Making the Day More Productive

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To improve collection efficiency, a common first thought among solid waste or recycling program managers is to invest in new collection vehicles. There are, however, plenty of things that can improve program efficiency before considering such a significant capital investment.

The possibilities begin with a thorough analysis of your collection day, existing equipment and labor force. A model for the type of study you might carry out for your own program comes from the Model Cities Demonstration Program, conducted recently by the American Plastics Council (APC) in several cities across the U.S. The Model Cities program collected data about more than 14,000 collection stops on 49 residential curbside recycling routes in California, Florida, Massachusetts, North Carolina, Oregon, Texas and Washington. The APC contracted with DSM Environmental Services to conduct the extensive research for the western Massachusetts Model Cities project, and to compile the data from all of the Model Cities projects for the APC-published manual. "How to Collect Plastics." DSM recorded and timed all activities on more than 2,000 collection stops in Chicopee and Springfield, MA, and modeled the results using ordinary least-squares regression analysis. The results were then compared with the data from the other 12,000 stops analyzed in the Model Cities program.

Allocation of the Collection Day

One way to begin to look for efficiency improvements is to divide the collection day into two broad categories:

- time spent on off-route activities, when truck and driver are not occupied with actually collecting recyclables and
- time actually spent on-route picking up materials.

To get the information you need to improve productivity, record the amount of time the driver spends on each category of activity from the moment he/she starts work in the morning to the moment when he leaves work at the end of the day. For the Model Cities analysis, on-route collection activities include driving between stops and all pick up, sorting, and loading of materials into trucks. Off-route activities included yard time, commuting to the route at the beginning of the day and back to the yard at the end of the day, and vehicle unloading at the materials processing or storage facility, including travel to and from the facility.

Table 1 illustrates the range in workday activity allocation observed over the seven Model Cities Demonstration programs. The average time spent on-route collecting recyclables, 68 percent of the total operating day, is equivalent to about 4.75 hours of the average 7-hour collection workday observed in the Model Cities program. One clear strategy to improve efficiency, then, is to increase on-route time by focusing on reducing off-route time.

Table 1. Measured Range of Workday Activities

Activity	PERCENT OF TOTAL DAY		
	Low	High	Average
On-Route Collection	58	71	68
Off-Route Travel To/From MRF And Unloading	16	22	16
Commuting To/From Route	8	10	9
Yard Time	2	10	8

Minimizing Off-Route Time

Reducing off-route time from the observed average high of 42 percent to the observed average low of 26 percent of the collection day gains 50 minutes of productive collection time per day. This is equivalent to between 50 and 100 additional stops per day. If the average recycling collection truck makes between 300 and 500 stops per day, adding 50 to 100 additional stops to each truck on your route could reduce the number of trucks and crews by 20 percent.

While some of the following ideas for reducing off-route time seem self-evident, observations made during the Model Cities project were that they were not universally followed. Therefore, giving them some attention may pay dividends, without the need for significant expenditures of new money.

- Reduce yard time by assigning collection routes in advance of the collection day, so that each crew knows where it is going for the day. Contingency plans for sick days or other absences should also be made in advance.
- Assign trucks to the same driver for extended periods. This reduces truck "familiarization" time that is lost to adjusting mirrors, getting personal belongings out of other trucks and rechecking engine fluids and equipment. This also makes it easier to track poor driving habits and to assign blame or praise for high or low maintenance on a given vehicle.
- Have drivers perform routine maintenance and report truck maintenance issues at the end of each day, so that repairs can be made before the next collection day, or at least have backup trucks assigned.
- Eliminate weighing and unloading bottle-necks at the materials processing or unloading facility by such means as redesigning traffic patterns and staggering delivery schedules. If you are planning a new MRF or transfer station, pay close attention to traffic flow, weighing and material unloading issues.

- Evaluate routes between the yard or delivery point and the collection route to minimize off-route travel distances and to assure that, to a practical extent, trucks are routed around slow-moving traffic areas.

