

**Practical Rural Recycling: Intersections of Municipalities, Providers, and Residents in
Rural Oklahoma, USA**

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Abstract

Do the recycling programs that residents are willing to participate in align with the programs that are currently available in rural communities? To answer this question, we have taken a three-pronged approach. First, we investigated barriers to recycling in rural communities located in central and south-central Oklahoma, USA. To do this, we interviewed three city managers and two recycling company managers about the challenges they face when implementing and maintaining recycling programs in rural communities, and analyzed the

interview transcripts to glean insight regarding the eagerness of municipalities and companies to provide particular recycling services to their communities, as well as the challenges and benefits associated with each system. Second, we surveyed residents in the study area regarding their willingness to engage in different recycling practices and analyzed the aggregate responses. Third, we compared the results of the survey with the themes that emerged from the interviews, to determine whether the recycling systems available to rural communities were well-suited to residents' desires and the communities' needs. The results of our analysis reveal several different strategies for improving rural recycling and therefore rural sustainability efforts. These strategies include applying simple, physical solutions to existing recycling systems; adjusting education campaigns regarding single-stream collection to highlight local variability in materials collected; direct reuse of material by the community; and collection of single waste types to promote local industry.

Keywords

Recycling, Waste Management, Oklahoma, Distributed Recycling, Rural Sustainability, Rural Recycling

1. Introduction

Recycling is a commonly known way for individuals to reduce their ecological impact. However, rural communities have less equitable access to recycling than other communities, as there are large regions of the United States where residents must drive over 100 miles to recycle basic household items such as paper and plastic (Eason, 2013). Studies by the Pew Research Center found that roughly 70% of individuals in urban and suburban communities had access to

curbside recycling, while only about 40% of individuals in rural communities had access to curbside recycling services (DeSilver, 2016). These statistics beget necessary questions: why do rural communities lack equitable access to recycling, and, how might this discrepancy be reduced?

Recent recycling policy changes in the People's Republic of China sent ripples through the U.S. recycling industry. China's "National Sword" policy restricts the types of materials that would be accepted as imports into the country, a move that caused many U.S. recycling companies to lose their primary market (Tomasic, 2018). As a result of China's change in policy, many recyclable materials in the U.S. are either piling up in warehouses or being sent to landfills (Watson, 2018; Albeck-Ripka, 2018; Margolis, 2018). When there are items that can be recycled and instead are disposed of improperly or warehoused, the goal of the monofunctional recycling system has been undermined, and all potential environmental benefits are lost. China's new policy has thus threatened the credibility of the U.S. recycling enterprise, as the U.S. default method of being "environmentally friendly" through sending recycling materials to China is no longer an option. Between rural communities' lack of access to recycling and recent changes that have threatened the worldwide market, a study that investigates the efficacy of rural recycling programs and their alternatives seems timely and advantageous.

Oklahoma currently has nine hundred and sixty-six locations that collect some variation of recycling materials (DEQ, 2019). Despite this seemingly large number, there continues to be a disproportionate representation of facilities in counties across the state. Not surprisingly, the Oklahoma City and Tulsa metropolitan areas have the most recycling facilities while the remainder of the state struggles to check the box of providing one service per county.

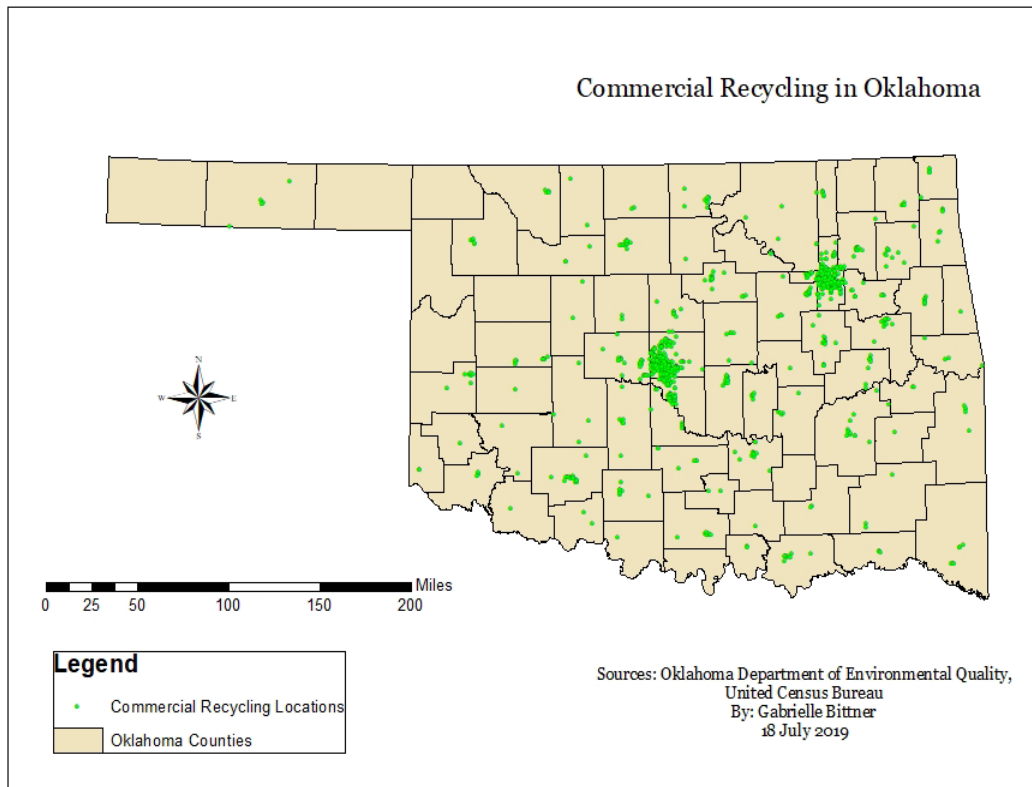


Figure 1. Location of commercial recycling centers in Oklahoma, USA.

In our research the focus was on seven items: Batteries, Cans, Cardboard, Electronic Waste, Glass, Paper, and Plastic. Figure 2 focuses on these items only, with all large businesses and chains eliminated, to focus on the true recycling services that are available to Oklahoma residents. What is depicted in Figure 2 reduces the number from 996 (Figure 1) to 116, 12 percent of the initial total. It is important to note that these locations may collect one or more of the seven items. None of these locations collected all seven items as of the time of the study. The difference between the two maps shows residents' lack of access to item-specific recycling services. Many counties have no locations in Figure 2, which means residents would have to travel to another county to recycle these materials if collection is not offered by their municipality. Clearly, there is a spatial discrepancy in access to item-specific recycling across the state of Oklahoma.

