

City of Milwaukee:

Impacts of Pay-As-You-Throw Municipal Solid Waste Collection

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Foreword

Students in the master of public affairs program in the Robert M. La Follette School of Public Affairs at the University of Wisconsin–Madison produced this report for the City of Milwaukee’s Department of Administration’s Budget and Management Division. The opinions and judgments presented in the report do not represent the views, official or unofficial, of the La Follette School or of the clients for whom the students prepared the report.

The authors are enrolled in the Public Affairs Workshop, Domestic Issues, the capstone course in their graduate program. The La Follette School offers a two-year graduate program leading to a master of public affairs or a master of international public affairs degree. The workshop provides practical experience applying the tools of analysis acquired during three semesters of coursework to actual issues clients face in the public, non-governmental, and private sectors. Students work in teams to produce carefully crafted policy reports that meet high professional standards within the timeframe of a single academic semester. The reports are research-based, analytical, and when appropriate, evaluative.

This report would not have been possible without the encouragement and leadership of the City of Milwaukee’s dedicated employees. A University of Wisconsin–Madison Engage grant for collaborative work from the Division of Information Technology supported additional costs of this report, including travel costs of meeting with clients. The report also benefited greatly from the support of the staff of the La Follette School. Outreach Director Terry Shelton, along with Kari Reynolds, Mary Mead, and Gregory Lynch, contributed logistical and practical support. Karen FASTER, La Follette Publications Director, edited the report and shouldered the task of producing the final bound document.

This report was generated primarily for the educational benefit of its student authors. The purpose of the project was to improve their analytical skills by applying them to an issue with a substantial policy or management component. This culminating experience is the ideal equivalent of the thesis for the La Follette School degrees in public affairs.

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Executive Summary

This report analyzes the possible implementation of a pay-as-you-throw (PAYT) user fee system for municipal solid waste (MSW) collection in the City of Milwaukee. PAYT collection systems serve more than 25 percent of the U.S. population and more than half of Wisconsin communities. These programs replace flat fees with charges based on the quantity of MSW generated per household. PAYT systems may cause residents to recognize the cost of their individual disposal habits and reduce their waste. Pay-As-You-Throw can also promote behavioral change in the form of greater recycling. Municipalities and residents find these systems to be equitable, since those who generate more waste pay more for collection services. PAYT revenue may also provide financial benefits to the city by fully compensating program costs.

Milwaukee charges each household \$150 per year for MSW and recycling services. This flat rate creates insufficient revenue for complete program cost recovery. Milwaukee wishes to pursue a PAYT user fee system that fully pays for the MSW and recycling programs, particularly as landfill rates charged for waste disposal continue to rise.

Our analysis draws upon research from the U.S. Environmental Protection Agency (EPA), academic studies, City of Milwaukee MSW and recycling data, contacts with MSW equipment suppliers, and a survey of 10 comparable U.S. cities using PAYT systems. We assess three program options for Milwaukee: the status quo, a multiple cart system with pricing based on household waste cart size, and a weight-based program that charges per pound of refuse collected. We examine each alternative based on metrics of efficiency, effectiveness, equity, and ease of implementation to determine which MSW system best suits Milwaukee.

We recommend a weight-based PAYT system for Milwaukee. The weight-based model offers the greatest efficiency and creates the greatest incentive to reduce waste. This alternative also scores highest in equity measures. In contrast, the current system and multiple carts allow greater disparities between the price per unit paid by households with low levels of MSW disposal and the prices paid by those with high levels. The weight-based system also requires less capital investment than a multiple cart system.

We also recommend a series of implementation measures to ease the transition to a PAYT system. Recycling rates rise an average of 16–17 percent in PAYT communities. Increasing the frequency of recycling collection (as recommended in the 2008 Audit of the City of Milwaukee Recycling Program) before PAYT is instituted would prepare residents and city staff before the anticipated increase in recycling. In addition, Milwaukee should conduct a pilot program to review equipment performance, implement new billing software, and gauge program acceptance. Steps to enhance responsiveness to the PAYT program include education and outreach, billing comparisons to show customer savings for MSW reductions, and collection of program feedback from pilot households.

Introduction

This report examines the City of Milwaukee's solid waste and recycling collection structure and fees. Milwaukee charges each household an annual \$150 flat fee for municipal solid waste (MSW) and recycling collection. This fee does not fully cover Milwaukee's cost for providing the services and charges each household the same rate, regardless of the amount of solid waste it generates.

More than 7,000 U.S. communities operate pay-as-you-throw (PAYT) municipal solid waste collection systems as an alternative to traditional flat rates. This report includes a comparative analysis of PAYT implementation and impacts in U.S. cities similar to Milwaukee. The analysis also examines potential impacts of reduced solid waste generation should Milwaukee implement a variable price structure. To evaluate the policy alternatives, the report considers the efficiency, effectiveness, equity, and ease of implementation in the current program, a multiple cart PAYT alternative, and a weight-based PAYT alternative.

Research Question

Which PAYT garbage collection system, that can be practically implemented, most effectively covers Milwaukee's solid waste and recycling costs while equitably charging residents for their solid waste output?

Definitions

The following definitions are used in this report:

- **Bin:** A small container used for recycling collection, typically less than 20 gallons in size.
- **Cart:** A wheeled receptacle used for municipal solid waste, recycling, or yard waste collection. Typical cart sizes range from 30 to 128 gallons.
- **Municipal solid waste (MSW):** Household garbage that is taken to a landfill or incinerator.
- **Pay-as-you-throw (PAYT):** Any MSW collection system that charges users a variable price based on the amount of waste they dispose of. PAYT systems are typically volume-based, but some are weight-based.
- **Recycling:** Any goods accepted by the municipal recycling program. It is illegal to dispose of recyclables in a landfill, although this is rarely enforced (Prohibitions on Land Disposal and Incineration 2008).
- **Tipping fee:** The charge, typically in dollars per ton, for unloading solid waste at a landfill.

Background

Traditional municipal solid waste programs charge households a flat fee for MSW collection and/or include garbage collection fees as part of the property tax levy. The rate per household applies uniformly regardless of the amount of waste generated. PAYT solid waste programs utilize variable rates that charge households for collection based on the amount of MSW they generate. PAYT systems fall into volume-based and weight-based categories, described in the following section (U.S. EPA 2008b).

Volume-Based PAYT Systems

These systems charge variable rates based on the volume of municipal solid waste a household generates. Volume-based PAYT systems commonly take three implementation forms:

- 1. Prepaid bags:** This system uses uniquely colored or marked trash bags for solid waste collection. Residents purchase the bags from the municipality or local retail outlets, and they must place all garbage in these bags. The cost per bag is set to cover all or part of the solid waste collection service plus a small fee for retail outlets distributing the bags.

Advantages: Prepaid bag systems are relatively easy to administer, simple for customers to understand, and provide a strong incentive for customers to reduce their MSW. Prepaid bag systems are compatible with existing billing systems and may allow for the elimination of billing for MSW collection all together.

Disadvantages: Prepaid bag systems are incompatible with the automated and semi-automated MSW collection trucks used by most mid-sized and large municipalities as they require collectors to manually check the bags and load them into the truck. Prepaid bag systems also result in unsteady revenue streams for the municipality since customers may purchase large numbers of bags at one time and then none for a number of months. Non-compliant bags are generally not collected, which can lead to solid waste accumulation for households.
- 2. Prepaid tags:** This system functions similarly to prepaid bag systems, except residents purchase tags or stickers to attach to their own trash bags.

Advantages: Prepaid tag systems have the same advantages as prepaid bag systems with the additional advantage that tags are smaller than bags and easier for retailers to handle.

Disadvantages: Prepaid tags have the same disadvantages as prepaid bags.
- 3. Multiple cart sizes:** This system uses different sized MSW carts and charges residents based on the size of their cart. Most municipalities using this system offer two or three cart sizes, although some offer as many as six. Many communities using multiple carts also utilize a prepaid bag or tag system for MSW items exceeding the cart size.

Advantages: Multiple cart programs are compatible with automated and semi-automated MSW collection vehicles used in many municipalities. In municipalities moving from a single cart program to a multiple cart program, customers are already familiar with how the cart and collection system works. Multiple cart programs are relatively easy to administer once the billing system is established.

Disadvantages: Multiple cart systems provide no economic incentive to customers to reduce their waste unless they can reduce it enough to move to a smaller cart size; this can be partially overcome by offering a large number of cart sizes. The purchase of a large number of carts to implement the program and billing administration can be costly for municipalities.

Weight-Based PAYT Systems

These systems weigh MSW during collection and bill residents per pound of MSW they generate.

1. **Truck-mounted scales:** Most weight-based systems utilize carts and a scale on the collection vehicle. The collection vehicle scans a bar code or radio frequency tag on the cart, weighs the cart as it is emptied, and records the cart number and weight in an on-board computer. This information is then uploaded into the billing system.

Advantages: Weight-based systems provide the greatest incentive for residents to reduce waste, as they can see a clear cost reduction with even small reductions in waste. Weight-based systems are compatible with automated and semi-automated collection vehicles when outfitted with the appropriate equipment. The systems are simple to understand and generally perceived as the most equitable form of PAYT (Skumatz 1995).

Disadvantages: The equipment needed to accurately weigh MSW and bill residents may be complicated and more expensive than other options (U.S. EPA 1994). Additionally, billing administration can be more complex. To date, weight-based PAYT programs in the United States have been limited to a number of pilot programs and a handful of municipalities.

Despite disadvantages in all PAYT systems, numerous communities nationwide have found it beneficial to adopt various forms of these systems to reduce solid waste output, promote greater equity, and increase recycling by residents (Miranda and Aldy 1996; Skumatz and Freeman 2006).

PAYT Links to Recycling

Successful PAYT programs operate in conjunction with comprehensive recycling programs. This allows residents to reduce much of their waste, and therefore their MSW bill, by increasing their recycling rates. The municipality benefits to the extent that recycling lowers landfill tipping fees and potentially increases revenue from the resale of recyclables.

Milwaukee operates a residential recycling program that collects recyclables monthly from the majority of households using 95-gallon carts, although a portion of the city uses 18-gallon bins and receives weekly collection. In 2008, the Milwaukee Comptroller conducted an audit of the city's recycling program at the request of the Common Council. The audit highlighted anecdotal evidence that many households completely fill their recycling carts in less than one month (Morics 2008). This implies that residents have little opportunity to increase their recycling rates under the monthly collection schedule and, as a result, residents may encounter difficulty reducing their MSW output. The audit recommended that Milwaukee conduct feasibility studies of moving to biweekly recycling collection throughout the city (Morics 2008). Biweekly collection allows households that fill their recycling carts before collection to increase their recycling rates. Increased residential recycling presumably results in less solid waste, which in turn results in smaller MSW bills for households under a PAYT program and lower tipping fees for the city.

To implement a successful PAYT program, the city must ensure that residents are able to recycle as much of their waste as possible. Monthly recycling collection provides inadequate opportunity for residents to increase recycling rates. Implementation of a PAYT system should be accompanied with an increase in residential recycling capacity, accomplished through increased collection frequency.

Rationale for PAYT

More than 7,000 American communities operate PAYT systems, covering 25 percent of the population and 30 percent of the nation's largest cities. This has led to the diversion of 6.5 million tons of MSW per year from landfills. Wisconsin ranks among the states with the most communities using PAYT systems, with more than 500 programs (Skumatz and Freeman 2006).

PAYT offers a market-based solution that encourages behavioral changes that serve the public welfare (Folz and Giles 2002). Economists often advocate unit-pricing approaches like PAYT because of their efficiency (Van Houtven and Morris 1999). Residents frequently overuse solid waste services in a flat fee system because local tax levies or flat fees for solid waste collection remain largely invisible to consumers (Van Houtven and Morris 1999). Essentially, flat fees and property-tax-based MSW systems break the link between the act of discarding waste and the payment for collection services. Households face the same cost regardless of how much MSW they generate, with little or no incentive to produce less waste. This can lead people to generate more MSW than they would if charged a variable rate.

In contrast, PAYT systems support efficiency and effectiveness goals by assigning proportional charges to various levels of service. A properly designed unit pricing system charges households based on the amount of waste management services they use (Van Houtven and Morris 1999). Many PAYT systems reduce overall MSW, allowing cities to extend collection routes, reduce the size and increase the automation of truck fleets, and reduce the number of collection crews or crew sizes. Less MSW may also reduce landfill tipping fees and the city's transportation costs and extend landfill life (Folz and Giles 2002). Additionally, PAYT systems promote equity because they reflect individual MSW service usage and enable residents to exercise some control over their solid waste collection costs (Skumatz and Freeman 2006; Folz and Giles 2002).

PAYT systems encourage recycling and composting. According to a Duke University study, communities experience a 20–35 percent increase in the weight of materials going through their recycling and composting programs after implementing PAYT (Miranda and Aldy 1996). Milwaukee's main recycling facility operates at only half capacity, ready to process additional recycling expected under a PAYT system (R. Meyers, personal communication February 26, 2009).