Modeling On-Route Activities

Enumerators in the seven Model Cities Demonstration programs followed collection vehicles on 49 routes and timed all activities on more than 14,000 stops. Source-separated, curbside-sort, and commingled collection routes were evaluated, as were co-collection routes, where recyclables and mixed waste were collected simultaneously in multi-compartment trucks.
Activities recorded included:

Time per stop. The time was recorded at the end of a stop and recorded again at the end of the next stop. The elapsed time, including driving time between stops, represented the time per stop.

The distance traveled by the collection vehicle between stops. This distance was estimated on some routes and measured on other routes and recorded in feet.

Duration of each "trip" from the curbside to the truck. This is the time it was estimated to take the driver to leave the cab, pick up and handle material, and return to the cab.

The time it took for every "toss" of material. On commingled collection routes, this might simply be the time for a collection crew member to stand at the curb and dump or throw a bin or bag of commingled material into the truck. On source-separated or curb-sort routes, researchers recorded trips, as well as the number of "tosses" required for each material. For example, if the operator picked up a paper bag of mixed containers, individually threw two plastic bottles into a plastic compactor, dumped the glass containers into one bin on the truck and then threw the paper bag into another bin, two "tosses" were recorded for plastic, one "toss" was recorded for glass, and one "toss" was recorded for paper.

Material handled in each trip or toss. Material was listed either as "containers," (bottles and cans) "fiber," or "fiber and containers." For source-separated routes, the material carried from the curb to the truck was recorded.

Compactor or cycle time. This time was required to run the plastic compactor or to cycle the loading hopper for vehicles with over-the-top dumping.

All of the data for each individual collection day were analyzed using ordinary least squares regression analysis to see if a statistically valid, or representative equation could be developed to explain the amount of time spent over each stop in terms of the activities conducted there. The regression analysis generated an equation for a line that most closely described, or "fit" changes in stop time in relation to travel distance and the different collection activities carried out at the stop. Table 2 presents the general regression equation.

Table 2. Modeling On-Route Collection Time Per Stop

TIME PER STOP (SECONDS)=

Coefficients	Variables
+ (X1)	(Distance Traveled From The Previous Stop In Feet)
+ (X2)	(Number Of Bags Tossed Of Paper)
+ (X3)	(Number Of Bags of Paper Walked From The Curb To The Truck)
+ (X4)	(Number Of Set-out Containers Of Paper And Bottles And Cans Carried Together To The Truck)
+ (X5)	(Bags Of Bottles And Cans Tossed Into The Truck)
+ (X6)	(Set-Out Bins With Bottles And Cans Only Tossed Into The Truck)
+ (X7)	(Set-Out Bins With Bottles And Cans Only Carried Into The Truck)
+ (X8)	(Amount Of Time Spent Operating Over-The-Top Dump Hoppers)
+	Constant

WHERE X1…X8 = REGRESSION COEFFICIENTS FOR EACH VALUE

The resulting equation was then tested to see what portion of the variation in stop time could be explained by the variables contained in the equation, and each variable was tested statistically to determine whether it was a significant variable. In general, variables tested in each model displayed the expected positive sign and were statistically valid at the five percent confidence level or higher. The coefficient of determination (R^2) for the resulting equations ranged from 0.40 to 0.70, which is significant for this type of cross-sectional data.

Results of On-Route Collection Modeling

While there was substantial variation among the many Model Cities Demonstration program routes studied, several general findings emerged from the modeling of on-route collection activities. Drive time between stops averaged 14 percent of on-route collection time. Collection of paper took an average of 27 percent of on-route collection time. Collection of bottles and cans took 22 percent of on-route collection time. Based on the model coefficients, we estimate that getting on and off the truck and walking between the curb and the truck accounted for 36 percent of on-route collection time. Use of a plastic compactor added between 4 and 10 percent to the on-route collection time use a plastic compactor added between 4 and 10 percent to the on-route collection time.