Existing recycling research has often overlooked recycling systems in rural communities in the United States. Research on rural research exists (Tang, Chen, and Luo, 2010; Lakhan, 2015), as does research on recycling in the United States. However, the latter tends to focus on urban and suburban communities (Czajkowski, Kądziałaa, and Hanley, 2014; Pollans, 2017). Recycling research also tends to focus on motivations and ideologies instead of the physical elements of the system itself (Ramayah and Rahbar, 2013; Byrne and O'Reagan, 2014; Saphores and Nixon, 2014; Lee and Paik, 2011; Pearson, Dawson, and Breitkopf, 2012; Tang, Chen, and Luo, 2010). By focusing on logistical challenges in rural communities, this study fills a large gap in contemporary recycling research.

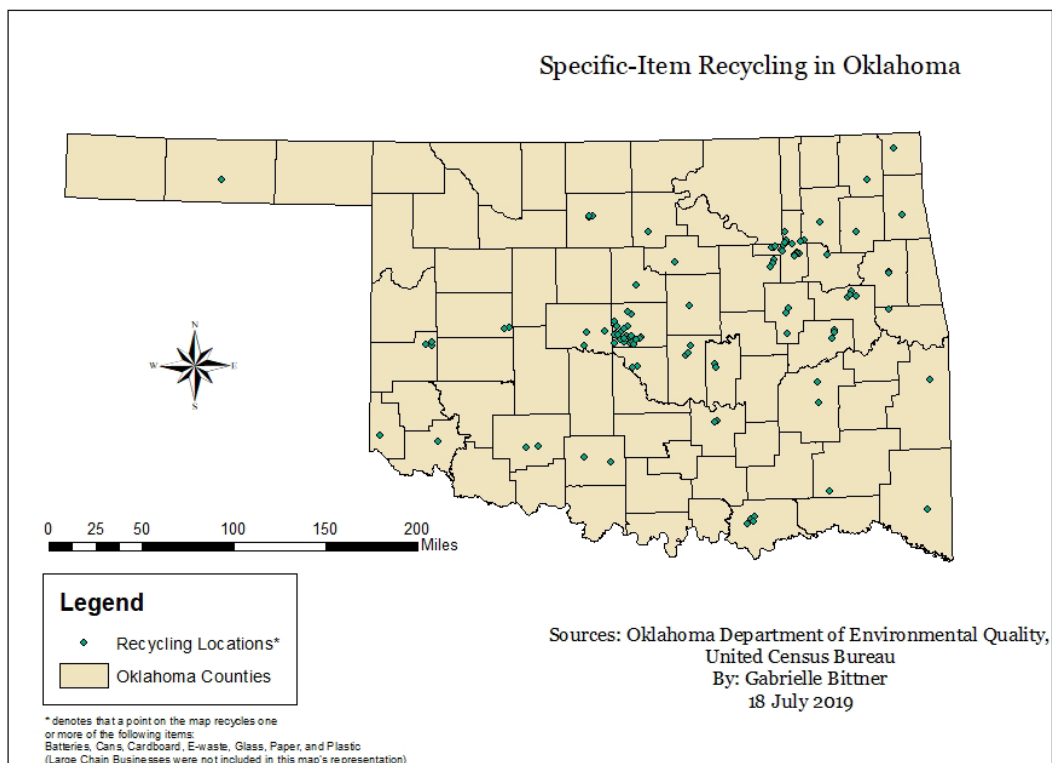


Figure 2. A map of current specific-item recycling in Oklahoma, USA

This study also seeks to counter the common belief that individuals' behavior needs to be changed in order to suit a proposed system. Instead, we seek a respectful, person-centric approach where individuals are treated as persons with valuable insights into their own preferences instead of merely problems to be solved. We aim to encourage municipalities and companies to design recycling systems around user preferences, instead of designing human behavior to fit a given system.

Our primary research question is, "Do the recycling programs that residents are willing to participate in align with the programs that are already available to rural communities?". This leads to other questions that are broken down into three categories: systems, residents, and an integrated category. The first category is concerned with what systems are available. Questions in this category include, "What recycling programs are providers willing to offer to rural communities?", "What programs are rural communities willing to provide to their residents?", and "What do these programs require residents to do?". The second category is centered around residents, including, "What practices are residents willing to engage in?" and "What materials are residents most likely to recycle?". A final integrated category contains questions such as, "Do the practices required by available systems correlate with the practices residents are willing to engage in?", "What sort of recycling program would accommodate these community preferences while still also reducing the amount of waste that the community sends to a landfill?", and "How might challenges that face rural recycling programs be addressed through existing or modified systems?". These three categories of questions are addressed by the three stages of our research methods.

2. Data and Methods

2.1 General Approach

This study was conducted in three stages. The first stage consisted of interviews with city managers and the managers of recycling providers, or waste hauling companies, followed by a qualitative analysis of the interview transcripts and notes. The second stage included surveys with predefined response options that were distributed to residents in the study area. The third stage compared results from stages one and two.

This study utilizes a mixed-methods approach. For looking at barriers to rural recycling, we employed a qualitative data analysis in the context of three case studies. Case studies are not concerned with generating statistically significant results but are instead concerned with investigating a few “instances of a phenomenon” in order to gain greater understanding about the nuances and context of that phenomenon (Baxter, 2016). The results of case studies can be transferable and can be applied to similar situations (Baxter, 2016). For looking at the practices that residents are willing to engage in, we employed a quantitative approach by surveying more than 30 residents in the study area. The combination of qualitative and quantitative approaches leads to a more robust understanding of the present situation Oklahoma.

2.2 Study Area

The study focuses on three towns in central and south-central Oklahoma, USA. This area was selected to balance “rural-ness” with feasibility of data collection. What qualifies an area as “rural” varies, even among government entities. For example, the Federal Office of Management and Budget uses a different definition than the U.S. Census Bureau, and each approach results in different estimations of rural land area (Health Resources and Services Administration, 2018).

For our interpretation of rural, we looked at town size and town distance from major cities. The towns included in this study have populations between roughly 3,000 and 7,000 individuals, and are located at least 40 minutes' drive time from Oklahoma City, the nearest metropolitan center. This proximity made them accessible to the lead author as a student researcher, but—together with their population—qualifies them as “rural”. To provide visual context, representative images of the three towns where interviews took place are shown in Figures 3 through 5.



Figure 3. A community garden next to the City Hall in Town A.



Figure 4. A sign pointing towards a recycling receptacle in Town B.



Figure 5. A neighborhood in Town C.

