

# Automating Waste Management: Transport and Sorting

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## ***PREFACE***

With the conditions of the waste management industry ever worsening and employment in the industry waning downwards in countries such as Brazil and the United States,<sup>1</sup> in addition to its rising fatality rate of 0.0414% (41.4 per 100,000 workers), making it the fourth-most deadliest job in the United States, # a transition towards automated solutions must inevitably be implemented—not only to prevent the acceleration of climate change and natural deterioration but also to ensure the continuation of profit for the companies involved in the industries above.

Although essential, as clarified in the previous paragraph, waste management is ultimately seen as a mundane job. Those seeking engineering careers that suit their academic backgrounds would likely choose something of a higher caliber, such as general development in Large Language Models (LLMs), which has seen a rise in growth according to LinkedIn's yearly summary for 2024.<sup>2</sup> However, it is essential to note that there is a significant overlap between what this paper seeks to introduce to the industry and the current norms within the industry—which should not result in a conflict of workplace for any hypothetical applicants. Holistically this white paper seeks to introduce several methodologies to recruitment, including outreach and accessibility, as well as industry standards such as new facilities and sorting mechanisms to streamline work, outsourcing work to other companies, and holistically strengthening the entire industry.

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<sup>1</sup> Valentina Stoevska, “Beyond the Bin: Decent Work Deficits in the Waste Management and Recycling Industry,” International Labor Organization Statistics (ILOSTAT), September 11, 2024, <https://ilostat ilo.org/blog/beyond-the-bin-decent-work-deficits-in-the-waste-management-and-recycling-industry/>.

<sup>2</sup> HR Grapevine USA. 2025. “Artificial Intelligence Roles Top LinkedIn's US ‘Jobs on the Rise’ Report.” Hrgrapevine.com. January 8, 2025. <https://www.hrgrapevine.com/us/content/article/2025-01-08-artificial-intelligence-roles-top-linkedins-us-jobs-on-the-rise-report>.

## ***INDUSTRY RELEVANCE***

Overall, the waste management industry faces several challenges, including those that are harmful to workers, within its current modus operandi. Automating industrial plants, though pre-existing, such as in Europe, with organizations automating ~50% of waste management plants, it's vital that other processes within the field should be automated, not only to streamline the process but also to reduce human error and risk during the handling process<sup>3</sup>. Though skilled workers may still be necessary for oversized materials, it's still notable that the integration of AI to sort materials streamlines processes heavily— increasing profit margins for private companies by reducing the cost of labor. However, it is essential to emphasize that the waste management industry is seeing growth by rising 3.85% between 2022 and 2023, so phasing out human intervention goes contrary to current market predictions.<sup>4</sup> Thus, the changes in this document should progress over a multi-year span, with executives notifying stockholders and prominent individuals as necessary.

## ***RECRUITMENT STRATEGIES***

Centrally speaking, the general work automation industry has seen growth. Seeing that researchers have approximated that automated solutions will replace 9 to 47% of currently active sectors, it is vital that the waste management industry seeks out talent - especially those at a

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<sup>3</sup> Practice, In. 2018. "In Practice: How Automation Is Revolutionising Waste." Environment Journal. April 19, 2018. <https://environmentjournal.online/waste/how-automation-is-revolutionising-waste/>.

<sup>4</sup> Number of Waste Workers Grew Faster than Broader US Jobs Category over 2022." n.d. Waste Dive. <https://www.wastedive.com/news/waste-recycling-december-jobs-report-2022/639875/>.

young age as well as industry professionals in the field.<sup>5</sup> A likely organization to collaborate with is the Engineering Ambassadors Network, which reaches out to schools from grades K-12 to provide insight into current engineering fields.<sup>6</sup> Having reached out to >277,013 students within the last year and lowering the entry barrier for the field overall increases the likelihood of more talent flocking toward the industry.<sup>7</sup> Furthermore, scholarships funded by organizations and accessed through events such as the REC Foundation, SME, and the NFPA allow students who possess the talent to navigate higher education.<sup>8</sup> easily Companies could also collaborate with the REC foundation to adjust not only the theming of their owned robotics competitions (FRC, VEX V5, VEX FAC) but also their content to provide those interested in the industry with experience on how to sort objects and interpret camera vision – two aspects of automation that are key to the progression of waste management. These could also be done outside the general REC robotics ecosystem and involve

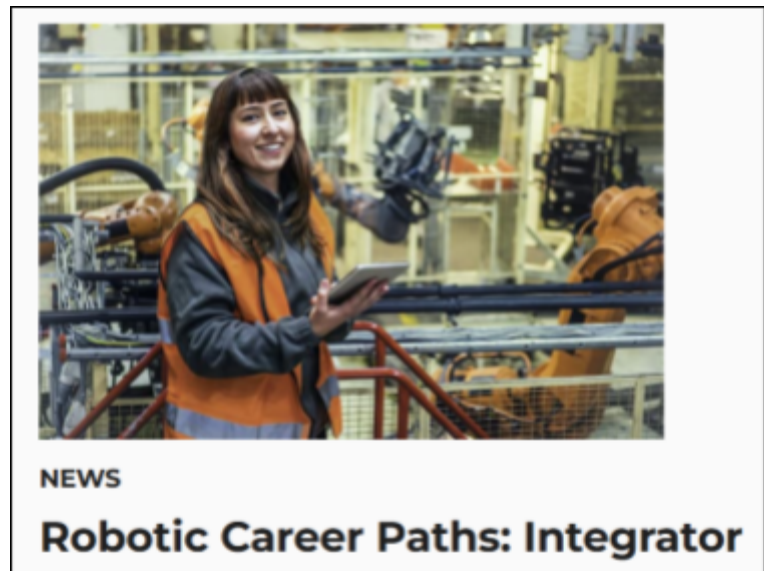


Figure 1: An example article on the career path 'Integrator,' introducing prospects of skills and possible companies to join.