Overall, PAYT provides a link between behavior and bills. Research shows that the average tonnage of waste disposed is 16–17 percent less in PAYT communities than comparable non-PAYT communities, with approximately one-third of this reduction attributable to source reduction, one-third to increased recycling, and one-third to composting. PAYT proves to be one of the most cost-effective methods to promote waste reduction (Harrison 2000).

Methodology

This section describes the methods of our investigation of PAYT programs employed in United States cities comparable to Milwaukee. This section also describes the methods, data, assumptions, and limitations in developing our quantitative analysis of the policy alternatives.

Comparable City Selection

We investigated PAYT programs in American cities that are comparable to Milwaukee to better understand the potential costs, benefits, and other impacts of implementing PAYT in Milwaukee. Identification of eligible cities began with the U.S. Environmental Protection Agency's website, which provides extensive resources on PAYT communities and programs (U.S. EPA 2008a). Initial criteria for comparable cities included populations between approximately 250,000 and 750,000, although a few cities beyond this range were included to broaden the selection, including Eau Claire, the largest municipality in Wisconsin using PAYT.

We also considered racial and ethnic composition, income and poverty data, and the ratio of owner- versus renter-occupied housing when selecting the most comparable cities. Finally, we included climate, particularly annual snowfall, because municipal snow removal equipment and labor needs overlap with that of MSW collection in Milwaukee. The additional data came from the U.S. Census Bureau's American FactFinder webpage (<http://factfinder.census.gov>) and the National Oceanic and Atmospheric Administration Satellite and Information Service webpage (<http://cdo.ncdc.noaa.gov>). From this research, we established an initial sample of 14 comparative cities.

Comparable Cities Data Collection

We collected PAYT program information specific to each city in the sample from each city's official website. We eliminated Eau Claire from the comparison because the city uses a system of multiple private haulers, each offering slight variations of PAYT that would have little in common with a Milwaukee program.

Next, in March 2009, we telephoned individuals working for each of the remaining 13 municipalities. Initial contact targets included directors of public works or solid waste or recycling management departments. If our first contacts were unable to provide specific information regarding PAYT, we asked them to direct us to a source better able to do so. Upon reaching the appropriate contact, we confirmed the details of the city's PAYT program. At this point, we eliminated Albuquerque, New Mexico, because the city's program details did not represent full PAYT implementation, and Oakland, California, due to an inability to access data from the city's private contractor. San Francisco, California, gave no response after repeated contact attempts, resulting in a final pool of 10 comparative cities. Similarities to Milwaukee among the final sample of comparable cities are depicted in Table 1. Appendix A describes the criteria used to determine each city's comparability to Milwaukee in given categories.

Table 1: Responding City Comparison

City	Population	Racial Composition	Median Household Income	Families Below Poverty Level	Owner-Occupied Housing	Climate
Milwaukee, WI	602,782	45% white/ 55% non-white or mixed race	\$35,233	21%	49%	seasonal snow
Most Comparable to Milwaukee						
Fort Worth, TX	Yes	No	Yes	Yes	Yes	No
Lansing, MI	No	No	Yes	Yes	Yes	Yes
Minneapolis, MN	No	No	Yes	Yes	Yes	Yes
Sacramento, CA	Yes	Yes	No	Yes	Yes	No
Moderately Comparable to Milwaukee						
Austin, TX	Yes	No	No	Yes	Yes	No
Grand Rapids, MI	No	No	Yes	Yes	No	Yes
Portland, OR	Yes	No	No	Yes	Yes	No
Least Comparable to Milwaukee						
Plano, TX	No	No	No	No	No	No
San Jose, CA	No	Yes	No	No	No	No
Seattle, WA	Yes	No	No	No	Yes	No

Sources: Barrett (2007), National Oceanic and Atmospheric Administration Satellite and Information Service (2009), U.S. Census Bureau (2005-2007)

We asked our final contact within each city to complete a survey administered electronically using SurveyMonkey (<http://www.surveymonkey.com>). The survey questions were designed to obtain a more detailed understanding of PAYT implementation, effectiveness, and other issues specific to each city. When possible, we created multiple choice questions based on our research of typical PAYT programs in order to make the survey more user-friendly. We also provided opportunities for the respondent to expand on answers in narrative form. Seven contacts responded immediately. The remaining three cities were resent the survey after seven to 10 days passed without response and each city subsequently responded. In total, we received 100 percent survey response from our 10 comparative city sample. See Appendix B for the complete survey and responses.

Milwaukee MSW Generation Distribution

The City of Milwaukee does not collect household level data regarding the amount of MSW residents generate. The finest level of data available for this analysis lists the average weight of solid waste collected per route during an eight-month period in 2007 (City of Milwaukee 2007). These data allow for analysis of routes and provide an overall average MSW weight per household. However, without more specific data, the distribution of average MSW weight per household remains unknown. In other words, we cannot know exact amounts of solid waste each household generates.

The lack of household-level MSW data presents particular problems with regard to the multiple cart PAYT program alternative. Knowing household MSW output allows us to estimate the number of households that will choose each cart size and appropriately set pricing for the different sizes. The lack of data also creates problems in determining an equity index for this project. The equity index serves as a measure of price paid per unit of MSW by households. To overcome these data limitations we made certain assumptions and produced multiple scenarios about the distribution of MSW in Milwaukee (see Appendix C for full details).

Setting Prices for Each Alternative

A program's full cost recovery depends on accurate establishment of prices for MSW collection. Prices represent the total amount of money paid for collection services, whether as a flat fee, volumetric charge, bag or tag price, or a combination of these charges. Costs that need to be recovered include personnel expenses, administrative costs, capital costs, collection expenses, and tipping fees.

Of these expenses, only the tipping fee varies significantly with the amount of MSW collected. To illustrate this, consider two households. One household disposes of 1 pound of waste per week, while the other disposes of 100 pounds each week. Milwaukee's collection costs for both households are the same, but disposing of the waste from the one pound household costs much less than from the 100 pound household. However, Milwaukee's tipping fee constitutes only a fraction of the overall cost of the program.

Given this, we determined that the PAYT alternatives should have a flat base fee with a variable fee added to it. The base prices described in this section partially cover the fixed collection costs to Milwaukee, while the variable fee reflects the amount of MSW disposed as well as some of the fixed costs.

Pricing for the Status Quo was left at the 2009 rate of \$150 per year.

Pricing for Alternative I, Multiple Cart Sizes, was complex. For this alternative, we devised scenarios using the standard deviations described in Appendix C to find the maximum number of households that might change from their current 95-gallon cart to a 32- or 64-gallon cart. We set annual cart prices at \$48 for a 32-gallon cart, \$96 for a 64-gallon cart, and \$144 for a 95-gallon cart; this represents a \$4 difference per month between each cart size. The pricing differential of \$4 per month is low relative to comparative cities but large enough to remain visible on residents' bills. We placed these annual cart prices into a formula established to set the base price assuming full cost recovery. The base price plus the cart price equals the total cost for MSW collection per household.

Establishing pricing for Alternative II, the Weight-Based Program, was relatively straightforward: We placed the base price of \$50 per year into a formula specifying both full cost recovery for the program and the amount of MSW generated each year. The formula produced the price per ton of MSW that the City would charge to customers based on those factors. This price could then be converted into a price per pound that customers understand is more easily.

Sample budget and pricing tables for the status quo and each alternative are presented in Appendix D.

Comparative Cities Analysis

Our survey results from comparable cities show that Milwaukee would be a relative pioneer in choosing to implement PAYT. Few similarly sized American cities with PAYT programs exist. Moreover, we find no PAYT systems in Midwest cities with population, climate, and demographics similar to Milwaukee. Given this, we identified cities using PAYT programs with roughly the same profile as Milwaukee. Although Milwaukee remains distinct within the profile of PAYT communities, experiences with the impacts of other PAYT systems nationwide provide valuable information, as many cities resemble Milwaukee in one or more of the comparable criteria categories (see Table 1 and Appendix A).

Survey Responses

The complete survey and survey responses are provided in Appendix B.

Program Descriptions

The PAYT systems surveyed function under varying conditions. All comparable programs service residential homes. In addition, 90 percent of these municipalities collect MSW from two- to four-unit multifamily residences; 30 percent include PAYT in multifamily homes beyond five units. Approximately 44 percent of the cities have unionized municipal employees. Another 22 percent employ non-unionized municipal collectors, and one-third utilize contract labor.

Eight of the 10 survey cities operate with multiple cart systems. The remaining two cities use bag and tag systems only. Of the eight multiple cart communities, three cities use a three-cart system. Two additional cities began with three-cart systems, then later added 10–20 gallon “micro-can” sizes. Cities most comparable to Milwaukee, where at least four of the six criteria match “yes” in Table 1, include Fort Worth, Sacramento, and Minneapolis. Each uses multiple cart systems.

Many cities using multiple cart systems identified customer choice and a variety of household family sizes as reasons for their cart size offerings. Eighty percent of responding communities identified increasing recycling as a goal tied to their programs. Seventy percent also wanted to increase their municipality’s diversion rates, decrease trash output, and promote equity by charging unit rates with variable pricing systems.

Most comparable cities allow MSW in excess of the cart limit for an additional fee. Three cities require prepaid bags or tags for additional waste. These items are available for purchase at grocery stores or retail outlets. Three other cities collect MSW beyond the cart limit and bill the household for additional service. One city allows bulky waste set outs beyond the cart limit one time per month.

Program Implementations

Two-thirds of the PAYT communities surveyed conducted pilot programs in their implementation process. Examples include a one-year pilot of 3,000 households in Austin and pilots with 17 neighborhoods in San Jose. Full-scale implementation varied by municipality. While Austin used a three year phase-in process for PAYT, five other communities moved directly from pilot programs to full implementation, and three cities moved directly from flat rate systems to full implementation without a phase-in period.

Almost 90 percent of the comparable cities promoted their PAYT programs to residents through education and outreach efforts. Cities used a broad range of techniques, from information included with the utility bill to public service announcements on radio and television, press releases, advertising, and news articles.

Seven cities identified a need for program change in conjunction with or subsequent to implementation. These include the introduction of smaller can sizes and changes such as switching recycling to carts from bins that are unrelated to the institution of PAYT. Six cities required administrative or billing changes for their MSW program. Necessary investments included software purchases; system adjustments for each new can size; expanded customer data, including tracking carts by serial number; and, in some cases, entire billing system overhauls. Specific cost estimates for enacting such changes were not specified by survey respondents and follow-up calls to comparable cities yielded no specific investment amounts.

Program Results

Seven of the 10 cities surveyed report decreases in MSW tonnage under their PAYT systems. Reductions varied in terms of landfilled tonnage and actual MSW collected. For example, Fort Worth reports a 12.5 percent tonnage decline and 25 percent less in MSW collections. San Jose reports average weekly household MSW rates at approximately 96 gallons prior to PAYT and averages near 32 gallons per household after program implementation. Austin reports an initial decrease in tonnage that leveled off in subsequent years. Three respondent cities indicate tonnage rates similar or higher under a PAYT system to that under flat rates. Respondents report total landfill diversion rates from 22 percent in Fort Worth to 52 percent in Sacramento and 60 percent in San Jose.

These findings reinforce research that shows households alter disposal behaviors, purchasing habits, and recycling rates to reduce output with a PAYT system (Skumatz and Freeman 2006). The research and our comparable cities survey show no noticeable illegal dumping or additional littering as a method for residents to reduce the MSW in their carts (Van Houtven and Morris 1999; Skumatz 2008). Instead, the survey shows 80 percent of cities report recycling increases that complement MSW reduction. Fort Worth indicates an average weekly household increase in recycling from 3.92 pounds in 2002 before PAYT,

to 11.59 pounds the year after PAYT implementation, and 13.54 pounds in 2008. Other cities reflect similar results, with recycling tonnage rising from 12,000 tons per year to 40,000 tons per year in Sacramento and a 23 percent increase in Portland. The two municipalities without increases have recycling rates similar to those seen before PAYT.

Some limitations of PAYT systems are apparent in the survey results. Only two-thirds of responding municipalities achieve full cost recovery under their programs. Another 11 percent report higher revenues under PAYT, but fall short of cost recovery, and two cities, or 22 percent, indicate the same revenues now as they experienced prior to PAYT. However, these shortfalls represent a program design limitation and are not PAYT specific. Fort Worth initially experienced some difficulty with full implementation due to the large number of households served. Portland also notes the revenue difficulty for municipalities due to low recycling resale rates in current recessionary economic conditions. Austin finds inefficiency with the additional prepaid bags outside carts, due to incompatibility with a semi-automated collection system. Despite pricing structures to encourage the use of a larger bin size as opposed to extra bags, some residents continue to use additional bags.

Comparative Cities Summary

Overall, the majority of comparable cities with PAYT programs use multiple cart systems. These programs work with union and non-union labor hired by the municipality or a contractor. Sixty percent of municipalities reported a need to retrain collection employees on the new system, which generally included minor actions, not significant investments. Nearly all survey cities took steps to prepare, such as resident education efforts, pilot programs, or both, before introducing PAYT to their communities. Many cities also adjusted their billing systems to accommodate variable pricing, but respondents did not specify adjustments or associated costs.

