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Solid waste collection automation in the United States

Some of my summer jobs during high school were labourer positions with our local regional parks authority where I was part of a beach clean-up crew responsible for trash collection. This was my introduction to the field of waste collection using manual, rear-loader packer trucks, the most common collection practice in the United States at the time (mid-20th Century). It was back-breaking work and resulted in numerous muscle strains, abrasions, and cuts, let alone carrying around the inevitable odour of stagnant beach trash for several days following collection duty. Years later, when I started in a public sector position in Tampa, Florida, I was amazed that we were still requiring our waste collectors to do their work as it was done in the early days of municipal solid waste collection in the United States.

The evolution of solid waste collection vehicles and practices over the past 40 years has been driven by an overwhelming desire by solid waste professionals and risk control managers to collect more waste for less money, while reducing the physical demands on sanitation workers and the career-ending injuries they often suffered. Residential waste collection over the past century has evolved from the horse-drawn and human-powered carts to motor-operated and hydraulics-equipped vehicles specifically designed for solid waste collection. These included the first collection vehicles in the 1940s and 1950s, which incorporated the cab-over-engine chassis design and improved winch and compaction technologies, to address the need for a shorter turning radius vehicle, and for increased waste capacity on each truck that was needed for more efficient residential collection; i.e. fewer trips and lower labour requirements per tonne of waste collected.

It was not until the early 1960s, however, that solid waste collection took a monumental leap in technology to improve overall efficiency. During this era, public works departments in communities primarily in western states, which were experiencing rapid suburban growth in the post-World War II period, were exploring the concept of improving their labour productivity, oftentimes in the face of limited financial resources. It is important to point out that these cities and agencies were less constrained by formal labour agreements, which were more typical of their larger and more established sister communities in the East and Midwest. Consequently, cities began to explore ways of collection vehicle automation as a substitute for brute-force labour to lift, tip, and empty trash containers that were normally placed curbside.

Automated side-loader trucks were first implemented in the United States by the cities of Phoenix and Scottsdale, Arizona, in the 1970s, with the aim of ending the back-breaking nature of residential, solid waste collection, and to minimise worker injuries. After the concept was proven effective, thousands of public agencies and private haulers eventually moved from the once-traditional rear-loader method of waste collection to one that also provides the customer with a variety of choices in standardised, rollout carts that are matched to the lifting configurations of automated collection trucks. These have enabled communities throughout the country to significantly reduce worker compensation claims and minimise insurance expenses, while at the same time offering opportunities to workers who are no longer selected for their work assignment based solely on physical abilities. In fact, trash collection workers ultimately became skilled labourers, responsible for the safe and efficient operation of equipment worth US$150,000 and up.

About this same time, the Federal government also began to study ways of improving all facets of solid waste management in the United States. Between 1965 and 1975, an arm of the US Public Health Service (a predecessor agency of the US Environmental Protection Agency) provided support for research studies to develop and demonstrate improved solid waste collection equipment with the aim of eliminating the need for multiple collection workers on each truck to manually lift and empty containers. Major truck manufacturers, such as Lodal and Maxxon, worked with various cities in the west (Santa Clara, California; Scottsdale and Phoenix, Arizona) to pioneer the development of a drop-frame truck chassis, stand-up driver stations, the use of both right- and left-hand steering wheels, and the standardisation of truck-matched refuse containers. These early equipment designs were identified with imaginative names such as ‘Godzilla’ and the ‘Son of Godzilla’.

For this type of collection system, residents are provided a standardised container into which they place their waste. Residents must place their cart at the curb on collection day, accessible to the compaction truck. During collection, the driver positions the collection vehicle beside the cart. Using controls inside the cab of the vehicle, the driver manoeuvres a side-mounted arm to pick up the container and dump its contents into the hopper of the vehicle. The driver then uses the arm to place the container back onto the curb. Under this type of collection system, the driver alone is able to service the entire route; the need for additional manual labour is eliminated. The savings in personnel and worker’s compensation costs, as well as the increase in crew productivity for automated collected, are well documented throughout the solid waste industry.

Currently, the National Waste and Recycling Association estimates that there are roughly about 120,000 solid waste vehicles on the road in the United States, and about half of all new waste collection vehicles purchased in 2013 (the most recent statistics

available) were automated one-person trucks. There is a real sense in the solid waste industry today that automated trucks are significantly increasing their share of the new sales in recent years. Most solid waste industry experts are of the opinion that this trend is rapidly increasing, as many agencies and private haulers attempt to minimise their increasing insurance costs and more effectively control their cost of labour, while at the same time providing increased customer service levels and opportunities for an aging work force.