2.3 Identifying Practices Required by Currently Available Systems

2.3.1 Recruitment

The lead author called the city halls of towns that had populations between roughly 3,000 and 7,000 individuals and were located at least 40 minutes' drive time from Oklahoma City and requested to speak with the person in charge of recycling or waste management decisions for the town. In all, the lead author called nine towns, and three city managers agreed to an interview. The three municipalities overseen by the managers had a diverse range of experiences with the recycling industry. Town A provided no recycling service but had attempted multiple different types of programs in the past. Town B offered drop-off recycling. Town C offered curbside collection. All three interviews occurred inside of the city hall of the municipality.

The approach for recruiting participants from the recycling industry was an extension of the efforts to recruit municipal officials. When contacting the governments of municipalities in the study region, the lead author asked what company (if any) collected their recyclables. This was done to ensure that the recycling industry professionals spoken with were familiar with the challenges particular to the study area. After compiling a list of contacts, she contacted those companies and asked for the manager. In total, three companies were contacted, and two company managers agreed to an interview. Both were regional managers of waste hauling companies with national and international presences. One interview took place in the manager's office, and another took place at a public coffee shop.

2.3.2 Interview Structure

A semi-structured interview instrument was utilized; it is defined as a formal format guideline that an interviewer uses but allows for conversation to stray away from the clear instructions (Cohen and Crabtree, 2008). This format allowed the lead author to approach the interviews with specific topics to pursue, but also enabled her to seek information regarding other topics that arose over the course of the conversations (Jacob and Fergusson, 2012). Questions arose from general background information about the interviewee, town, and area to the challenges the town or company faced regarding rural recycling efforts. This approach provided valuable contextual information and gradually eased the interviewee into more sensitive topics (Jacob and Fergusson, 2012). Four of the five interviews were recorded using a standalone audio recorder. One participant did not grant permission to record the interview but allowed for the taking of detailed notes. After each interview was completed, audio files were transcribed by hand, and notes taken throughout the interview were typed.

2.3.3. Analysis of Interview Data

Interview transcripts and notes were analyzed for prevailing themes through descriptive coding (Cope, 2016). We distinguished between contextual information and information about challenges germane to rural recycling programs, and separated the contextual information into smaller categories, such as information about the town, information about the interviewee, etc. This allowed for more efficacious and agile reference as analysis progressed. The approach for coding for recycling practices required by available systems was as follows: every occurrence of an interviewee mentioning a practice they wish residents would perform was noted, then that desired practice was recorded on a notecard and in a written list (codebook). If a single practice

was mentioned multiple times, tally marks were added to the codebook entries and to the notecards.

To identify more subtle desired practices, interviewees' complaints and frustrations with efforts to implement or maintain rural recycling systems were examined. Recognizing that implicit in a complaint is a desire for a different behavior, interviewees' complaints indicated a desire for new practices or a change to their current system. Each complaint or challenge identified by the interviewee was recorded on a notecard and in the codebook and the same tallying system was employed. After sorting complaints into similar collections, we identified what recycling practices would alleviate the interviewees' concerns based on the source of the complaint.

In addition to marking complaints about resident behavior, we identified the challenges to implementing and maintaining rural recycling systems using the same method noted above (marking explicit and implicit mentions, tallying, and grouping). Recording these challenges provided additional context about what elements the interviewees deemed necessary for a well-functioning rural recycling program.

2.4. Identifying Practices Residents are Willing to Engage In

2.4.1 Recruitment and Data Collection Strategy

To identify the practices that residents are willing to engage in, the lead author surveyed residents of the three towns, as well as residents of neighboring towns. Recruitment took place in two forms: online and in person. To reach residents with an online survey, local organizations such as the municipal government, churches, and libraries were contacted. These organizations were asked to share the survey link in their mailing list or on their social media pages. Of the

thirty organizations contacted, three agreed to help distribute the link. One was a municipal government that shared the link on its Facebook page. One was a church that distributed the link through its email list. The third was a public library that posted the link on its Facebook page. A total of 13 participants took the online survey.

To collect in-person survey responses, the lead author visited public libraries in two of the three towns. She called the library in each town, provided a brief overview of the study, and asked whether they would let her sit for a while and ask patrons to take the survey. Two libraries agreed, while the third discouraged her to come since only a few individuals visited the library over the course of the day, and the librarian did not feel that this approach would be an efficient use of time. Library visits lasted 4-5 hours at a time. When patrons entered, they were asked if they would be interested in taking a short survey about recycling. If they indicated interest, they were read an IRB-approved consent script and then allowed to retreat a short distance away to allow them some privacy as they filled out the survey. Once they were finished, the survey was collected and put in a shoe box. After each data collection session, all data collected was entered into a spreadsheet. A total of 25 survey responses came from in-person data collection sessions.

2.4.2 Survey

The online survey was hosted on a secure website and was nearly identical to the paper survey. The only difference was in response options for three questions. This discrepancy was noticed after the collection occurred, so in our analysis the data for those responses were disregarded.

Survey questions reflected our desire to focus on the practical elements of recycling systems instead of individuals' motivations for or values connected to recycling. Residents were

asked to identify their top recycling priorities for curbside collection, as well as the materials they would be willing to recycle in a drop-off collection system. They were asked how far they would be willing to drive to a drop-off point in different scenarios and how much money they would be willing to pay for different types of recycling services. They were also asked to indicate how willing they would be to recycle if they had to perform certain tasks as part of the process.

All recycling practice-based questions were closed (McGuirk and O’Neal, 2016). This limitation of only allowing one response from a fixed set of possible answers provides for a greater ease of comparison when examining individuals’ responses. These practice-based questions were formulated after completing and analyzing the interviews with municipal and company managers. This allowed us to target the interviewees’ concerns directly, and provided an easy comparison of survey responses with desired practices indicated by the interviewees.

In addition to questions about recycling practices, essential demographic information was collected. This was done to allow for later comparisons of responses between demographic groups. Additionally, we included an inquiry as to whether the individual being surveyed oversaw the recycling decisions for their household. This inquiry was included to ensure that the individual taking the survey truly interacted with potential recycling systems that could be implemented. All but one respondent indicated that they were in charge of making recycling decisions for their household. Data from that participant was withheld from the analysis.

2.4.3 Survey Analysis

Data from the surveys was primarily qualitative. Questions of a quantitative nature had pre-determined numerical ranges as answer options. Therefore, the most effective method for

analyzing the surveys was graphic summaries. Bar charts were generated for each question, which allowed for quick interpretations of results. Differences in demographic groups' responses to survey questions were not analyzed. This study is concerned with large scale-trends, and not with differences between demographic groups. The demographic questions on the survey were included to allow for later analysis, if desired.