Once implemented, the comparable cities generally experienced MSW tonnage declines paired with recycling increases. Two multiple cart cities added more cart sizes in later years in the form of 10-20 gallon “micro-cans” in response to MSW reduction trends. Other cities reported only modest gains in terms of revenue and MSW reductions under PAYT, and a few results could be considered neutral. Other limitations under PAYT include insufficient pricing gaps to create incentive for cart size changes and inconveniences from manual pickup of additional bags or tagged items.

Policy Options and Analysis

This section describes the three policy alternatives evaluated in this report: the status quo solid waste collection program, PAYT using multiple solid waste cart sizes, and PAYT using weight-based solid waste collection. The alternatives are analyzed in the context of the evaluative criteria of efficiency, effectiveness, equity, and ease of administration.

Selecting Viable Alternatives

The administrative and equipment capabilities of Milwaukee and information gathered from comparable cities narrow the list of appropriate PAYT policies for analysis. Among specific PAYT options, both weight-based and volume-based systems serve as feasible options.

Within volume-based options, bag and tag PAYT programs are widespread throughout Wisconsin and the United States (U.S. EPA 1999a). These programs offer relatively simple administration and eliminate the need for a billing system (Folz and Giles 2002). However, bag and tag programs require manual collection of MSW to ensure residents' proper use, along with a distribution system through local retailers or the municipality for selling the appropriate supplies. Manual collection aligns best with smaller communities. The largest bag or tag system in Wisconsin operates in Manitowoc, with a population of approximately 34,000; Milwaukee is approximately 18 times larger in population and faces significantly different logistical challenges relative to small communities (U.S. EPA 1999b). Many communities including Milwaukee have moved to automated or semi-automated collection systems to speed MSW collection and reduce potential workers' compensation claims stemming from lifting and moving trash bags into trucks. Bag and tag systems lack compatibility with automated or semi-automated collection vehicles, like those used in Milwaukee. Milwaukee's size and semi-automated collection system eliminate bag and tag programs from further consideration in our analysis.

The remainder of this section compares the City of Milwaukee's current MSW and recycling collection program with two alternatives: a weight-based program and a multiple cart system.

Policy Criteria for Evaluation

The following policy goals guide our evaluation of the alternatives. Appendix E provides a detailed description of the development of the criteria.

- **Efficiency:** An efficient PAYT system diverts the greatest amount of MSW, while charging the lowest possible fee for customers and using the fewest taxpayer dollars in the long run. To evaluate this, we consider capital investments relative to potential savings and new benefits of the PAYT alternatives. Full program cost recovery also serves as an efficiency metric for Milwaukee. We define cost recovery as the percentage of

program expenses paid by program income.

- **Effectiveness:** Guidelines for effectiveness include resident compliance with the collection program. Physical impacts, such as changes in MSW diversion and recycling rates, also measure effectiveness. A more effective program creates higher MSW diversion and recycling rates.
- **Equity:** Equity measures the ability of a program to charge residents based on the amount of service they consume, or, in other words, the amount of solid waste they generate. We defined an equity index to consistently measure the relative fairness of each policy alternative. This index shows the ratio of the prices paid between those that generate the most MSW and those that generate the least. An index of 1.0 indicates the most equitable system possible, where all residents pay the same price for each unit of MSW they generate. By comparison, an index of 2.0 indicates that households generating the least MSW pay twice as much per unit of MSW as those generating the most waste.
- **Ease of implementation:** This criterion examines the administrative requirements of the status quo and alternatives to compare the structural changes and information dissemination necessary for implementation.

We also consider political feasibility in our analysis. Because the City of Milwaukee has expressed interest in a PAYT program, we believe a full analysis of benefits and limitations under various alternatives will yield an acceptable result for the client. Therefore, feasibility discussion within each alternative occurs within the cost and administrative aspects listed in our policy goals, rather than as a stand-alone criterion for evaluation.

Status Quo: Current Milwaukee MSW and Recycling Collection Program

Milwaukee's solid waste program provides weekly collection of refuse from all single-family and multi-family homes with up to four units, totaling approximately 190,000 households. Recycling collection using 95-gallon carts occurs approximately once per month for most households, although 15 percent of households have weekly recycling collection using 18-gallon bins. Households pay a \$150 annual flat fee for MSW and recycling collection, which covers approximately 91 percent of the \$35.7 million combined program budgets for 2009. Milwaukee covers remaining costs through revenue from the resale of recyclables, state recycling grants, and the local property tax levy.

Households place their solid waste in 95-gallon carts, which two-person crews empty weekly using semi-automated collection trucks. The semi-automated system requires operators to connect the cart to the truck, which then automatically empties the cart. Households may request a second cart at no additional charge if they consistently produce more than 95 gallons of MSW per week. Residents may also place up to 4 cubic yards of additional solid waste out

with the cart for collection at no charge. More than 4 cubic yards of waste or large items require special pickup at a \$50 fee. Table 2 depicts the various services and charges under the status quo.

Table 2: Description of Status Quo: Current Milwaukee MSW Collection System

Type of System	Single cart size
Size of MSW Carts	95-gallons
Charge for Single-Cart Service	\$150/year (\$12.50/month)
Charge for Additional Carts	\$0
Charge for Additional MSW (Not in Cart)	\$0 (up to 4 cubic yards/week)
Charge for Special Pickup (Large Items)	\$50/pickup
Charge for Recycling Collection	\$0 (included in MSW collection fees)

Source: R. Meyers, personal communication January 30, 2009

Most Milwaukee households also use 95-gallon carts for recycling collection. These carts have a divided interior for separation of paper recyclables from glass, metal, and plastic recyclables. No set schedule exists, but Milwaukee collects recycling approximately once per month. Approximately 28,000 households use 18-gallon bins for their recycling collection. Bin use occurs in central city areas that have a majority of rental properties and alley pick-up service rather than curbside collection. Milwaukee collects bin recyclables weekly on set days.

Recycling markets continue to experience sharp variability with the recent economic downturn. Milwaukee contracts with Waste Management Recycle America to process and market recyclables at an annually adjusted fee of more than \$40 per ton. The proceeds from the resale of recyclables are split evenly between the city and Waste Management Recycle America. In 2008, the City received resale revenue of \$58 per ton, resulting in a net income of \$18 per ton after paying the processing fee. The 2009 budget figures in Table 3 rely on projected recycling resale revenues of \$40 per ton. Due to recycling resale declines, the City expects zero net revenue after paying for processing. Should recycling resale values drop below \$40 per ton, the total cost and cost per household figures may rise for collection services. However, overall cost savings can still be achieved relative to landfilling as the landfill tipping fee is avoided.

Table 3: Status Quo: Ongoing Income, Costs, and Cost Recovery

Total Income/Revenue	+\$33,165,000
Total Expenses/Costs	-\$36,325,385
Net Income/Loss	-\$3,160,385
Percentage Cost Recovery	91.30%

Source: E. Shambarger, personal communication February 16, 2009; authors' calculations

Note: Assumes standard deviation of 12.00 pounds, municipal tipping fee of \$30/ton, and 0% MSW reduction; see Appendix C for more details

Efficiency: Milwaukee's current system presents several opportunities to improve efficiency. The status quo provides little incentive, beyond offering recycling services without additional charge, for residents to divert more MSW. Households

pay the same flat rate regardless of their waste output. As Table 3 shows, the status quo does not achieve full cost recovery. In 2009, Milwaukee expects \$28.6 million in revenue from MSW user and special collection fees. State recycling grants and the resale of recyclables will generate an additional \$4.5 million. These revenue streams cover approximately 91 percent of the total cost for the MSW and recycling programs, leaving a \$3.1 million shortfall that must be covered by the local property tax levy.

The status quo provides efficiency benefits with respect to financial feasibility. The current MSW and recycling system requires little capital investment, limited to regular annual maintenance and adjustments for existing budgetary considerations.

The loss of value for recyclables due to economic recession and rising landfill fees are unfavorable economic trends that will make full cost recovery less attainable without increases in the flat fee. Continuing the current system rather than adopting PAYT maintains Milwaukee’s reliance on property taxes to balance the MSW budget. Without change, the combination of these two trends may increase pressure on the budget.

Effectiveness: The status quo results in effective resident compliance. Milwaukee experiences no noticeable issues arising from illegal dumping (R. Meyers, personal communication February 26, 2009). However, this alternative shows less effectiveness due to a lack of incentive for households to divert MSW.

Equity: Flat fee MSW systems lack equity. Under the status quo, all Milwaukee households pay the same rate despite the amount of waste. As a result, residents who create little waste pay a higher rate per pound than residents who generate significantly more solid waste. Using the equity index described in Appendix E, City of Milwaukee households with the lowest disposal rates pay a range of 1.5 to 5.3 times as much per pound as households disposing the highest levels of MSW under the status quo. Appendix D provides detailed equity index calculations under different scenarios in the status quo.

Ease of implementation: Milwaukee’s current system requires no implementation changes. Table 4 reflects the potential costs to implementing a different MSW program, but because the status quo is already in operation, there are no upfront costs to this program.

Table 4: Status Quo: Program Startup Costs

New Cart Purchases	\$0
Updated Billing System	\$0
Truck Modification	\$0
Education/Outreach	\$0
Total Startup Costs	\$0

Source: Authors’ calculations

Alternative I: Multiple Cart Sizes

Introduction of additional cart sizes for MSW, with higher prices for larger carts, shifts toward a full cost recovery PAYT system by aligning user fees with the amount of MSW collected. Many possible permutations of numbers of carts, gallon capacity combinations, and fee differentials exist when designing an optimal multiple cart PAYT system. Our peer cities survey shows that eight of our 10 responding cities use a multiple cart PAYT system. Of these, three operate a three-cart model, including Fort Worth and Sacramento, two of the most comparable cities to Milwaukee demographically (See Table 1 and Appendix A). In a three-cart model, Milwaukee would maintain the current 95-gallon carts as the largest MSW size option and as the standard size for recycling at all non-bin residences. Two new cart options include 32- and 64-gallon sizes.

By analyzing average tonnage rates for 2007 summer routes, we estimate a range of multiple cart pricing options. To achieve full cost recovery, we consider several scenarios to reflect data variance and two landfill fee scenarios for Milwaukee. Depending on the variables used, each household choosing a 32-gallon cart pays in the range of \$116 to \$136 annually under the multiple cart system. A household with a 64-gallon cart pays \$164 to \$184 per year. A household with a 95-gallon cart pays \$212 to \$232. These rates consist of a base rate plus a variable rate dependent upon the cart size each household chooses (see Setting Prices on page 9 for base rate details and Appendix C for additional details). These charges are shown in Table 5.

Table 5: Description of Alternative I: Multiple Cart Size MSW Collection

Type of System	Multiple Cart
Size of MSW carts	32, 64, and 95-gallons
Base charge	\$68–\$88/year
Cart charge	32-gallon: \$48/year 64-gallon: \$96/year 95-gallon: \$144/year
Charge for additional carts	Same as cart charge for first cart
Charge for additional MSW (not in cart)	\$3/30-gallon bag
Charge for special pickup (large items)	\$50/pickup
Charge for recycling collection	\$0 (included in MSW collection fees)

Source: Authors' calculations

Beyond the regular cart fees, a multiple cart system commonly involves extra charges for excess waste beyond the cart size. Based on peer city responses and research, we find pricing for additional bags of MSW and special pickups to be critical. Per bag and special pickup pricing may influence the cart size a household selects, and reinforce diversion and recycling MSW behaviors. In this multiple cart model, residents pay a \$3 charge for each 30-gallon garbage bag left outside the cart. Only distinct bags, sold through local retailers, will be collected. We assume that \$1 of each bag's cost will be used to cover administrative costs as well as reimburse retailers for distributing the bags. In addition, excess waste outside the cart, up to 4 cubic yards, costs \$50 per pickup, the same as a special

pick-up request. A second cart costs each household the same amount (base fee not included) as the first cart of the same volume. As an example, a second 64-gallon cart costs \$96 per year in addition to the \$166–\$186 per year for the first 64-gallon cart. Table 6 outlines these charges.

Table 6: Alternative I: Ongoing Income, Costs, and Cost Recovery Projections

Total Income/Revenue	+\$36,386,737
Total Expenses/Costs	-\$36,386,737
Net Income/Loss	\$0
Percentage Cost Recovery	100.00%

Source: Authors' calculations

Note: Assumes standard deviation of 12.00 gallons, municipal landfill/tipping fee of \$30/ton, and 0% MSW reduction; see Appendix C for more details

Efficiency: The multiple carts alternative allows Milwaukee to introduce pricing incentives that influence household disposal behaviors. Using three set monthly rates achieves greater efficiency than the status quo. This alternative requires significant investment in new carts, however, which detracts from efficiency. Current average household MSW rates indicate that instituting a multiple cart system would result in the vast majority of households switching to 32-gallon or 64-gallon carts. This reduces efficiency of the multiple cart system, because significant cart investments will be necessary to meet actual household disposal rates. Most households generate far less than 95 gallons of MSW on a weekly basis (authors' calculations, see Appendix D).