For routes collecting commingled paper and commingled bottles and cans, the average time per stop, including drive time from the last stop, was 44 seconds, ranging from an average of 30 to 54 seconds. For the few routes studied collecting source-separated material, average time per stop was 59 seconds. For dual collection routes where MSW and recyclables were collected on the same truck in separate compartments, average time per stop was 40 seconds, ranging from 30 to 50 seconds.

Maximizing On-Route Collection Activities

Combining the results of the on-route and off-route collection activity analysis leads to an important observation. After deducting off-route activities, which averaged 2.5 hours per day, and such on-route activities as between-stop travel and boarding and exiting the truck, which average another 2 hours per day, only approximately 2.5 hours (or 35 percent), on average, out of a 7-hour day were actually spent handling recyclables on the routes. Thus, curbside collection utilizes relatively expensive labor and capital

intensive equipment for only a few hours per day of truly productive collection and sorting materials. This one significant statistic alone-only 35 percent of the collection day is actually spent physically collecting materials – can lead to the following conclusions:

- Single-person crews are essential to maximizing collection efficiency. A collection program using two-person crews, one to drive and one to collect, is essentially wasting 65 percent of the other crew members time during the day.
- It is essential to maximize the amount of material collected per stop. One important way to do this is to reduce collection frequency, especially if your recyclables collection is twice weekly or weekly. Our analysis of household participation and set-out rates in western Massachusetts clearly indicated that, in many cases, the average household places just under two weeks' worth of material at the curb. Thus, it is not an inconvenience to the average household to store material for two weeks. Table 3 illustrates that monthly participation was not affected when comparing bi-weekly collection on Springfield, MA and weekly collection in Chicopee, MA. More importantly, the set-out rate and the weight of material in the set-out bin in Springfield was almost double that of Chicopee. Thus, the Springfield driver/collector was more productive, simply by virtue of a change in the collection frequency (due to a shorter distance between stops and more material to pick up at each stop).

Table 3. Comparison of Set-Out Rates And Average Monthly Participation Rates For Weekly And Bi-Weekly Collection Programs

	CHICOPEE, MA (Weekly Collection)	SPRINGFIELD, MA (Bi-Weekly Collection)
Percent Of Participating Households Setting Out Recyclables On Collection Day	47%	75%
Weight Of Material In Set-Out Bin	12.4 lbs.	22.6 lbs.
Monthly Participation Rate	65%	65%

- If you are currently collecting source-separated material or sorting at the curb, consider commingling compatible material and using a materials processing facility. Net recycling system savings will depend on the efficiency of the processing facility.

  Table 4 compares a source-separated route in West Linn, OR with a similar commingled route in Springfield, MA. As illustrated, the average time per stop is 22 seconds greater in West Linn, and the total number of stops is approximately one-half of Springfield's. Therefore, it takes about twice as many trucks and crews to collect recyclables in West Linn compared to Springfield. Clearly, it is worth investigating whether separation at a processing facility makes sense compared to separation at the curb or the household.

Table 4. Comparison of Source Separated And Commingled Collection Productivity

	WEST LINN, OR (Source-Separated)	SPRINGFIELD, MA (Commingled)
Stops/Day	223	424
Pounds/Set-Out	23.5	25.9
Average Time/Stop (seconds)	55	33
Average Distance Between Stops (feet)	165	181
Time of Year	June	June

- Collection drivers should be trained to pull close to the curb and toss material into the truck, instead of walking material from the curb to the truck.
- Drive time between stops represents a significant amount of on-route time and should be minimized through efficient routing, and maximizing set-out rates and quantities. Also, in most cases, the collection models indicate that it is more efficient to collect from only the right side of the street, instead of from both sides of the street, which increases walking distance and time.

Summary

The foregoing analysis of the collection day demonstrates that on-route collection activities can be accurately modeled. These models indicate that, on average only 35 percent of the total collection day is spent actually physically collecting and loading recyclables. Thus, managers of collection systems must concentrate on increasing on-route collection time and reducing non-productive time if they are to reduce resource use and the economic cost of collecting recyclables.