2.5 Method for Comparing Recycling Practices

Once the graphic summaries of resident survey responses were complete, we compared the trends in resident survey responses to the desired recycling practices sourced from the interviews with the city and recycling provider managers. First, we consulted the themes that emerged from the interviews, and for each challenge or desired practice identified, we consulted the survey responses germane to that topic. For example, when looking at the complaint of waste stream contamination (and the corresponding desired practice of residents not contaminating the waste stream), we looked at the graphic summary of survey responses to the question "How likely would you be to participate in curbside recycling if you had to separate materials before pickup (ex: placing plastics, metals, cardboard, etc. in separate containers)?" These concepts are connected since multi-stream systems stand as a potential alternative to single-stream systems.

3. Results

3.1 Interview Results

The interviews lasted between ten and thirty minutes. While the interview participants are anonymous, the following table includes contextual information to help characterize them and their experience.

Town Manager A	Retired school teacher; taught vocational agriculture for 30+ years Became city manager out of desire to help hometown Helps run a community garden by the city hall
Town Manager B	Army veteran (25 years) and former police officer Runs cattle ranch outside of town Was chief of police for the town before becoming city manager
Town Manager C	Bachelor's degree in Environmental Design, Masters degrees in Regional and City Planning and Public Administration Has been city manager for the past 10 years
Industry Professional 1	Joined the municipal waste industry in 1993 General manager since 1998 Before joining the waste industry, was a general manager for a company that dealt with processing industrial waste
Industry Professional 2	Manages an area that includes 27 municipalities Passionate about the company's connection with the recycling industry and relationships with local communities Has run several campaigns targeted at reducing contamination of recycling streams in the local communities

From the interviews, we identified four main themes related to recycling challenges: the effects of wind, acceptable materials for recycling and waste stream contamination, market uncertainty, and town size/remoteness from recycling centers.

3.1.1 The Effects of Wind

The first theme is the effects of wind. Oklahoma is known for its ever-present wind, and it poses problems for recycling and trash collection alike as things tend to blow away if not secured properly. When discussing previous attempts to implement curbside recycling, one city manager noted that containers without lids were a serious disincentive.

Town Manager C: "The council said no to recycling because recycling at that time was curbside. It involved putting a small bin next to the curb [...] we didn't want to just have trash blowin' around everywhere."

In another interview, the city manager noted that wind posed a challenge for drop-off containers too:

Town Manager A: "And the main problems I remember is, y'know, that they [the residents] would leave the tops up, wind would come along and blow the newspapers all over the neighborhood."

This challenge proved to be a significant-enough disincentive that the town ceased its efforts to offer drop-off recycling to its residents.

The problem of wind is not exclusive to recycling efforts. City Manager A noted that similar challenges arose with lightweight materials in trash collection. However, these materials could be placed in bags for trash pickup, which would make them far less likely to be caught by the wind and blown around. Unfortunately, plastic bags are forbidden in the recycling waste stream because of challenges at the processing center in Oklahoma City. All of the recyclables in the study area were taken to the same material recovery facility (MRF) in Oklahoma City, even if they were collected by different waste hauling companies. Plastic bags become tangled in the equipment and therefore lead to delays and loss of profit. Industry Professional 2 explains:

Industry Professional 2: "I always say it's like hair getting caught in a vacuum. [...] It gets caught on those cogs at the, at the recycling plant and then they have to um, they have to actually harness over it and stop the machines and pull all those bags out. Bags also get caught in clean recycling and all of that has to go to trash, because it's not cost-effective to stand there and go through all of that."

The MRF's difficulty with plastic bags in their waste streams is emblematic of the larger problem of waste stream contamination, a topic cited by all the interviewees. Contaminated waste streams lead to lower profits for waste hauling companies and MRFs alike because not all material collected is able to be sold. However, residents appear to have extreme confusion about what can and cannot be recycled in their area. Industry Professional 2 explains:

Industry Professional 2: "We [the company] are looking—to educate our cities. Like,

recycle only things that should be recycled. We see all kinds of things when you go to the MRF. You'll see garden hoses; you'll see mattresses; you'll see clothing, I mean, while you can recycle some of those things, not at that MRF you can't."

3.1.2 Acceptable Materials for Recycling/Waste Stream Contamination

This confusion about what materials are accepted in a given location and the resulting waste stream contamination is the second major theme of the interviews. Figure 6 displays a simplified process of operations within the recycling industry. At each step, companies are trying to maximize their profits. This means that each company is calculating what materials it can sell for what price and the cost of collecting or processing those materials. These calculations lead to companies making different decisions about the materials they will accept. Thus, neighboring towns may accept different materials into their waste stream, even though all materials from the various locations will end up at the same processing center. Towns B and C in the study area accepted different materials, even though the materials went to the same MRF in Oklahoma City.

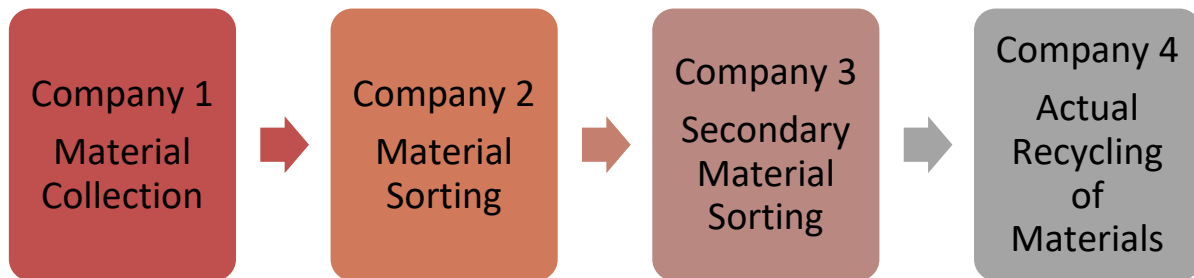


Figure 6. Simplified example of a traditional recycling system, as described by Industry Professional 2.

3.1.3 Market Uncertainty

The third theme that emerged from the interviews is market uncertainty. The country of China, along with general uncertainty about the future, comprised the largest category of concern

mentioned by interviewees. This concern was mentioned seventeen times across the interviews. One industry professional noted that market prices had been variable and unpredictable even before China's National Sword policy, but all interviewees expressed concern about the legitimacy and financial feasibility of their program.

Town Manager B: "There's no use having a recycling program that's not really a recycling program."

Town Manager C: "[We're] trying to figure out just how viable is the program if you don't have a market for your products."

Town Manager B: [speaking of the town's drop-off service, currently offered at no cost to the city] "Whether they'll continue to be able to do that...I don't know. It just kinda depends on if China keeps taking our trash or not."

Industry Professional 2: [speaking of the cost of offering recycling services to rural communities] "I will tell you with, with China Sword though, it has driven the cost up to where it's about the same as it would be to get rid of your trash."