Non-binding price estimates from cart manufacturers Schaefer Systems and Rehrig Pacific Company create the basis for cart investment estimates. Schaefer Systems provides the lower price estimate at \$35 per 32-gallon cart and \$45 per 64-gallon cart. Based on the assumption that households would select the least expensive cart option to meet their MSW needs, we estimate a need to purchase 24,759 to 67,228 of the 32-gallon carts and 107,507 to 165,239 of the 64-gallon carts (see Appendix C). Zero to 15,265 households would keep the current 95-gallon bin. This totals an estimated \$5.7 million to \$9.8 million in capital investment costs for carts alone, using the lowest estimated rates for carts. These costs are reflected in Table 7.

Table 7: Alternative I: Program Startup Costs

New Cart Purchases	\$5,700,000–\$9,800,000
Updated Billing System	\$0
Truck Modification	\$0
Education/Outreach	\$200,000
Total Startup Costs	~\$5,900,000–\$10,000,000

Source: Authors' calculations

Potential exists for modest cost recovery on carts. Milwaukee can eliminate recycling bin costs for several years by reserving the unused 95-gallon carts for this purpose. Milwaukee may also possibly sell any excess cart overstock

back to the product distributor for \$15–\$20 each (Schaefer Systems, personal communication April 3, 2009). Milwaukee could also consider a phase-in period to reduce the financial impact of cart investments in any single budget cycle or consider requiring residents to purchase smaller carts with the recognition that households would recover the cost during the first year of the program.

Effectiveness: A multiple cart system influences household disposal and MSW diversion rates more than the status quo. Multiple carts should garner effectiveness in terms of residential compliance and acceptance because the cart rate remains consistent from one collection period to the next.

Pricing drives diversion rates in this system. Austin uses a \$5 per month gap between cart sizes, which is too small to motivate residents to switch to smaller carts (see Appendix B). Pricing carts and additional MSW services requires balance between incentives and revenues to find the threshold in each community for cart rates.

Equity: Multiple cart options enhance the equity of MSW services. Variable pricing based on household waste output reflects Milwaukee’s goal of equitably establishing an MSW user fee system to a greater degree than the status quo, using common guidelines found in other U.S. cities. This alternative enhances both the process and perception of equity in municipalities. The equity index for multiple carts ranges from 1.22 to 4.40. This ranks more equitably than the status quo under all household disposal scenarios.

Ease of implementation: Switching to a multiple cart system would require few changes in the physical collection process of MSW. This system would require notable changes elsewhere, however. For the multiple cart system to work effectively, Milwaukee would need to implement a bag or tag system for excess waste. This includes establishing a network of local grocers and retailers to sell the bags or tags. Billing administration requires investment for modifications as well, although changes would be minor and would primarily require data input time as opposed to actual software changes (E. Shambarger, personal communication April 13, 2009; D. Rasmussen, personal communication April 24, 2009). Billing needs to reflect extra cart charges and collection fees for up to 4 cubic yards of MSW. We anticipate a need for Milwaukee to hire one additional employee or to train a current employee to manage multiple cart billing. This cost is included in all budget scenarios depicted in Appendix D.

Alternative II: Weight-Based Program

Weight-based programs use technology to measure weekly household MSW disposal. Under this alternative, Milwaukee would contract with a company to install weight measuring scales in the lift mechanism of the current semi-automated MSW and recycling collection fleet. During collection, the truck calculates the MSW cart weight through the load cells outfitted in the lifting mechanism. Radio frequency identification transponder chips or bar code tags are attached to each customer's cart. As the lifting mechanism empties the cart, a receiver detects the cart's identification code and sends the registered weight information wirelessly to a computer in the truck. The computer decodes the identification number into a street address and records the average weight of several readings taken during the collection process (McLellan 1994). The data would be transmitted to Milwaukee's MSW billing system. Overall, this process adds less than 10 seconds to the collection (Luken and Smith 1994).

Unlike the multiple cart system, few examples of weight-based PAYT systems exist. In place of comparable cities data, we rely primarily on research and discussions with equipment vendors to evaluate this alternative. We find that Seattle and Minneapolis are among the most comparable communities with published results of weight-based pilot projects.

Seattle conducted the first weight-based pilot program in two phases during 1989 and 1990, with financing from a U.S. Environmental Protection Agency grant. The second phase of Seattle's pilot used semi-automated trucks, like those found in Milwaukee, and electronic identification tags comparable to technology available today. Weights recorded during collection were included in mock billing given to residents as a supplement to their regular, non-pilot MSW fees. Post-project analysis suggests that households accepted the system change and reduced their MSW rates by an average of 15 percent. This is significant because Seattle already operated under an established multiple cart PAYT system. The published case study identifies weight-based PAYT in Seattle's long-term MSW plans. However, more than a decade later, Seattle still uses multiple carts (Skumatz 1995; L. Skumatz, personal communication April 13, 2009).

Minneapolis conducted a pilot test for weight-based systems in the spring and summer of 1993. They installed weight-reading load cells in the lift mechanisms of their semi-automatic MSW collection trucks and recorded household information with electronic identification software. Minneapolis reported good accuracy and scale reliability in a post-pilot report, but ultimately decided against weight-based PAYT due to the short-term nature of their pilot and concerns about an unfamiliar system creating dissatisfaction for customers (Skumatz 1995).

Loadman On-Board Scales, a company based in Texas, specializes in weight-based equipment for MSW collection and recycling trucks. Their representatives contributed cost and accuracy information used in our considerations. Although the technology continues to develop, details for the weight-based alternative

require some speculation beyond our research and interviews. The basic features of the weight-based PAYT alternative are described in Table 8.

Table 8: Description of Alternative II: Weight-Based MSW Collection

Type of System	Weight-based
Size of MSW Carts	95 gallons
Base Charge	\$50/year
Charge per Pound of MSW	7.7–11.1 cents
Charge for Additional Carts	Charged at same rate per pound
Charge for Additional MSW (Not in Cart)	Charged at same rate per pound
Charge for Special Pickup (Large Items)	\$50/pickup
Charge for Recycling Collection	\$0 (included in MSW collection fees)

Source: Authors' calculations

In contrast with the current flat fee system, this alternative would include full cost recovery as a requirement when MSW collection charges are established. This results in income and revenue exactly equaling expenses and costs as shown in Table 9.

Table 9: Alternative II: Ongoing Income, Costs, and Cost Recovery

Total Income/Revenue	+\$36,448,089
Total Expenses/Costs	-\$36,448,089
Net Income/Loss	\$0
Percentage Cost Recovery	100.00%

Source: Authors' calculations

Note: Assumes standard deviation of 12.00 pounds, municipal tipping fee of \$30/ton, and 0% MSW reduction; see Appendix C for more details

Efficiency: Weight-based PAYT offers the highest incentive for efficiency by tying charges to the amount of household MSW. Charging by the pound provides clear incentives for residents to divert the greatest amount of MSW. We project full cost recovery as a result (see Table 9). Moreover, Milwaukee pays fees to the landfill by the ton. A weight-based system creates consistency between the unit of measure the City charges to residents and pays to the landfill.

Converting to a weight-based program would require capital investments in the loading equipment and software. This would include \$14,500 to retrofit each of Milwaukee's 173 rear-loading MSW and recycling fleet. An additional \$570,000–\$950,000 investment would cover electronic tag installation on Milwaukee's carts (D. Hoven, personal communication April 23, 2009). This totals \$3 million to \$3.5 million for fleet retrofitting, cart tags, and software investments. If Milwaukee refrained from retrofitting its 49 recycling trucks, capital investments would drop to \$2.2 million to \$2.6 million. However, retrofitting the recycling trucks might prove beneficial in the event that Milwaukee needed to deploy MSW trucks for other purposes.

This truck system also requires approximately \$36,000 in expenditures to make Milwaukee's billing system compatible with the weight-based equipment (D. Hoven, personal communication April 23, 2009; K. Klawitter, personal communication, April 24, 2009). In addition, two additional municipal staff positions may be required. These include one billing administrator for the weight-based system and a municipal technician for equipment service and maintenance. The price scenarios in Appendix C include two new employees, paid \$40,000 each annually and the associated fringe costs. Alternatively, Milwaukee may invest in training current employees to manage these functions. For the weight-based system, capital and additional staff investments total significantly less than the multiple cart alternative, although future maintenance costs remain unclear.

Effectiveness: Weight-based systems create little visible change in the physical process of collection services from residents' perspective. The primary concern arises in the need for Milwaukee to explain cost changes, the purpose behind them, and the new billing method to which residents must adapt. Otherwise, problems may surface with resident compliance. Residents may find a different monthly MSW bill unacceptable, compared to a consistent rate under the status quo or multiple cart system. With the proper outreach and education, opportunities under weight-based systems are extensive for diversion and recycling behavioral change. Milwaukee can charge a set rate per pound to achieve greater program cost recovery than under the status quo.

One concern with this alternative is that residents may subvert the weight system by, for example, disposing of MSW in a neighbor's cart. Research frequently examines this concern and consistently finds no evidence of this occurring (Folz and Giles 2002; Morris and Van Houtven 1999; Harrison 2000). Other concerns include "migrating" carts that do not remain with their assigned households. This may be best solved by stenciling the assigned address on each cart, although this complicates reuse of carts at other addresses. Electronic tagging can also tie each cart to a specific household, allowing Milwaukee to pinpoint carts that have been separated from their households. While using electronic tags without stenciling does not allow residents to know if they have their own carts, residents could label their own carts at their own expense.

Equity: In terms of paying for service use, weight-based PAYT programs promote the greatest equity of any alternative, outscoring the status quo and multiple cart system in all but one scenario. The equity index for Milwaukee in the weight-based model ranges from 1.09 to 1.80. In theory, weight-based systems could achieve an ideal 1.0 equity rating, where all households pay the same rate per pound of MSW. However, our pricing operates with a \$50 annual base fee, which makes a 1.0 equity rating unattainable.

Ease of implementation: A weight-based MSW collection system would function nearly identically to the current system in use in Milwaukee. In fact, residents would likely only notice changes in their bills. Under this alternative,

semi-automated trucks would collect MSW from 95-gallon carts. Loadman On-Board Scales sends technicians to install the weighing equipment between the city MSW truck bodies and the lifting mechanism. The trucks weigh the waste as it is emptied into the truck, and the weight is logged in the billing system. Because all MSW can be weighed, no additional fee would be charged for extra carts or for additional MSW outside the cart. Extra MSW would be placed into the household cart, weighed during a second emptying cycle, and included in the total weight billed for that week. Households that regularly generate excess MSW beyond 95-gallons would receive another RFID-tagged cart to save the manual labor of loading extra bags for a second weigh cycle. Single, odd-shaped items that do not fit in the cart, but are not considered laborious special pick-up items, may be collected free of charge once per month. These items constitute only a negligible percentage of MSW collection. Table 8 depicts the various services and charges under the weight-based alternative.

Equipment effectiveness relative to performance certification requirements is a concern with weight-based PAYT. A suburban Minnesota pilot encountered difficulties meeting state-mandated weight accuracy standards with its truck scales. When charging residents per pound of refuse, the scale needs to reflect the same accuracy as the fee structure. Streets on hills or sharply crowned roads may compromise some scale types when tilting more than 3 degrees (Luken and Smith 1994). Loadman On-Board Scales guarantees scale accuracy within a 1.5 percent margin of error. For a home disposing of 30 pounds of MSW per week, this means the scales and recording equipment will register a weight between 29.55 pounds and 30.45 pounds (K. Klawitter, personal communication April 3, 2009). The manufacturer claims that the scales maintain accuracy on uneven surfaces and guarantees the return of equipment failing to meet performance standards (K. Klawitter, personal communication April 3, 2009 and April 24, 2009).

Loadman runs full testing with Bayne MSW collection vehicles, including the TaskMaster and TaskMaster Hi-Lift models used in Milwaukee. With this partnership and equipment familiarity, Milwaukee may avoid some of the implementation challenges other pilot programs faced in the 1990s. Currently, the equipment meets Wisconsin Department of Agriculture, Trade, and Consumer Protection guidelines for commercial maintenance accuracy. The agency's initial equipment test uses more restrictive weight tolerances though, which may require the passage of legislation to allow the equipment's use in Milwaukee. Overriding the initial tolerance does not detract from the regular truck scale performance requirements. The legislative action does, however, create an additional political acceptability consideration for the weight-based alternative.

Weight-based systems also involve greater administrative complexity than the status quo or multiple carts. Weekly variability in billing rates per household requires more attention than a flat rate or established cart rate during the three-month billing accrual period. Milwaukee may choose to adapt the current billing system, similar to the way water meter reading occurs, to accommodate weight-

based billing (D. Rasmussen, personal communication April 24, 2009). This can be accomplished through the Loadman company's software writing capabilities for a onetime fee (K. Klawitter, personal communication April 24, 2009). Rehrig Pacific Company could also replace the current billing software with a web-based system for a \$36,000 annual fee (D. Hoven, personal communication April 23, 2009). Table 10 reflects this and other costs for the weight-based alternative.

