, and social media). The high rate of response suggests that many residents in Lansing are actively engaged with the recycling program and want to improve recycling outcomes for the city. To see the questions that composed our survey, "Residential Trash and Recycling Disposal Habits Among Lansing Residents" (see Appendix H).

Update for next round of surveys

- Zip code, neighborhoods, and/or routes residents belong to to assess patterns and relationships between geographic location and recycling variables
- Add demographic information (age, household size, gender, race, and if children are in the household) to assess patterns and relationships between demographics and recycling variables
- Add questions addressing any new marketing resources. For example, "Have you received a reminder magnet?" "Do you find the reminder magnet helpful?"
- Comparison to statewide recycling data to assess where different factors of Lansing's recycling fall compared to other cities
- Interest in a volunteer program in neighborhoods to determine possibilities and logistics of furthering resident education within Lansing communities
- Level of participation in recycling program to reevaluate participation in recycling program and compare to previous participation studies

Explore Resident Feedback Data Analysis

Previous data collection involving residential participation and contamination rates included input from residents. While this is effective in obtaining objective and unbiased data, it is also important to analyze this data in conjunction with the residential recycling experience. As residents are the ones submitting materials for collection, it is crucial to understand how residents conceptualize recycling, understand city resources, and identify gaps in their experience. This survey was created and distributed in an effort to better the resident's understanding of recycling.

Our survey examined residential experience through the following concepts: residential receipt of city informational resources; typical disposal patterns of a variety of common items; common situations residents experience when recycling; and understanding of contaminant effect on submitted recycling. (See complete Analysis Report or reference correlations in Appendix I)

Interviews

In addition to surveys, which gathered quantitative data for our analysis, our team relied on interviews with residents to gather qualitative data related to individual recycling experiences. These interviews proved very useful to our understanding of the problem space, but we recognize that they can be difficult to facilitate. We gathered a pool of residents interested in being interviewed by following up with survey respondents.

In case Lansing is interested in conducting additional interviews with residents, (see Appendix / "Residents' Trash and Recycling Disposal Habits Among Lansing Residents Survey Respondents Who Were Interested in Follow-Up Interviews"), with a list of residents who we did not have a chance to interview but indicated a desire to participate in a follow-up interview. We have also attached our interview questions. If Lansing is interested in conducting additional interviews, we suggest adding the following question to the list: What do you do when you're unsure whether to put something in the recycling bin? Could you walk me through the last time this happened?

Use of "Oops Tags" for tracking recycling contamination

- One of the Lansing residents we interviewed (and, incidentally, a whole! recycler) mentioned that sanitation workers never actually inspect her recycling bin for contaminants.
- A different respondent similarly, and added that sanitation workers do not get out of their trucks at all, and instead use a crane to empty bins into the truck.
- These findings suggest a need to examine the workflows of sanitation workers to determine whether the process of applying "Oops Tags" to recycling bins is operating as intended. In order to maximize the value of "Oops Tags," we suggest reaching out to the managers of sanitation workers to learn about how and why "Oops Tags" are applied.
- The "Oops Tags" could be used to communicate opportunities for change in recycling habits. Otherwise residents believe they have appropriate habits.

References

- City of Lansing CART and City of East Lansing. *Residential recyclables contamination audit report*. (2019). [url unavailable]
- City of Lansing CART. *2017 Recycling participation rate study*. (2017). [url unavailable]
- City of Lansing. *Wards*. [Data set]. Lansing Open Data.
https://services1.arcgis.com/pNPbgWy7hpfFGWoZ/arcgis/rest/services/Wards_Open_Data/FeatureServer/0/query?where=1%3D1&outFields=*&outSR=4326&f=json
- City of Lansing. (n.d.). [Northeast Lansing Interactive Map]. Retrieved October 14, 2020 from <https://neighborhoods.lansingmi.gov/497/Northeast-Lansing-Map>
- City of Lansing. (n.d.). [Northwest Lansing Interactive Map]. Retrieved October 14, 2020 from <https://neighborhoods.lansingmi.gov/471/Northwest-Lansing-Map>
- City of Lansing. (n.d.). [Southwest Lansing Interactive Map]. Retrieved October 14, 2020 from <https://neighborhoods.lansingmi.gov/425/Southeast-Lansing-Map>
- City of Lansing. (n.d.). [Southeast Lansing Interactive Map]. Retrieved October 14, 2020 from <https://neighborhoods.lansingmi.gov/448/Southwest-Lansing-Map>
- Mouw, S., et al. (2020). *State of curbside recycling report*. The Recycling Partnership.
https://recyclingpartnership.org/wp-content/uploads/dlm_uploads/2020/02/2020-State-of-Curbside-Recycling.pdf
- Northeast Michigan Council of Governments. *Recycling in Michigan: successful recycling programs, best Practices, and diversion potential*. (2016).
https://www.michigan.gov/documents/deq/480235-14_NEMCOG_FINAL_RECYCLING_REPORT_521916_7.PDF
- United States Census Bureau (2020). *Quick facts, Lansing city*. [Data set]. US Census Bureau.
<https://www.census.gov/quickfacts/lansingcitymichigan>