3.1.4 Town Size/Remoteness from Recycling Centers

The fourth theme that emerged from the interviews was the size and distance of small towns from recycling centers, which could prohibit participation in traditional recycling systems (the system detailed in Figure 8 above). Rural towns are farther from sorting centers than other communities because sorting centers are usually located in larger metropolitan centers. This distance leads to increased cost of collection, and the size of the rural towns means that there are not enough recoverable materials to justify that cost.

Industry Professional 2: "We [would] have to have 100% participation... It would not be cost-effective for anybody to do onsies-twosies, because you're still using the gas to go there. You're still using the driver."

In the end, the very nature of rural communities poses a challenge for traditional recycling programs.

3.2 Survey Results

A total of 38 individuals took the survey. Of these, 13 took the online survey and 25 completed the paper survey. Of these 38 individuals, three indicated that they were not in charge of making recycling decisions for their household, and their responses were excluded from the analysis. Twenty-nine respondents identified as White, non-Hispanic. Three respondents identified as American Indian/Alaska Native and the remaining respondents declined to self-identify. Two-thirds of the respondents identified as female, with the remaining third identifying as male, with three individuals declining to respond. Roughly two-thirds of the participants were over the age of 45. The median income range was \$75,000-\$99,999 a year.

Figure 7 illustrates the willingness of residents to recycle if different tasks are required. The darker bar shows willingness to recycle if the individual had to rinse out materials before placing them in the receptacle, while the lighter bar shows willingness to recycle if different materials had to be sorted into different receptacles by the individual. Most residents noted that they were likely or very likely to recycle if these tasks were required.

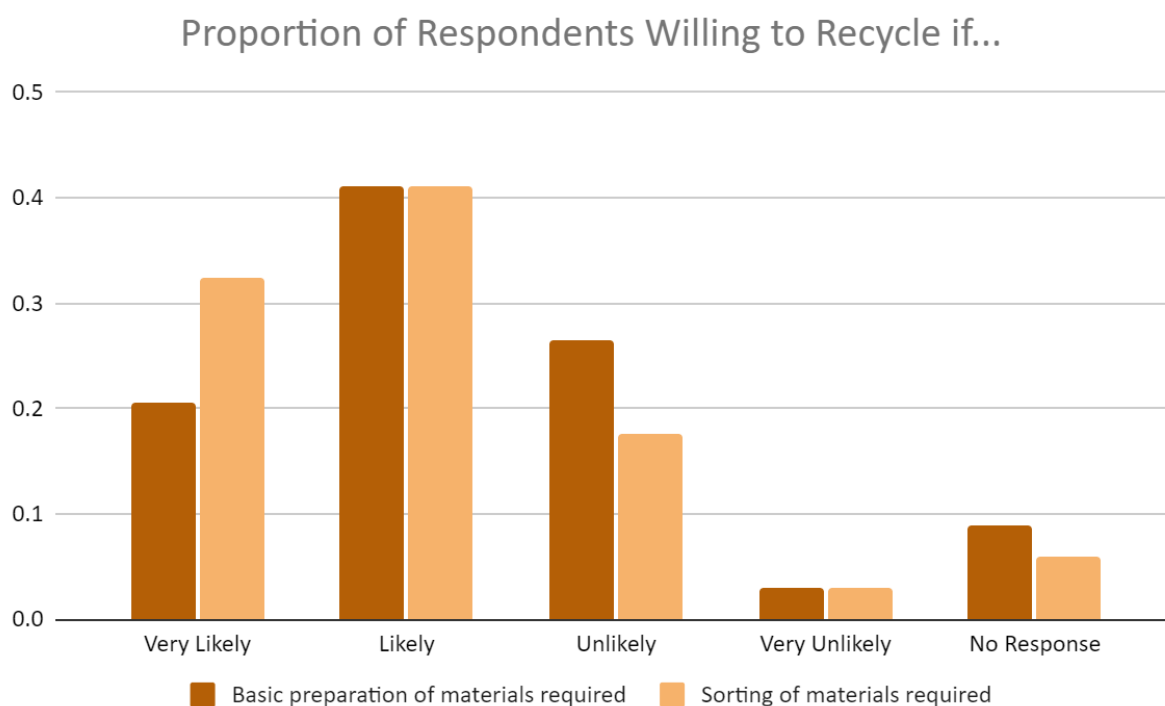


Figure 7. Willingness of respondents to recycle if different tasks required ($n=34$)

Figure 8 shows residents' priorities for material collected in a curbside program. Participants were asked to rank the materials from one to seven. These rankings were averaged and subtracted from the average value of 7 to show the relative importance of each material. . The top three priorities are plastic, cardboard, and glass.