Due to the relatively unprecedented use of weight-based PAYT systems, education and outreach efforts to explain the purpose and goals of this system could make implementation easier and enhance the program's effectiveness. Adoption of a weight-based system also would require corresponding changes to Milwaukee's recycling systems, such as increased collection frequency or larger bins, to handle expected increases in recycling volume (Skumatz and Freeman 2006).

Initial startup expenses are lower for this alternative than for the multiple cart alternative. An estimate of program startup costs is provided in Table 10.

Table 10: Alternative II: Program Startup Costs

New Cart Purchases	\$0
RFID Tags for Existing Carts	~\$570,000 - \$950,000
Updated Billing System	~\$36,000
Truck Modification	~\$2,500,000
Education/Outreach	\$200,000
Total Startup Costs	~\$3,306,000 - \$3,686,000

Source: Authors' calculations

Recommendation and Conclusion

Based on analysis of research, comparable cities, City of Milwaukee data, and various alternatives, we recommend the weight-based PAYT system. The weight-based system creates the greatest efficiency and effectiveness with the least equity disparity among our alternatives. While less empirical information exists about the use of weight-based systems relative to other PAYT programs, Milwaukee benefits financially from substantially lower capital investment in weight-based equipment. The weight-based system presents implementation concerns to the extent that it requires more investment in maintenance, in the form of a municipal employee and potential equipment repairs. However, our calculations project that intermittent maintenance, staffing, and billing under a weight-based system require substantially less investment, even over a 10-year time horizon, than the additional millions of dollars in upfront costs necessary to implement a multiple cart system.

To ease the implementation process, we recommend that Milwaukee conduct a one-year pilot program that encompasses approximately 10 percent of the city's collection routes. Pilot programs for various aspects of MSW collection have been used in Milwaukee in the past (R. Meyers, personal communication February 26, 2009). A comprehensive pilot program could verify efficiency and effectiveness of the equipment and billing systems prior to full-scale implementation. Additionally, a one-year pilot would ensure that the equipment functions properly under all weather conditions. The lack of weight-based models and historical PAYT funding opportunities through the U.S. EPA may create possibilities for federal funding to support such a program (See Appendix B, Question 11). In addition, scale manufacturers have an economic incentive to provide equipment on favorable terms or at reduced prices to the extent that successful demonstration may open up new markets for them. Throughout the pilot process, detailed data tracking for waste collected per household will help to inform effectiveness of weight-based PAYT and contribute to Milwaukee's knowledge of MSW and recycling trends in the current flat rate system.

The new and generally unfamiliar weight-based program requires extensive education and outreach to residents to explain the transition to PAYT. These efforts could include information dissemination through billing statements, media outlets, advertisements on buses, and online resources. During the pilot period, Milwaukee might wish to institute a "dual billing" system to show residents their current flat fee monthly rates in comparison to the rates they would pay under a weight-based system. Milwaukee might consider sharing data with residents to show how their amount of garbage compares with other households on their route. Evidence from utility companies shows that social factors, such as neighbor comparisons, can add effectiveness to rolling out new programs. Some systems use graphics included with municipal service bills to demonstrate collection rates compared to the average and to those who throw away the lowest weight of solid waste (Ceniceros 2008; Kaufman 2009).

In conjunction with broad and effective communication enhancing political support for PAYT, some administrative changes can boost public acceptance. Communities attribute actions such as visibly removing the trash fee from the tax levy before imposing PAYT as being key to their success. Other communities attribute their success to receiving input from haulers when designing the PAYT program or using a pilot program or a phase-in approach for the PAYT program (Skumatz 2008).

Implementation of a weight-based Pay-as-You-Throw system will allow Milwaukee to enhance the efficiency and cost effectiveness of its municipal solid waste collection. While the lack of a weight-based operation in the United States creates some concerns, this alternative promotes the greatest equity and requires the least upfront capital investment of the PAYT alternatives. This alternative also meets Milwaukee's needs while making the greatest use of existing equipment and carts. Experts identify weight-based PAYT as the ideal system to reduce MSW generation, increase recycling, and create a sense of personal responsibility for households with respect to their waste. Implementing weight-based PAYT provides a genuine opportunity for Milwaukee to lead comparable cities and the rest of the United States in municipal solid waste service design and delivery.

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Appendix A: Comparative City Selection Criteria

We administered a survey to a sample of 10 U.S. cities with PAYT programs. Within the final sample of responding cities, we denoted in Table 1 whether these cities were sufficiently comparable to Milwaukee based on specific criteria, including population, racial composition, median household income, families below poverty level, type of housing occupancy, and climate. Table 11 depicts the data on which we based our comparisons.

Table 11: Comparative Cities Data

City	Population	Racial Composition	Median Household Income	Families Below Poverty Level	Owner-Occupied Housing	Climate
Milwaukee, WI	602,782	45% white/ 55% non-white or mixed race	\$35,233	21%	49%	Seasonal snowfall
Austin, TX	725,306	64/36	\$48,227	13%	47%	No
Fort Worth, TX	635,612	62/38	\$44,804	14%	59%	No
Grand Rapids, MI	193,671	67/33	\$38,792	17%	62%	Yes
Lansing, MI	115,366	67/33	\$35,990	20%	59%	Yes
Minneapolis, MN	362,513	68/32	\$44,478	16%	54%	Yes
Plano, TX	255,591	76/24	\$79,687	4%	67%	No
Portland, OR	541,550	79/21	\$45,512	11%	57%	No
Sacramento, CA	446,721	50/50	\$48,584	12%	52%	No
San Jose, CA	898,901	49/51	\$76,354	7%	62%	No
Seattle, WA	565,809	71/30	\$56,319	7%	51%	No

Sources: Barrett (2007), National Oceanic and Atmospheric Administration Satellite and Information Service (2009), U.S. Census Bureau (2005-2007)

Cities in Table 1 received a ranking of “Yes” in each respective category if the following standards were met relative to Milwaukee:

- Population: Within 200,000 residents
- Racial Composition: Within 10 percent of white and 10 percent of non-white or mixed race residents
- Median Household Income: Within \$10,000 per household
- Families Below Poverty Level: Within 10 percent of families
- Owner-Occupied Housing: Within 10 percent of owner-occupied housing units
- Climate: Experiences regular seasonal snowfall

Cities that did not match the preceding standard received a “No” in the corresponding category.

Appendix B: Comparative City PAYT Survey Results

To better understand the potential costs, benefits, and impacts of pay-as-you-throw programs, we surveyed 10 U.S. cities that use them: Austin, TX; Fort Worth, TX; Grand Rapids, MI; Lansing, MI; Minneapolis, MN; Plano, TX; Portland, OR; Sacramento, CA; San Jose, CA; and Seattle, WA. They are comparable to Milwaukee in size, population, demographics, and climate. We asked a contact within each city’s government to complete a survey using SurveyMonkey (<http://www.surveymonkey.com>). We designed the questions to obtain more detailed understanding of PAYT implementation, effectiveness, and other issues specific to each city. When possible, we created multiple choice questions based on our research of typical PAYT programs. We also provided opportunities for respondents to expand on some answers in narrative form. This appendix provides the full comparative survey and results.

Each respondent answered every question. The results below indicate the frequency that respondents chose an answer as well as the actual number of times the answer was chosen. The results also include verbatim text that were typed by respondents into “Other” or “Comments” text boxes as well as answers to open-ended questions.

Question 1: What type of Pay-As-You-Throw system is being utilized by your municipality?

Answer Options	Frequency	Count
Prepaid bags	0.0%	0
Prepaid tags	0.0%	0
Multiple cart sizes	80.0%	8
Other (please specify)	20.0%	2

Other:

- Prepaid bags and multiple cart sizes
- All above options are being used.

Question 2: What cart sizes are used in your system? Check all that apply.

Answer Options	Frequency	Count
10 gallon	12.5%	1
15 gallon	12.5%	1
30/32/35 gallon	87.5%	7
45 gallon	0.0%	0
60/65 gallon	87.5%	7
90/95 gallon	100.0%	8
Other (please specify):	37.5%	3

Other:

- 32, 64 & 96 gallon carts
- 20 gallon
- 20 gallon mini-cans. This size is not supplied by franchised haulers and must be purchased by the residential customer

Question 3: Why were these particular cart sizes chosen?

Answer Options	Count
Open ended question	7

Answers:

- Pilot study indicated need for 95 gallon for once/week collection. 60-68 gallon chosen as incentive for reducing waste. 32 gallons tested but we had problems with collection arm in servicing this size.
- 32 gal was std industry garbage can size. We pretty much worked off of multiples or fractions of that, although the Mini-can that was available is 20 gallon and the micro-can size available is 10 gallon
- Standard 32 gallon increments, Manufacturer Availability
- Based on historical volumes.
- Standard sizes used by cities in Bay Area (CA); also sufficient movement between sizes including the “mini” size of 22 gallons - also all still can receive automated collection
- To provide standardized choice along with two frequencies of service (monthly and weekly) to meet a variety of residential needs. Roll carts supplied by the hauler result in a slightly higher cost than containers supplied by the customer.
- It was a good range of sizes to accommodate all sizes of families.

Question 4: Why was the specific number of cart offerings chosen (two cart sizes vs. three sizes...)?

Answer Options	Count
Open ended question	7

Answers:

- Started with 32 gal, 64, 96 for customer choice. Then added mini (20 gal) and micro (10 gal) as folks recycled more
- 32 gallon carts for single person households 64 gallon carts for small families and 96 gallon carts for large families
- To offer a wider range of savings to fit the customers’ needs.
- Because we have found that there is a variety of needs throughout the community due to different family & household sizes, cultural practices, frequency of service, and other factors; and we wish to avoid the practice of extra set-outs when possible. Please note that recycling & yard debris containers are standardized to ONE size (65 gallon roll carts) and all are provided by the hauler.
- We have a variety of family sizes in Austin.

Question 5: Are residents allowed to place out solid waste that does not fit in their cart?

Answer Options	Frequency	Count
Yes, and there is no additional charge	12.5%	1
Yes, but waste must be in prepaid bags or have a prepaid tag on it	25.0%	2
Yes, and residents are billed separately for additional waste	37.5%	3
No, residents must take additional waste to the dump or hold it for later pickup	0.0%	0
No, residents must call for special pickup	0.0%	0
Other (please describe)	25.0%	2

Other:

- No. Residents have the option of placing items that cannot fit into the cart for once monthly bulky waste collection or taking the items to the transfer stations (limited to 2x per month). We do collect items outside of cart the week after holidays.
- Additional solid waste bags can be placed outside of the cart but each bag must have a \$4.00 sticker which can be purchased at area grocery stores. There is an \$8.00 per bag charge for each unstickered bag

Question 6: Why was this specific type of program selected over other Pay As You Throw programs or alternative options? Check all that apply.

Answer Options	Frequency	Count
Compatibility with existing collection equipment	60.0%	6
Ease of implementation	50.0%	5
Accurately charges users for their solid waste output	80.0%	8
Politically feasible	60.0%	6
Other (please specify)	30.0%	3

Other:

- We originally used prepaid stickers for “extra garbage” beyond the cart, but that proved to be a huge hassle.
- Encourage recycling/diversion
- Garbage collection & recycling service is not required for SFR homes unless they are a rental property (all rental property owners & managers are required to provide garbage & recycling to tenants).

Question 7: What were the goals of the municipality in changing to a Pay As You Throw program? Check all that apply.

Answer Options	Frequency	Count
Recovering a higher cost ratio for services provided	20.0%	2
Increasing the solid waste diversion rate	70.0%	7
Decreasing trash output	70.0%	7
Promoting equity for residents by charging per unit rather than a flat fee	70.0%	7
Increasing recycling rates	80.0%	8
Other (please specify)	0.0%	0

Question 8: Approximately how many households are served by the program?

Answer Options	Count
Open ended question	10

Answers:

- 14,750; 55,000; 68,000; 105,000; 130,000; 150,000; 150,000; 175,000; 195,000; 202,000

Question 9: What types of homes are served by the program? Check all that apply.

Answer Options	Frequency	Count
Single family homes	100.0%	10
Multifamily homes, 2-4 units	90.0%	9
Multifamily homes, 5+ units	30.0%	3
Other (please specify)	20.0%	2

Other:

- Multifamily complexes (regardless of the number of units) currently have an option to choose individual carts or common bins.
- Multi-family includes moorages, group homes, trailer parks, congregate care & retirement facilities, etc.

Question 10: What year was the Pay As You Throw program implemented in?

Answer Options	Count
Open ended question	10

Answers:

- 1968; 1973; 1989; 1993; 1995; 1996; 1997; 1998; 2000; 2003

Question 11: Were pilot programs conducted before full implementation of the program?