Solid waste collection workers have long been exposed to health and environmental safety risks owing to repetitive lifting and the presence of volatile compounds and potentially hazardous or even infectious materials in even the most seemingly benign trash bins, resulting in musculoskeletal, dermal, respiratory, and gastrointestinal problems. Typical rear-loader operations require manually lifting of sometimes overly full bins into collection vehicles. Statistics from such programmes suggest that collection crews on manual routes lift on average, over six tonnes per worker per day. In general, this heavy, repetitive, manual lifting, combined with an aging workforce, tends to generate an increasing number of injured staff. In this light, it is not surprising to learn that most trash collection workers do not stay in that job past their mid-50s.

A fully automated collection programme enhances worker safety and comfort, and minimises manual lifting and exposure to possible hazards in the waste, such as sharp objects and infections from pathogens. Fully automated collection eliminates heavy lifting, walking between set-outs, and frequent steps onto and off of the truck. The mechanical arms on modern, fully automated collection trucks are typically operated by the driver using a joystick control. Rather than slogging through rain and extreme temperature environments, operators of automated refuse collection systems spend their shifts in relatively comfortable climate controlled cabs. The reduced physical requirement increases the diversity and longevity of the workforce that is able to collect waste. Automated collection has proven to significantly reduce collection-worker injuries, directly resulting in reduced workers compensation costs, decreasing disability claims, decreasing the number and cost of temporary light duty assignments, and reducing long-term salary fringe benefit costs.

Under the traditional manual collection system, customers in many communities are typically allocated a basic service level of two cans for trash collected once or sometimes twice per week(e.g. in hot climates where less frequent collection would result in fly breeding). Those homeowners who are ardent recyclers and who reduce waste and regularly set out less than two full cans of garbage oftentimes do not see any savings as they pay the same as those residents who use two full cans. (Note that it is increasingly common for source-separated recyclables also to be collected by one-person trucks.)

Most communities have found that implementation of automated collection allows them to provide their customers with various sizes of containers, thereby moving closer to a true ‘pay as you throw’ (PAYT) system for funding waste management programmes, where residents pay only for the level service they need or use. Tailoring the size of the cart to the amount of garbage produced and charging a higher fee for larger garbage cart sizes encourages residents to recycle and thus reduce the amount of waste disposed in landfills.

The use of standardised containers for automated collection has proven to result in a number of clear environmental benefits as well. The rolling carts are more resistant to tipping by foraging animals, which reduces unsightly blowing litter and strewn garbage, and replaces unsightly set-outs with a single uniform container over an entire community. The carts also are designed with closed lids, which also help to reduce odours and keep water out of set-outs, reducing leakage from trucks and the unproductive hauling of water along with trash (and reducing the wet weight of trash at waste-to-energy facilities and landfills).

Automated solid waste collection is considered a higher level of service (versus manual collection) for residents. For most residents, wheeled carts are easier to move and set out than cans and bags that must be lifted. The newer-styled wheeled containers are extremely durable, often lasting ten years or more, and are convenient to use as residents no longer need to buy (directly) replacement garbage cans or plastic yard trimmings bags. In most cases, carts are owned and maintained by the jurisdiction or contract hauler.

The primary disadvantage of automated collection is the initial costs of purchasing specialised vehicles and providing compatible standardised carts to homeowners. On average, the capital cost of an automated side-loader is 20% more than that of a manual rear loader. Additionally, the useful life of an automated vehicle is often less than a rear loader. Cart costs generally average between US$35 and US$50 each depending on container size. Additional disadvantages include the following.

- Automated vehicles require more maintenance than traditional rear end load vehicles and require specialised training of operators/drivers.
- Homeowners must be educated on where to place bins and what kinds of trash can be collected. Bulky items that do not fit in the cart usually require a separate collection. Overloaded containers, or waste left on the ground, can adversely impact the productivity of collection.
- Automated collection does not work well or at all in densely populated areas with on-street parking on collection days or where most people live in mid-to-high rise multi-family buildings. However, on-street parking does not prevent a cart-based approach to collection. A hybrid system can be employed in these cases where carts are collected in a semi-automated fashion and many cart system benefits can still be enjoyed.
- Adjustments typically need to be made to alley collection in areas with limited side-loader clearance. Some communities have required these areas to migrate to street-side collection or have implemented semi-automation (use of hydraulically assisted can ‘lifters/flippers’).

- While the capital costs are generally higher, the increased productivity and the life-cycle costs savings in most communities from reduced personnel by implementing an automated collection programme will usually offset the differences in capital costs between rear and automated programmes over time. There are also savings produced from labour-related costs, such as lower worker's compensation costs, lower health insurance rates, and less turnover. Other ancillary benefits that are oftentimes difficult to quantify include reduced wear and tear on streets and reduced air emissions owing to the reduced truck operation times.

Given the many demonstrated advantages associated with automated collection, researchers are encouraged to develop and/or evaluate the cost-advantages of automated or semi-automated collection systems suitable for more densely populated urban areas in both developed and developing countries.

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