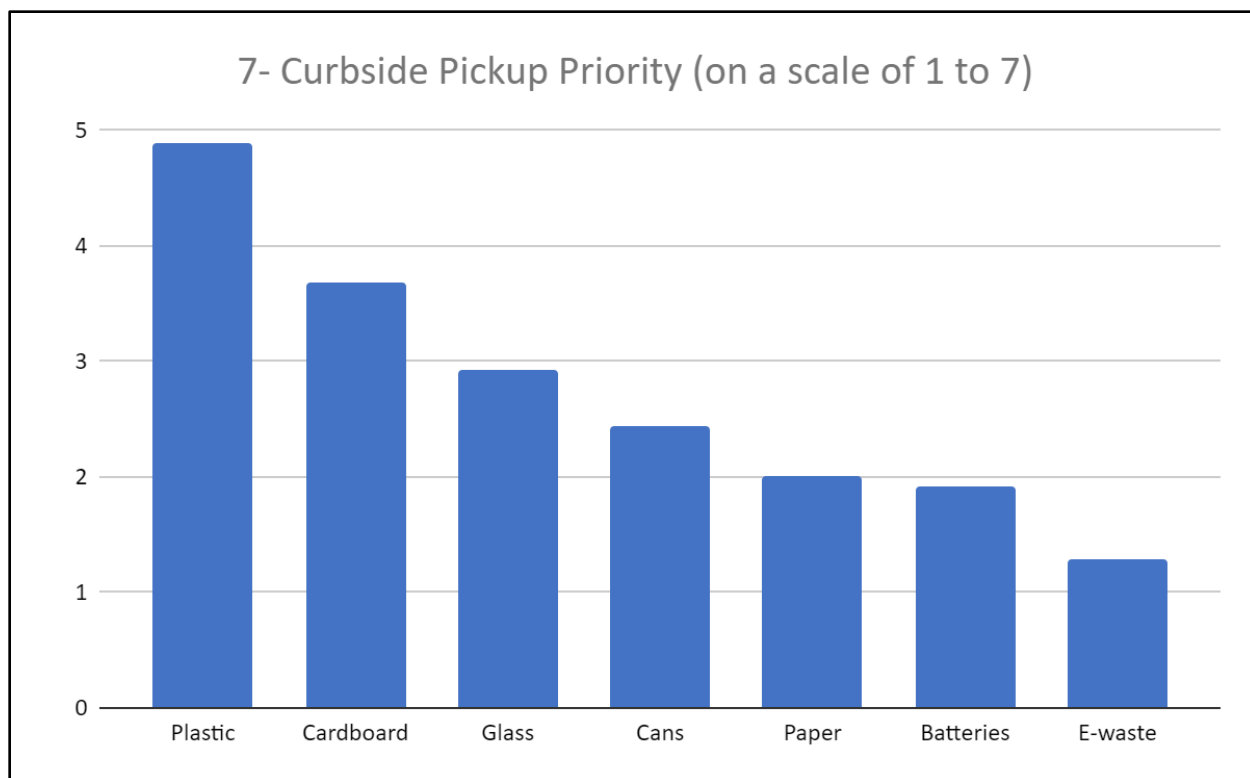


Figure 8. Resident preferences for curbside collection ($n=34$, where 8 respondents did not indicate a priority for any of the noted recyclable items).

A drop-off recycling system requires residents to drive materials to a drop-off point. Figure 9 displays the percent of respondents willing to recycle each kind of material in a drop-off collection system. The percentages do not equal 100 because of values tagged NA due to unclear responses. The figure shows that most residents are willing to drop off plastic, electronic waste (cell phones, computers, tablets, and other electronic devices, paper, and cardboard. Meanwhile, Figure 10 shows the maximum distance participants are willing to drive to deposit materials if a) they are paid for doing so or b) they must pay for the drop-off collection service. The median distance for situation a) is 8-10 miles, while the median distance for situation b) is 4-6 miles.

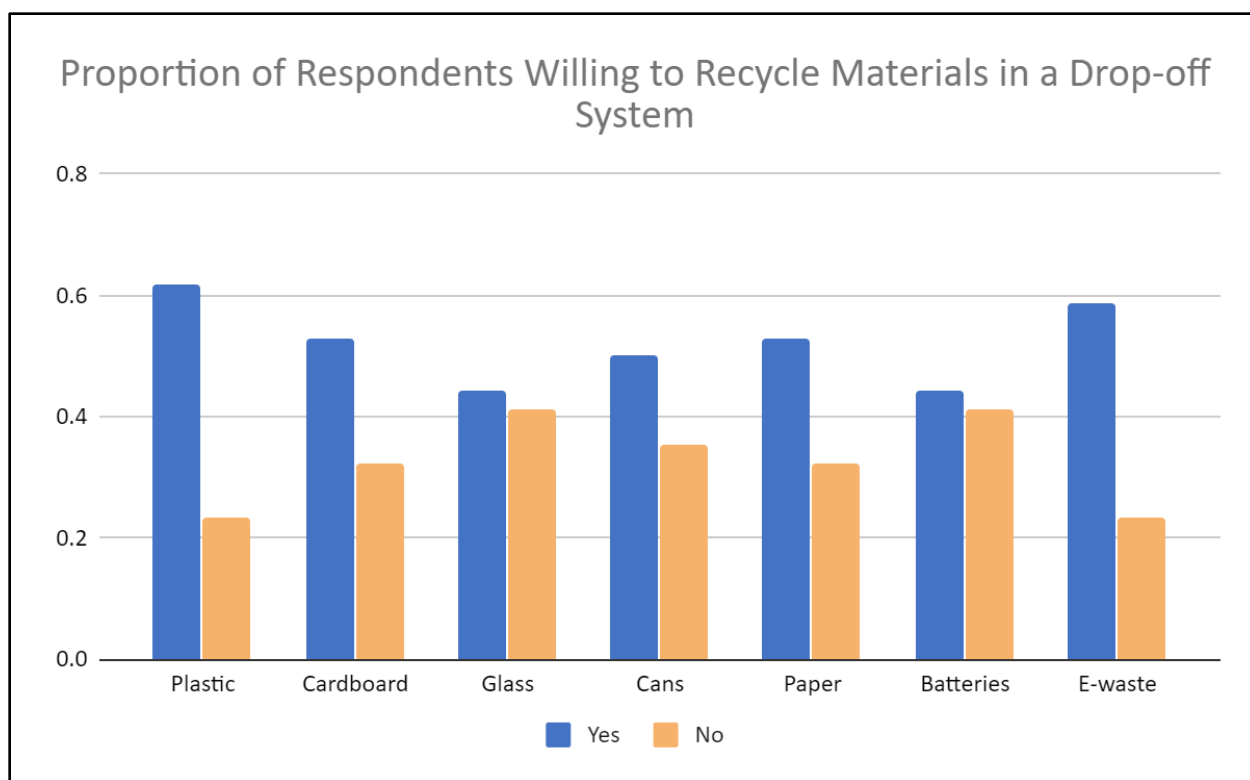


Figure 9. Residents' willingness to recycle various materials in a drop-off system ($n=34$, where NA responses are considered as unwillingness to drop off materials and are therefore included in the "No" category).