Answer Options	Frequency	Count
No	33.3%	3
Yes (describe the size and scope of the pilot program)	66.7%	6

Answers:

- 8,000 homes with 32 and 68 gallon containers
- Several thousand homes
- There was a pilot cart program but it was not PAYT. Areas were selected based on varying demographics but all waste was collected with no additional cost.
- From July 1991 thru July 1992 the Solid Waste Department conducted a one year PAYT pilot with 3000 households which tested all elements of the new approach, including different cart sizes and variable rates.

- The program began as part of a federal study to determine the feasibility of cost-per-unit collection systems as opposed to flat rate unlimited services in regard to their potential for limiting trash generation.

Question 12: Was the program rolled out to all participants at one time, or was it phased in?

Answer Options	Frequency	Count
All participants at one time	88.9%	8
Phased in (please describe)	11.1%	1

Answers:

- City Council approved a three year, phased in conversion, of the entire city to begin in 1993. Service implementation began with Phase I in Aug 1993, Phase II in June 1994, Phase III-A in Nov 1995, and Phase III-B in June 1996.
- City Council adopted variable rates in July 1997, and all customers citywide were converted to PAYT in 1997.

Question 13: Was there an education or outreach program targeted at citizens alerting them to the changes in solid waste collection and costs?

Answer Options	Frequency	Count
No	11.1%	1
Yes (describe education/outreach programs)	88.9%	8

Answers:

- Articles in citywide newsletter, press release, website
- Direct mail, print and electronic media advertising
- News articles, water bill inserts, mass mailing
- Bill stuffers and mailers.
- A comprehensive public outreach campaign aimed at single-family households explained the new variable rates being introduced, the new categories of recyclables being added to the services provided, and the benefits of participating. All materials were produced in three languages (English, Spanish, and Vietnamese). The campaign was guided by the information received during a series of focus groups in the three languages, baseline and follow-up telephone surveys, and shopping mall intercept surveys. More than 250 community meetings were held in 1993, and a block leader program and school education program were organized. See EPA case study at <http://www.epa.gov/epawaste/conservation/tools/payt/tools/ssanjose.htm>
- At the time of implementation, we were bringing several complementary programs on-line. We were adding materials to our curbside recycling program, and expanding our yard trimmings program. Educating the public about PAYT was a comprehensive, multi-media approach to information which included paid advertisement and inserts about program guidelines in the Austin American Statesman, 14 billboards around town

with program guidelines, utility bill inserts about the new extra garbage stickers, radio advertisements and press releases about the message “Recycle or PAYT, it’s your choice”, direct communication with neighborhoods and new neighborhoods as they were added to the program, door hangers with program guidelines, and bi-monthly newsletters to neighborhood associations, and presentations at neighborhood meetings. To keep awareness of the new program high, messages using the tagline “Recycling Right” and “Take the bin to the curb” were also run during the early stages of the implementation.

- Mailings and school students and advertisements.
- Media releases and mailings

Question 14: Have there been any significant changes to the program since its original implementation?

Answer Options	Frequency	Count
No	30.0%	3
Yes (please describe)	70.0%	7

Answers:

- Introduced mini can and micro can after initial rollout
- Changed from bi-weekly to weekly.
- No longer offer 128 gallon cart, now offer 22 gallon cart
- Residential solid waste collection has been a franchised service historically in Portland. With the mandate that recycling be available to all residents, there have been multiple changes to the Portland Recycles! program with pilot programs and ongoing training & educational outreach to residents and businesses.
- Garbage collection rates and extra garbage fees have gone up over the years, but recycling is still included in the base rate at no extra charge. Garbage collection is now fully automated. We have just over the last several months switched from the bin system for recycling to a 90 gallon cart based single stream recycling program. We accept more materials in the recycling program and materials can all be co-mingled in the recycling cart.
- The addition of various sized carts was implemented in 1997. 21/32/65/95 gallon carts.
- Added the refuse cart program (various sizes). Added appliance stickers and bulk sticker items.

Question 15: Were major changes to the solid waste billing or administration program required with implementation of the PAYT program?

Answer Options	Frequency	Count
No	40.0%	4
Yes (please describe)	60.0%	6

Answers:

- Each time we added a size of can, we needed to modify the billing system
- Varying pay rates had to be set up, cart tracking by serial number, new customer service tracking program implemented. The PAYT started at the same time the City of Fort Worth took control of customer service for solid waste collections; this was previously a function of the collections contractor.
- Setup billing system and expand data on customer base.
- Software required to bill residents appropriately
- Our rates are adjusted annually through review by independent economists, and the most recent (2008) change to the recycling program (mandating hauler-provided roll carts for recycling & yard debris collection) resulted in a significant increase in residential rates and tipping fees (commercial rates are determined by the hauler & business customer in a non-franchised system).
- Prior to implementing variable billing rates, the City of Austin had to update its entire billing system.

Question 16: Did implementation of the PAYT program require retraining of solid waste collectors?

Answer Options	Frequency	Count
Yes	60.0%	6
No	40.0%	4

Comments:

- A little bit when we introduced semi-automated carts
- All services are contracted
- City collects single family residential and some commercial customers.
- Likely to some degree but still mainly just emptying carts regardless of what's in them.

Question 17: Which statement best describes the status of solid waste collectors in your municipality?

Answer Options	Frequency	Count
Unionized municipal employees	44.4%	4
Non-unionized municipal employees	22.2%	2
Unionized contract employees	22.2%	2
Non-unionized contract employees	11.1%	1

Comments:

- Private franchised haulers
- They have the option to join the Municipal Employees Union which offers membership to all municipal, federal, state and county employees. Membership dues are deducted from employee paychecks.
- Private haulers are permitted to acquire as many customers as they would like, no franchise agreements and these are almost all non-union employees that the municipality competes against. There are also no requirements on the days that areas are served. As a result there are many trucks in many areas on different days. We are working toward improving that as we write.

Question 18: Per capita solid waste (garbage) tonnage collected has...

Answer Options	Frequency	Count
Increased	10.0%	1
stayed the same	20.0%	2
Decreased	70.0%	7

Please describe magnitude of change:

- Have relatively few residents that have elected to participate with smaller container and lower fee. 68 GAL CARTS - 3,612; 95 GAL CARTS - 65,349
- Overall recycling rate across all waste streams has gone from 24% to 48.4%. Increase is even greater for single family sector - now reaching near 60% recycling. This is due to introduction of curbside yard waste and curbside recycling collection as well as PAYT
- Based on the information available the total tonnage was reduced by about 12.5% & garbage collected was reduced by about 25%
- disposal has decreased with recycling increasing significantly, from 12,000 tons per year to over 40,000 tpy
- Prior to PAYT and the cart-based recycling program, residents set out an average of three 32-gallon garbage carts per week. Now approx. 80% have one, 32-gallon garbage carts.
- Unclear at this time - not enough data. Overall our recycling rates have increased from mid 40 percentile in mid-90s to 63% in 2007.
- Solid Waste Services tracks performance measures by residential customer account, or household, not per capita. Our per household garbage tonnage

decreased since the beginning of the program, and then has leveled off and stayed consistent since.

- For the city crews, we are not aware of the private sector experience. They own the landfill, we pay to tip there.

Question 19: Per capita recycling tonnage collected has...

Answer Options	Frequency	Count
Increased	80.0%	8
Stayed the same	20.0%	2
Decreased	0.0%	0

Please describe magnitude of change:

- .0194% increase
- City -wide all waste streams we are at 48+% recycling as of 2007
- 02-03 - 3.92 pounds per household per week 03-04 - 11.59 pounds per household per week Last year 13.54 pounds per household per week
- Increased from 12,000 tpy in 2000 to 36,000 tpy in 2004 to a little over 40,000 tpy in 2008.
- The volume of recyclables and yard trimmings being collected more than doubled the levels recorded prior to the cart-based recycling program and PAYT.
- Solid Waste Services tracks performance measures by residential customer account, or household, not per capita. Before PAYT implementation, tonnage was low but increasing. Since implementation, levels have been static

Question 20: Solid waste (garbage) diversion rates have...

Answer Options	Frequency	Count
Increased	77.8%	7
Stayed the same	22.2%	2
Decreased	0.0%	0

Please describe the magnitude of change:

- Residential diversion increased from 39.8% to 41.1%. This number includes yard trimmings composting, HHW recycling and reuse, electronic recycling and appliance recycling.
- up to 48+%
- 02-03 diversion rate was 5.48% 03-04 diversion rate was 19.3% The last couple of years we are running between 22 & 23%
- Currently at approximately 52%
- Diverted 60% in 2006 and 44% in 1995 according to the CIWMB (<http://www.ciwmb.ca.gov/LGTools/mars/JurDrSta.asp?VW=In>)
- Solid Waste Services defines diversion rate as the amount of yard trimmings and recyclables diverted as a percentage of the total amount of garbage, recyclables, and yard trimmings generated and collected through weekly curbside pickups. Through the PAYT program and enhancements

to the curbside recycling program, the diversion rate went up and has, with minor fluctuations, remained constant over the last twelve years or so.

Question 21: Has there been any noticeable increase in littering or illegal dumping since implementing the PAYT program?

Answer Options	Frequency	Count
Yes	0.0%	0
No	100.0%	10

Comments:

- Littering/illegal dumping is a chronic low-level problem, but has not gone up w/ PAYT
- We opened citizen drop off stations along with the start of the PAYT program and have actually had a decrease in illegal dumping.
- In the beginning we did have instances where extra bags came from neighbors, but that leveled off.

Question 22: How has PAYT impacted solid waste revenues? Check all that apply.

Answer Options	Frequency	Count
The program is at full cost recovery	66.7%	6
The program is at less than full cost recovery and revenues are higher under PAYT than previously	11.1%	1
The program is at less than full cost recovery and revenues are the same under PAYT as previously	22.2%	2
The program is at less than full cost recovery and revenues are lower under PAYT than previously	0.0%	0

Comments:

- We have a profit sharing contract for our recycle processing and the revenue generated depends on the market. The last two quarters have seen drastic drops in commodity prices and our share of the revenue.
- Recycling is subsidized by payment per ton by the processor.
- Check back later
- We are an enterprise fund and through the rates that we charge our customers, we generate excess money that goes to the general fund. Also, with PAYT we realize more money through charging for larger carts, extra carts and collection of extra garbage.
- Just barely coming out even.
- The refuse program is supplemented by a refuse millage

Question 23: Please describe any unanticipated problems or difficulties with the Pay As You Throw program.

Answer Options	Count
Open ended question	9

Answers:

- None (x4)
- Contamination in recycling is high. Full implementation at one time was difficult due to the number of households.
- The cost savings are not difficult for the customer to see.
- Sustained economic downturn has affected recycling markets - recycling subsidizes residential garbage rates in Portland, and this loss of income has negatively impacted haulers. Given that the changes to our recycling program were implemented less than a year ago, it's hard to quantify how the changes have impacted our recovery rates, etc - simply not enough data AND too many variables.
- Manual collection of extra garbage bags creates inefficiencies with a system designed to tip garbage carts with automated trucks. Also, there are households that regularly generate larger volumes of extra garbage, and its more desirable to all parties concerned, if they properly size their garbage carts, ie, go to a larger sized garbage cart. Although it goes against the philosophy of PAYT, its cheaper for these customers to upgrade to a larger sized cart, and more efficient for our collection. There are also administrative costs to tracking and billing for extra garbage.
- We have to drive every street looking for the bags, there is no subscription requirement!! More fuel, more time, more cost!

Question 24: Please describe any other major issues, benefits, or relevant points associated with the program.

Answer Options	Count
Open ended question	7

Answers:

- The citizens get it. It is logical and is perceived as equitable. We are applying PAYT to our curbside yard waste/food waste composting collection with 13 gal, 32 gal and 96 gal options.
- Increased diversion has resulted in decreased disposal, and therefore stabilized disposal rates.
- There is some concern (and some anecdotal evidence) that, in order to save money, people will choose a smaller sized garbage bin and put their garbage into the larger recyclables cart. Some people do seem to do this but it's not the majority of people and tagging carts for contamination rather than just picking them up.
- The City of Portland currently provides commercial food generators with food composting - we hope to site a local composting facility to offer this service to residents in the next 18 months to 2 years.

- We found that if you allow for extra garbage, you must have a large enough rate gap between garbage cart sizes to incentivize recycling.
- We hope with the upcoming conversion to single stream recycling, from sort separated at curb, that we begin to see volume of trash being landfilled decline.
- None

Appendix C: Constructing a Distribution of MSW Production

Milwaukee does not collect data on the amount of municipal solid waste each household in the city produces. The best data available show the average amount of MSW per collection route during an eight-month period in 2007 (City of Milwaukee 2007). This data can provide route-level information, but specific household data cannot be derived from it because the standard deviation of the data is unknown. The standard deviation describes how tightly all of the observations in a data set cluster around the mean (average) of the data. For example, if the mean of a data set is 40.00 and the standard deviation is 2, the majority of the data points fall between 38.00 and 42.00.

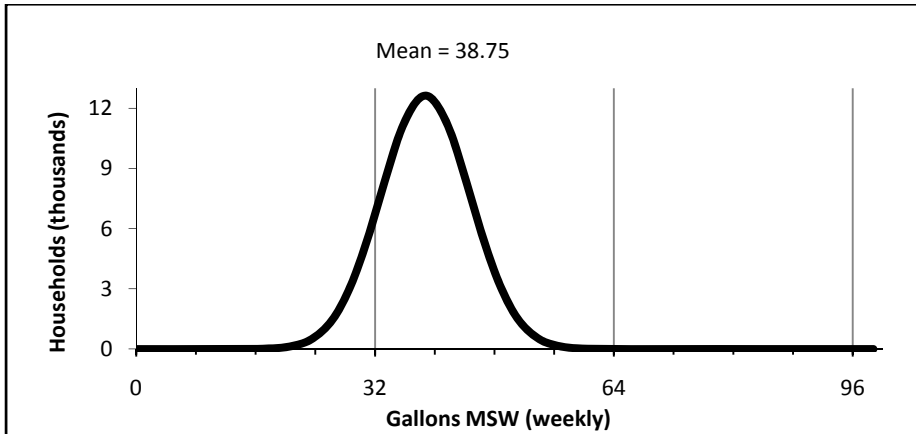
If the standard deviation and mean of a data set are known, the distribution of data points can be known. In this case, the mean of the MSW is known, but the standard deviation for Milwaukee's data is unknown. Therefore, the distribution of MSW generation by household cannot be generated from empirical records. The only relevant information that can be drawn from the available data is that the average household disposed of 43.16 pounds of MSW per week during this period. We converted this figure to an average weekly volume of 38.75 gallons using a standard conversion of 225 pounds per cubic yard of MSW.

The distribution of household MSW determines the pricing structure for a multiple cart PAYT system by determining the number of households that may subscribe to each cart size. To develop reasonable estimates of the unknown distribution of households, standard deviations from 1.00 to 38.00 (just less than the mean of 38.75 gallons per household) were considered. This range produced wide variation in the number of households potentially using each cart size. Using a more plausible range of standard deviations from 6.00 to 18.00 also produced widely varying estimates of the number of households using each cart size.

However, when these estimates were placed into the pricing formula, the range of prices for each cart size was fairly narrow and stable. In fact, the range of prices varied by only a few dollars for each cart size, even when the distribution of carts changed considerably. Given this, we examined the status quo and each alternative using theoretical distributions with standard deviations of 6.00, 12.00, and 18.00. The standard deviations were measured in either pounds or gallons depending on what was relevant for each alternative.

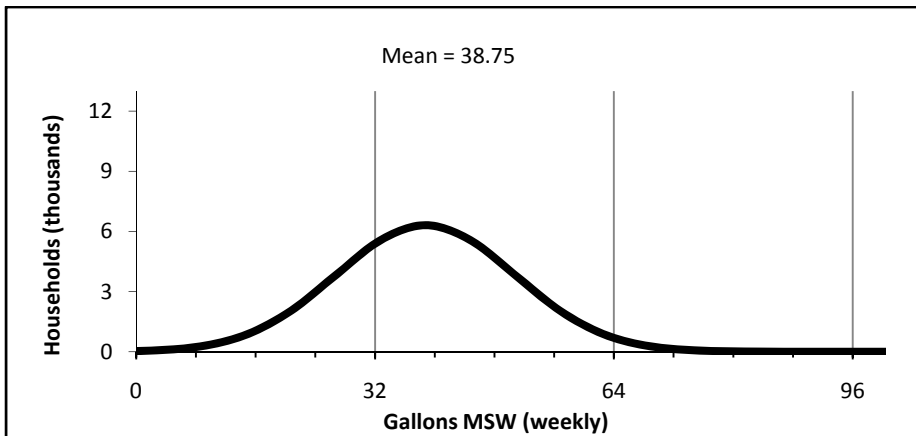
Figures 1, 2, and 3 graphically depict these standard deviations.

Figure 1: Normal MSW Distribution with Standard Deviation of 6.00



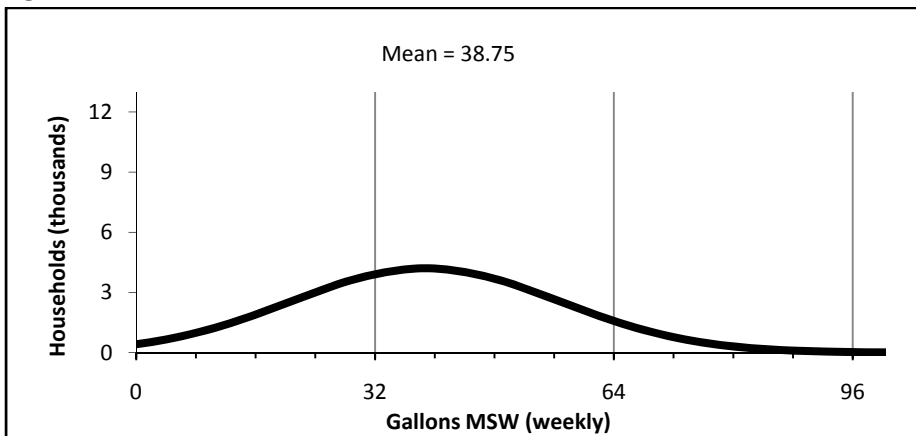
Source: Authors' calculations

Figure 2: Normal MSW Distribution with Standard Deviation of 12.0



Source: Authors' calculations

Figure 3: Normal MSW Distribution with Standard Deviation of 18.0



Source: Authors' calculations

Appendix D: Alternative Budget and Pricing Development

This section describes the method used to establish budgets and an equity index for the status quo and both alternatives. Because we did not know the standard deviation for household MSW distribution, we outlined scenarios using hypothetical standard deviations of 6.00, 12.00, and 18.00. We also hypothesized scenarios using a tipping fee of \$30 per ton, the approximate rate Milwaukee pays in 2009 to unload waste at the dump, and \$35 per ton, which the client asked us to include. Finally, we projected scenarios using current levels of MSW generated by the city, a 10 percent reduction in total waste, and a 20 percent reduction in total waste. These waste reduction figures fall within the reasonable range of waste reduction reported by the comparative cities we surveyed and literature on cities moving to PAYT systems from flat-rate MSW collection.

These considerations resulted in six status quo scenarios, where no waste reduction was analyzed; 18 Alternative I scenarios; and 18 Alternative II scenarios. For each alternative, only one budget scenario is presented in this appendix, demonstrating a standard deviation of 6.00, a tipping fee of \$30, and zero reduction in MSW.

We started with a budget for the status quo which was based on the 2009 Milwaukee Solid Waste Budget (City of Milwaukee). This base budget was used for all of the pricing and equity index scenarios, with changes that are described below for each alternative.

Tables 12, 14, and 16 show the prices and the equity index for each scenario of each alternative. These tables show the standard deviation, the tipping fee, the waste collection charge, the equity index, and the cost recovery percentage for each scenario. The tables also present the total annual price that would be paid by the median Milwaukee household under each scenario.

Status Quo Summary: Current MSW and Recycling Program

Six scenarios were constructed for the status quo. These used standard deviations of 6.00, 12.00, and 18.00, each with a landfill tipping fee of \$30 or \$35 per ton. Because no municipal solid waste reduction is assumed under the status quo, the scenarios do not reflect any reduction in MSW.

Under the status quo, the median household (in fact all households) pays \$150 per year for its MSW and recycling collection. This results in a program cost recovery of 88 to 91 percent depending on the tipping fee that is used. Table 12 displays these summary results as well as the equity index for each scenario.

Table 12: Status Quo Scenarios

Scenario	Std. Dev.	Tipping Fee	0% MSW Reduction Median Charge	% Cost Recovery
SQ1	6.00	\$30	\$150 Equity Index: 1.23	91.3%
SQ2	6.00	\$35	\$150 Equity Index: 1.23	88.7%
SQ3	12.00	\$30	\$150 Equity Index: 2.11	91.3%
SQ4	12.00	\$35	\$150 Equity Index: 2.11	88.7%
SQ5	18.00	\$30	\$150 Equity Index: 3.30	91.3%
SQ6	18.00	\$35	\$150 Equity Index: 3.30	88.7%

Source: Authors' calculations

A sample status quo budget scenario is presented in Table 13. A number of assumptions are contained in this budget:

- It is assumed that the long-run resale value of recyclables is \$80 per ton (R. Meyers, personal communication, March 24, 2009). Of this amount, Milwaukee receives \$40 in gross revenue. This amount is used in all budget scenarios.
- The state recycling grant is assumed to be the same as the FY2008 grant.
- “Overhead” excludes fringe benefits and depreciation expenses.
- Standard deviations of 6.00, 12.00, and 18.00 were used in calculating the equity index. The standard deviations were not relevant for price determination in the status quo.
- The tipping fee was set at \$30 and \$35 per ton as the client requested.

Table 13: Status Quo Sample Budget Scenario

Status Quo: Current Milwaukee System Estimated Budget				
Scenario 1: Standard Deviation = 6, MSW Tipping Fee = \$30				
INCOME/REVENUES				
MSW Program				
Number of Households	190,000	x Base Price	\$150	\$28,500,000
Extra Collection				
Large Pickups (>4 Yards ³)	2,500	x Charge per pickup	\$50	\$125,000
<i>Total MSW Income/Revenue</i>				<i>\$28,625,000</i>
Recycling Collection				
Tons Collected	26,000	x Resale value per ton	\$40	\$1,040,000
Recycling state grants				\$3,500,000
<i>Total Recycling Income/Revenue</i>				<i>\$4,540,000</i>
Total Income/Revenue				\$33,165,000
EXPENSES/COSTS				
MSW Program				
Labor			\$11,334,141	
ODWs Salaries (77 routes)			\$9,507,027	
OT (driver only)			\$327,019	
Field Clerks/Cart Techs			\$208,934	
San Workers			\$493,630	
Supervisors			\$797,532	
Fringe Benefit			\$4,646,998	
Trucks			\$3,779,577	
Maint/Repair/Fuel			\$1,902,096	
Depreciation			\$1,877,481	
Tonnage	190,000	x Tipping fee per ton	\$30	\$5,700,000
Other operating expenses				\$475,000
Containers				\$645,000
Overhead (13.38%)				\$2,683,525
<i>MSW Total</i>				<i>\$29,264,241</i>

Continued on following page

EXPENSES/COSTS *continued*

Recycling Program

Labor				\$2,306,512
ODWs Salaries (34 routes)		\$2,098,954		
OT		\$144,398		
Supervisors		\$265,884		
Recycling Manager		\$63,160		
Fringe Benefit				\$945,670
Trucks				\$1,471,882
Maint/Repair/Fuel		\$839,664		
Depreciation		\$632,218		
Tonnage	26,000	x Processing fee per ton	\$40	\$1,040,000
Other operating expenses				\$250,000
Containers				\$400,000
Overhead (13.38%)				\$647,080
<i>Recycling Total</i>				<i>\$7,061,144</i>
Total Expenses/Costs				\$36,325,385

COST RECOVERY

Total Income/Revenue				\$33,165,000
Total Expenses/Costs				\$36,325,385
Net Income/Loss				-\$3,160,385
Percentage Cost Recovery				91.3%

EQUITY MEASURE

Resident	Charge		Price/pound	
10th Percentile Household	\$150 ÷ Annual MSW Pounds	1,735		\$0.086
Median Household	\$150 ÷ Annual MSW Pounds	2,158		\$0.070
90th Percentile Household	\$150 ÷ Annual MSW Pounds	2,543		\$0.059
Equity Index	1.47	Ratio of low-volume price to high-volume price		

Alternative I Summary: Multiple Cart Sizes

Alternative I required the construction of 18 scenarios. As in the status quo, the standard deviation was 6.00, 12.00, and 18.00, each with a landfill tipping fee of \$30 and \$35. We assumed that some level of MSW reduction will occur when customers are charged based on their MSW output. We constructed scenarios to reflect 10 percent or 20 percent total reductions in MSW in addition to the other variables.

Under Alternative I, the median household produces 38.75 gallons of MSW per week with no MSW reduction, 34.84 gallons with a 10 percent reduction, and 31 gallons with a 20 percent reduction. We assume that under all of these scenarios the median household will use a 64-gallon cart. In this case, the median household will pay between \$164 and \$184 per year for MSW and recycling collection depending on the variables. Table 14 displays these summary results as well as the equity index for each scenario.