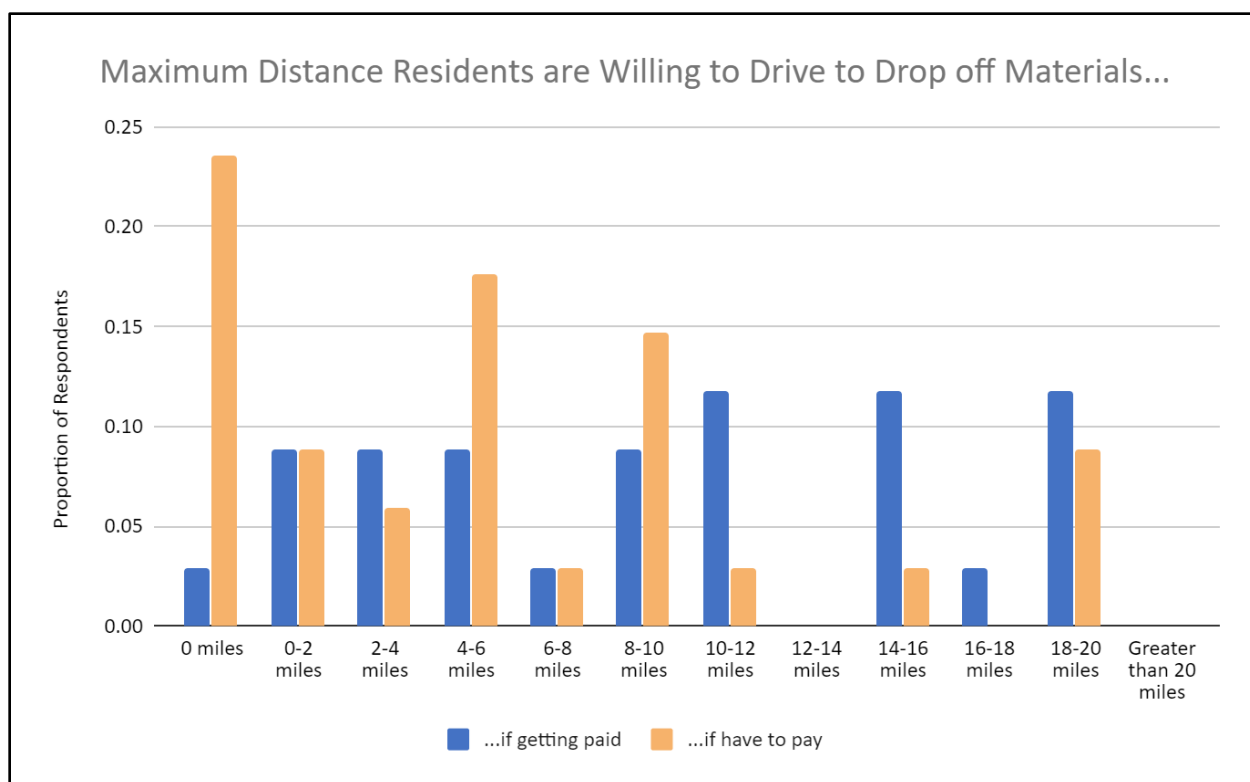


Figure 10. The maximum distance participants are willing to drive to drop off materials in two different cost circumstances ($n=34$, where NA responses are included in the total denominator but are not included in the chart).

Since all recycling programs require funding to operate, participants were asked how much per month they would be willing to pay for different recycling services. The results are found in Figure 11. Interestingly, the trends in the maximum amount of money residents are willing to pay is extremely similar. This indicates little differentiation on behalf of municipal residents when it comes to paying for a specific type of recycling service.

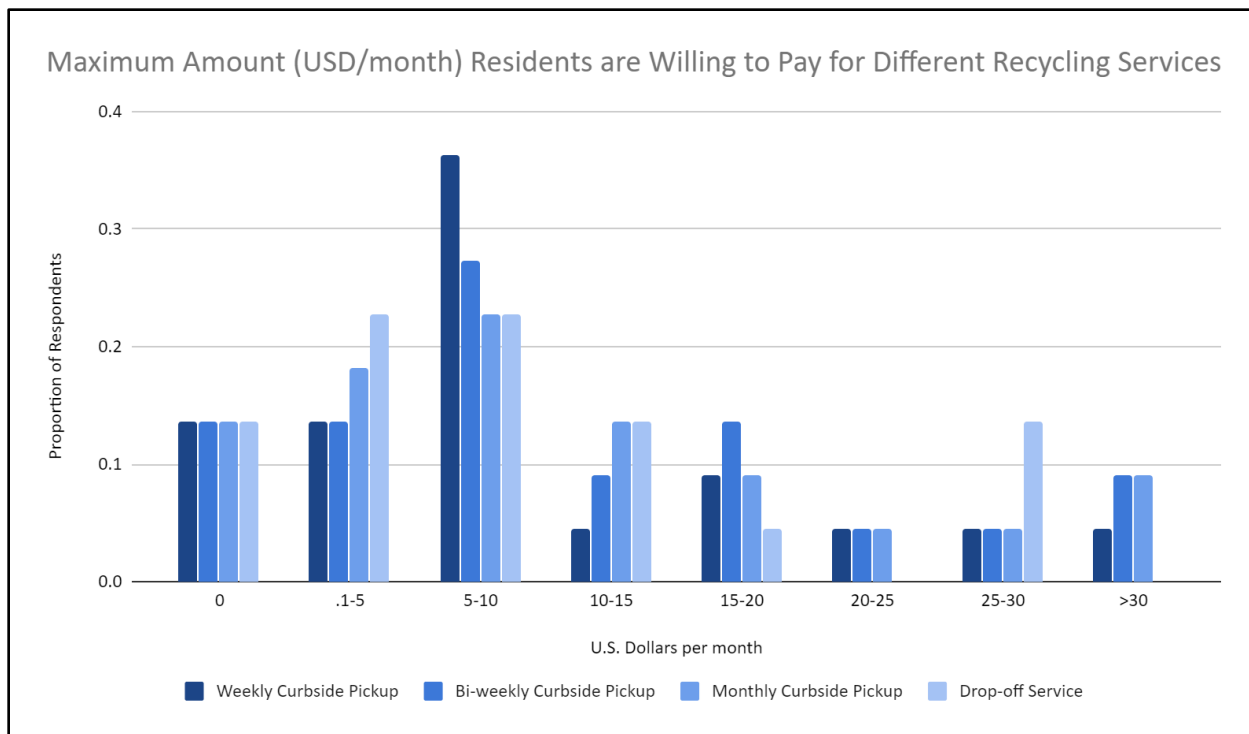


Figure 11. The maximum amount of money residents are willing to pay per month for various recycling services ($n=34$, where fourteen residents chose not to respond).

3.3 Comparing Interview and Survey Results

While the implications of the results from the thematic analysis and survey responses will be explored further in the Discussion section, here we draw direct connections between the two sets of results. Survey questions were designed to correlate with concerns expressed by the city managers and industry professionals in the interviews. For example, interview concerns about waste stream contamination led to the survey question that asked individuals about their willingness to sort materials into separate bins, since a multi-stream system would reduce waste stream contamination. Residents overwhelmingly indicated willingness to sort materials, which makes a multi-stream system a viable option for addressing contamination in rural recycling programs.

Interview complaints about the financial feasibility of programs and the travel distances required to collect materials led to the survey questions about driving distance and maximum willingness to pay for recycling services. Interestingly, participants did not distinguish between types of recycling services in their willingness to pay (Figure 11). This is valuable knowledge for the recycling industry and municipalities looking to finance a rural collection system. As for driving distance, if residents are paid to drop off materials, they are willing to travel a median maximum distance of 8-10 miles, and if they must pay for materials, the median maximum distance they are willing to drive is 4-6 miles (Figure 10). Interview concerns about financial feasibility also led to survey questions about what items residents are most willing to recycle. As indicated above, in a curbside collection program, the top items are plastic, cardboard, and glass (Figure 6), and in a drop-off program, the top items are plastic, electronic waste, cardboard, and paper (Figure 9).