Table 14: Alternative I: Multiple Carts Scenarios

Scenario	Std. Dev.	Tipping Fee	0% MSW Reduction Median Charge	10% MSW Reduction Median Charge	20% MSW Reduction Median Charge
MC1	6.00	\$30	\$171 Equity Index: 1.08	\$168 Equity Index: 1.07	\$164 Equity Index: 1.06
MC2	6.00	\$35	\$177 Equity Index: 1.09	\$173 Equity Index: 1.08	\$169 Equity Index: 1.07
MC3	12.00	\$30	\$178 Equity Index: 1.69	\$174 Equity Index: 1.68	\$171 Equity Index: 1.67
MC4	12.00	\$35	\$184 Equity Index: 1.71	\$180 Equity Index: 1.70	\$176 Equity Index: 1.68
MC5	18.00	\$30	\$178 Equity Index: 2.88	\$175 Equity Index: 2.86	\$171 Equity Index: 2.84
MC6	18.00	\$35	\$184 Equity Index: 2.91	\$180 Equity Index: 2.89	\$176 Equity Index: 2.87

Source: Authors' calculations

A sample multiple cart budget scenario is presented in Table 15. A number of assumptions are contained in this budget:

- This alternative will require one new employee for billing, technical support and maintenance of the weighing system. This employee is budgeted at \$40,000 annually, plus the associated fringe costs.
- Full price recovery was specified for the alternative.
- Cart charges were set at \$48 per year for a 32-gallon cart, \$96 per year for a 64-gallon cart, and \$144 per year for a 95-gallon cart. Once these prices were established, a base charge could be set.

Table 15: Alternative I Sample Budget Scenario

Alternative I: Multiple Cart System Estimated Budget				
Scenario 1: Standard Deviation = 6, MSW Tipping Fee = \$30, MSW Reduction = 0%				
INCOME/REVENUES				
MSW Program				
Number of Households	190,000	x Base Price	\$75	\$14,290,073
Cart Charge				
Number 32g Households	24,759	x Annual Charge	\$48	\$1,188,432
Number 64g Households	165,239	x Annual Charge	\$96	\$15,862,944
Number 95g Households	2	x Annual Charge	\$144	\$288
Number additional carts	0	x Annual Charge	\$0	\$0
Extra Collection				
Additional 30g Bags	190,000	x Charge per bag	\$2	\$380,000
Large Pickups (>4 Yards ³)	2,500	x Charge per pickup	\$50	\$125,000
<i>Total MSW Income/Revenue</i>				<i>\$31,846,737</i>
Recycling Collection				
Tons Collected	26,000	x Resale value per ton	\$40	\$1,040,000
Recycling state grants				\$3,500,000
<i>Total Recycling Income/Revenue</i>				<i>\$4,540,000</i>
Total Income/Revenue				\$36,386,737
EXPENSES/COSTS				
MSW Program				
Labor				\$11,374,141
ODWs Salaries (77 routes)			\$9,507,027	
OT (driver only)			\$327,019	
Field Clerks/Cart Techs			\$208,934	
San Workers			\$493,630	
Supervisors			\$837,532	
Fringe Benefit				\$4,662,998
Trucks				\$3,779,577
Maint/Repair/Fuel			\$1,902,096	
Depreciation			\$1,877,481	
Tonnage	190,000	x Tipping fee per ton	\$30	\$5,700,000
Other operating expenses				\$475,000
Containers				\$645,000
Overhead (13.38%)				\$2,688,877
<i>MSW Total</i>			<i>\$3,779,607</i>	<i>\$29,325,593</i>

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EXPENSES/COSTS *continued*

Recycling Program

Labor				\$2,306,512
ODWs Salaries (34 routes)		\$2,098,954		
OT		\$144,398		
Supervisors		\$265,884		
Recycling Manager		\$63,160		
Fringe Benefit				\$945,670
Trucks				\$1,471,882
Maint/Repair/Fuel		\$839,664		
Depreciation		\$632,218		
Tonnage	26,000	x Processing fee per ton	\$40	\$1,040,000
Other operating expenses				\$250,000
Containers				\$400,000
Overhead (13.38%)				\$647,080
<i>Recycling Total</i>				<i>\$7,061,144</i>
Total Expenses/Costs				\$36,386,737

COST RECOVERY

Total Income/Revenue				\$36,386,737
Total Expenses/Costs				\$36,386,737
Net Income/Loss				\$0
Percentage Cost Recovery				100.0%

EQUITY MEASURE

Resident	Charge		Price/gallon	
10th Percentile Household	\$123 ÷ Annual MSW Gallons		1,553	\$0.079
Median Household	\$171 ÷ Annual MSW Gallons		1,937	\$0.088
90th Percentile Household	\$171 ÷ Annual MSW Gallons		2,322	\$0.074
Equity Index	1.08	Ratio of low-volume price to high-volume price		

Alternative II Summary: Weight-Based Program

Alternative II included the same 18 scenarios used in Alternative I.

Under Alternative II, the median household produces 43.16 pounds of MSW per week with no MSW reduction, 39.29 pounds with a 10 percent reduction, and 35.41 pounds with a 20 percent reduction. Given this, the median household will pay between \$169 and \$182 per year for MSW and recycling collection depending on the variables chosen. It is notable that this range is nearly identical to the range paid by the median household under Alternative I. Table 16 displays these summary results as well as the equity index for each scenario.

Table 16: Alternative II: Weight-Based Scenarios

Scenario	Std. Dev.	Tipping Fee	0% MSW Reduction Median Charge	10% MSW Reduction Median Charge	20% MSW Reduction Median Charge
W1	6.00	\$30	\$176 Equity Index: 1.11	\$172 Equity Index: 1.10	\$169 Equity Index: 1.10
W2	6.00	\$35	\$182 Equity Index: 1.11	\$178 Equity Index: 1.10	\$174 Equity Index: 1.09
W3	12.00	\$30	\$177 Equity Index: 1.25	\$172 Equity Index: 1.24	\$169 Equity Index: 1.22
W4	12.00	\$35	\$182 Equity Index: 1.24	\$178 Equity Index: 1.23	\$174 Equity Index: 1.21
W5	18.00	\$30	\$177 Equity Index: 1.47	\$172 Equity Index: 1.44	\$169 Equity Index: 1.41
W6	18.00	\$35	\$182 Equity Index: 1.45	\$178 Equity Index: 1.43	\$174 Equity Index: 1.40

Source: Authors' calculations

A sample weight-based budget scenario is presented in Table 17. A number of assumptions are contained in this budget:

- This alternative will require two new employees for billing and technical support and maintenance of the weighing system. These employees are budgeted at \$40,000 each annually, plus the associated fringe costs.
- Full price recovery was specified for the alternative.
- All customers pay a base fee of \$50 per year, regardless of their actual MSW output. The base fee covers fixed costs borne by Milwaukee regardless of the amount of MSW generated by households for collection. Based on this base charge, the total amount of MSW generated and the expenses that had to be recovered, a charge per pound of MSW was established.

Table 17: Alternative II Sample Budget Scenario

Alternative II: Weight-Based System Estimated Budget				
Scenario 1: Standard Deviation = 6, MSW Tipping Fee = \$30, MSW Reduction = 0%				
INCOME/REVENUES				
MSW Program				
Collection Charge	190,000	x Base Price	\$50	\$9,500,000
Weight Charge	190,000	x Charge per ton	\$117	\$22,283,089
Extra Collection				
Large Pickups (>4 Yards ³)	2,500	x Charge per pickup	\$50	\$125,000
<i>Total MSW Income/Revenue</i>				<i>\$31,908,089</i>
Recycling Collection				
Tons Collected	26,000	x Resale value per ton	\$40	\$1,040,000
Recycling state grants				\$3,500,000
<i>Total Recycling Income/Revenue</i>				<i>\$4,540,000</i>
Total Income/Revenue				\$36,448,089
EXPENSES/COSTS				
MSW Program				
Labor				\$11,414,141
ODWs Salaries (77 routes)				\$9,507,027
OT (driver only)				\$327,019
Field Clerks/Cart Techs				\$208,934
San Workers				\$493,630
Supervisors				\$877,532
Fringe Benefit				\$4,678,998
Trucks				\$3,779,577
Maint/Repair/Fuel				\$1,902,096
Depreciation				\$1,877,481
Tonnage	190,000	x Tipping fee per ton	\$30	\$5,700,000
Other operating expenses				\$475,000
Containers				\$645,000
Overhead (13.38%)				\$2,694,229
<i>MSW Total</i>				<i>\$3,779,607</i> <i>\$29,386,945</i>

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EXPENSES/COSTS *continued*

Recycling Program

Labor				\$2,306,512
ODWs Salaries (34 routes)		\$2,098,954		
OT		\$144,398		
Supervisors		\$265,884		
Recycling Manager		\$63,160		
Fringe Benefit				\$945,670
Trucks				\$1,471,882
Maint/Repair/Fuel		\$839,664		
Depreciation		\$632,218		
Tonnage	26,000	x Processing fee per ton	\$40	\$1,040,000
Other operating expenses				\$250,000
Containers				\$400,000
Overhead (13.38%)				\$647,080
<i>Recycling Total</i>				<i>\$7,061,144</i>
Total Expenses/Costs				\$36,448,089

COST RECOVERY

Total Income/Revenue				\$36,448,089
Total Expenses/Costs				\$36,448,089
Net Income/Loss				\$0
Percentage Cost Recovery				100.0%

EQUITY MEASURE

Resident	Charge		Price/pound	
10th Percentile Household	\$154 ÷ Annual MSW Pounds	1,773		\$0.087
Median Household	\$177 ÷ Annual MSW Pounds	2,158		\$0.082
90th Percentile Household	\$199 ÷ Annual MSW Pounds	2,543		\$0.078
Equity Index	1.11	Ratio of low-volume price to high-volume price		

Appendix E: Development of Policy Analysis Criteria

We evaluated each policy option according to four criteria: efficiency, effectiveness, equity, and ease of implementation. These are summarized in the “Policy Criteria” section of this report. Our measurement and data collection methods for each are described here.

Efficiency

We measure efficiency through the percentage program cost recovery under each alternative. We calculate program using the following formula:

$$\% \text{ Cost Recovery} = \text{Program Income and Revenue} / \text{Program Expenses and Costs}$$

We used the spreadsheet template to total the income and expenses under a range of assumptions for six scenarios for each policy option. Additionally, each alternative scenario was run with 0 percent, 10 percent, and 20 percent MSW reductions, creating up to 18 scenarios for each alternative. Assumptions included the possibility of no reduction in the number of tons of MSW and, therefore, no expense reduction due to reduced tipping fees. To calculate the pricing structure needed for each scenario, we first determined the income needed to obtain full cost recovery. For PAYT options, this was weighted by the distribution of MSW per household given the base fees in each case.

In addition, we evaluate efficiency by the additional budget expenses each alternative requires. We calculated costs of new PAYT system inputs, public outreach and education expenses, and additional staffing expenses from the alternatives. We conducted telephone interviews with vendors and potential contractors, reviewed our comparable cities survey results and telephone contacts, and relied on estimates given by City of Milwaukee staff. Due to lack of detailed response, we must estimate some budget items such as education and outreach for the multiple cart and weight-based alternatives.

Effectiveness

Effectiveness is quantifiable by MSW tonnage reduction resulting from residents’ disposal behavior under each alternative. Data in this category come from research studies and our comparable city survey responses. We also make relative comparisons of effectiveness regarding household acceptance of and compliance with the programs.

The spreadsheet calculations were based on the approach and assumptions about pricing and distributions of waste per household described in the methodology section (see page 7 and Appendix C).

We based these estimated tonnage inputs on three sources. First, the ranges of variation in tonnage found over time in Milwaukee prior to consideration of PAYT provided a magnitude of changes due to all non-PAYT factors.

Varying percentage reductions in solid waste from comparably sized PAYT municipalities act as a second benchmark. We also took into account averages from government and industry sources showing diversion rates and other impacts during the years following the introduction of PAYT. As most reductions in MSW following the introduction of PAYT came in the first year or two and then leveled off, our quantitative evaluations covered an entire single year and should be considered the long-run average.

City of Milwaukee staff provided recycling revenues and landfill fees per ton for the current budget cycle. These are not modified to account for long-term forecasts of variations in recycling prices in our analysis.

Equity

We defined an equity index to consistently measure the relative fairness of each policy alternative. The index shows the ratio of the prices paid between those that generate the most MSW and those that generate the least. Specifically, the index compares the price paid per pound or gallon of MSW by the individual household 10 percent from the bottom and 10 percent from the top of the MSW distribution range. This approach provides a single number to compare the equity of different systems and different scenarios. A score of 2.0 on the index indicates those generating the least MSW pay twice as much as those generating the most. An index of 1.0 indicates residents pay the same amount for MSW collection per unit, which we consider to be the most equitable system possible. In our calculations, we found 1.08 as the most equitable score in our alternatives, occurring under the weight-based system. The status quo scores the highest equity disparity at 4.8. This means that under one possible status quo scenario, households with the lowest amount of MSW pay nearly five times the rate per pound of households generating the most waste.

Ease of Implementation

Assessment of ease of implementation was a relative comparison between alternatives and considered issues such as education and billing changes. We also considered availability of new equipment and maintenance services, and whether the alternative requires substantial re-training of collection workers. We obtained this information from interviews with City of Milwaukee employees, our comparable cities survey results, and telephone contacts with vendors. We also used research on published PAYT information.