4. Discussion

The city managers and industry professionals in our interviews discussed several potential solutions to the problems they highlighted. The solutions explored here are informed by the residents' responses to the survey. These solutions fall into two categories: solutions within a traditional recycling system, and solutions that exist outside of traditional recycling systems, or alternative solutions. We are defining traditional recycling systems as ones that follow the model described in Figure 6, where one company collects materials and delivers them to another company that sorts the materials (a step that is potentially repeated several times), which in turn delivers them to yet another company that actually recycles the materials. Alternative solutions or systems would be any recycling strategies that exist outside of the traditional system.

4.1 Solutions Within Traditional Recycling Systems

In some cases, solutions can be as simple as adding lids to recycling containers. The City Council of Town C declined to adopt a formal recycling program when the company offered open-top containers because of concerns about wind and resultant litter. However, when the company offered carts with lids, the Council approved the program.

Another solution is the restructuring of education campaigns regarding waste stream contamination and what can be recycled. Industry Professional 2 described an educational campaign targeted at reducing the presence of plastic bags in the waste stream. The campaign was directed at fifth grade students, based on the logic that these students would go home and insist that their parents follow the rules they learned at school. This campaign led to a reduction in waste stream contamination from 26 to 22 percent over the course of four months. Campaigns like the one described by Industry Professional 2 may be effective at reducing a single contaminant, but they are not very transferrable. Residents may become confused when they visit a different town and different materials are accepted. It would be better to craft a campaign that informs residents about spatial variability in what can and cannot be recycled and encourages them to consult local signs or online postings to learn what is or is not accepted in a given area. This strategy would reduce waste stream contamination locally and reduce confusion about what can and cannot be recycled both locally and elsewhere.

4.2 Solutions Outside of Traditional Recycling Systems

In cases where the cost of collection is prohibitively high, alternative approaches to reusing materials could be employed. For example, some materials may be reused directly by the community. The following examples from Town A illustrate this approach, although they deal

with materials not traditionally considered recyclable. Town A did not have a formal recycling service, but the municipal government wanted to reduce the amount of material it sent to the landfill. This was a primarily financial motivation—the less material the town sent, the less money it would have to pay. When the town replaced the pavement of its main thoroughfare, it used the old asphalt chunks to create and refresh gravel roads in the area. The manager of Town A also expressed a desire to obtain a woodchipper so that tree waste could be turned into wood chips that the municipality and residents could use for landscaping projects. While these approaches deal with materials separate from the ones traditionally collected by formal recycling systems, they do reduce the amount of material that ends up in landfills, thereby improving local sustainability. They also represent an interest in the reuse of materials for the larger benefit of the community, something that could be incorporated into approaches dealing with traditional recycling materials.

For other materials, a distributed recycling system may be more appropriate. Distributed recycling occurs at a much smaller scale than traditional recycling. Instead of numerous companies passing materials around a geographically widespread area, distributed recycling consists of one individual, group, or company collecting one specific type of material for personal or commercial reuse. For example, a local business owner may collect plastic from nearby towns for the purpose of breaking it down and turning it into new products for sale (Kreiger et al., 2014). Distributed recycling in theory then could support local businesses, in addition to improving local sustainability by keeping materials out of the landfill. The local buyers and users of materials found in distributed recycling systems also alleviate the concerns many municipalities face about the legitimacy of their recycling program. Because the materials would be processed locally, it would be easy to track them and ensure that they are being

recycled and not just sent to a far-off landfill. Distributed recycling is well-suited for rural communities in central and south-central Oklahoma because of residents' willingness to sort materials into different waste streams. Presumably, residents would not be opposed to setting aside only cans or only plastic for either curbside collection or drop-off at a nearby location.

Distributed recycling also addresses several issues that traditional recycling systems have with specific materials. In some cases, single-stream traditional recycling programs do not want to collect glass because it breaks and presents a hazard to workers who sort by hand (this concern was mentioned by Industry Professional 2). However, glass can be collected by a local entrepreneur for reuse, reprocessing, or sale. This was the case for Ripple Glass, which started out as a Kansas City brewery's effort to keep their bottles out of landfills (Goth, 2019). Additionally, cardboard was cited by Industry Professional 2 as an undesirable material due to how much it breaks down over the course of a traditional recycling system. The material's value at the end of the process is very low as a result. However, in a distributed recycling system, cardboard—which was listed as a top priority for residents in both curbside and drop-off programs—would not have to travel as far and as such would be handled less and would not break down as much. Thus, distributed recycling systems could counter many of the challenges faced by traditional recycling systems and could more effectively fill the needs and desires of communities that are not currently being met by traditional recycling systems.

A significant challenge for distributed recycling systems lies in establishing and financing the systems. Distributed recycling relies on locals using and reusing materials, and these individuals and small businesses may not have the financial capital or expertise necessary to implement such systems. It is possible that federal grants could help initiate these programs

(e.g., BioCycle World, 2014). In any case, some sort of structure would need to be provided to encourage and enable rural entrepreneurs to implement a local collection and processing system.

5. Conclusion

Are the recycling systems available to rural communities in Oklahoma well-suited to the needs and wants of those communities? The answer is “somewhat”. In some cases, small changes to existing recycling programs may enable more communities to adopt them. These changes include strategies such as containers with lids, increased fees for certain collection systems, and education campaigns aimed at informing residents about spatial variability in what materials are and are not accepted for recycling. In other cases—when a town is too far away and too small for traditional recycling programs to work—alternatives such as community reuse of materials and distributed recycling systems may be more appropriate. These strategies—both inside and outside of traditional recycling systems—respect residents’ wants, desires, and inclinations, and offer promising options to communities that want to improve local sustainability by reducing the amount of waste they send to the landfill. Further research should look at the feasibility of implementing these changes and the possibility of alternative strategies in rural communities.

The results of our study could be used by municipalities, the recycling industry, and individuals. Municipalities would have access to greater insight about the recycling practices their residents are willing to engage in and would then be better equipped to make more educated decisions about community-wide recycling programs. The industry could learn how to adjust its current recycling programs to increase the efficacy of their collection of materials from rural communities. Individuals might learn of opportunities to improve their own ecological footprint

or that of their community. Finally, the academic community would benefit from greater discussion about an under-researched area of study: how existing recycling programs meet or fail to meet the needs and desires of rural residents and their communities.

About

This undergraduate research project was led by Sarah Melcher, under the direction of Dr. Randy Pepler and Dr. Angela Person, as part of their Environmental Sustainability Working Group from 2018-2019.

Ethics Review

The study was approved by the University of Oklahoma Institutional Review Board (#9426).

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