<sup>5</sup> U.S. Government Accountability Office. 2022. "Which Workers Are the Most Affected by Automation and What Could Help Them Get New Jobs?" [www.gao.gov](https://www.gao.gov/blog/which-workers-are-most-affected-automation-and-what-could-help-them-get-new-jobs). U.S. Government Accountability Office. August 23, 2022.

<sup>6</sup> K-12 Community – Engineering Ambassadors Network." 2025. [Engineeringambassadorsnetwork.org](https://www.engineeringambassadorsnetwork.org/k-12-community/). 2025.

<sup>7</sup> Impact – Engineering Ambassadors Network." 2023. [Engineeringambassadorsnetwork.org](https://www.engineeringambassadorsnetwork.org/impact/). 2023.

<sup>8</sup> Robotics Career." 2025. [Roboticscareer.org](https://www.roboticscareer.org/landing/robotics-scholarships). 2025.

sponsored hackathons. Companies could also seamlessly integrate introductions to the waste management industry through articles reviewing what each job description does, as seen on the RoboticsCareer website (figure 1)<sup>9</sup>. For talent already involved within the engineering industry wanting to switch career focuses, waste disposal organizations could aim to establish progression paths for those already in specific sectors. An example could be that those working in automated computer

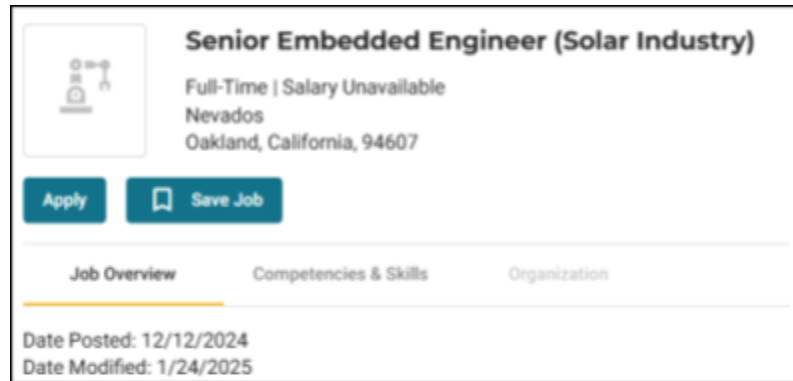


Figure 2: An example of a job listing on RoboticsCareer

vision could be easily and swiftly reassigned within a waste management automated solutions company to identify pieces of waste for adequate disposal. Companies could make new job offerings in the ‘Explore Job’ section of the RoboticsCareer website (figure 2)<sup>10</sup>, where the job title could specify the industry - while companies set qualifications depending on job seniority. These cross-industry collaborations allow for collaboration between adjacent subfields, such as oceanic waste management, and a holistically stronger tie to the industry through accessibility.

<sup>9</sup> Masciantonio, Lisa. 2021. “Robotics Career - Robotic Career Paths: Integrator.” Roboticscareer.org. 2021. <https://www.roboticscareer.org/news-and-events/news/16926>.

<sup>10</sup> Search RoboticsCareer.org for Training and Education in Robotics.” 2025. Roboticscareer.org. 2025. <https://www.roboticscareer.org/search/jobs>.

## TRAINING PROGRAM

Centrally, companies should seek out training programs franchised and overseen by the ARM institute due to their legitimacy in their field. The organization itself identifies key skills that a worker within an industry requires to succeed.<sup>11</sup> An example of a training regimen that covers all the vital strategies needed and is designed explicitly for integrating automation in industries is Advanced

Manufacturing and Integration Technology, which was established by Washington State College of Ohio (figure 3)<sup>12</sup>.

Companies should seek to collaborate with institutions similar to the one listed as it

expands the waste management industry's demographic and allows for skills to be quickly and adequately integrated into the workplace. Applicants should train under an educational institution or adjacent organization for a duration of two to three years, depending on what the applicant seeks to automate (garbage collecting, sorting, etc.) concerning entry-level positions—while senior positions should require more training of either 3 to 5 years or a position in a previous workplace of an adjacent engineering field. The training itself should primarily focus on the



Figure 3: A training opportunity conducted by the Washington State College of Ohio, an example of a training opportunity that teaches skills necessary for automating technologies.

<sup>11</sup> Robotics Career - Endorsement Information for Visitors.” 2025. Roboticscareer.org. 2025.  
<https://www.roboticscareer.org/endorsement-visitors>.

<sup>12</sup> Find Endorsed Robotics Training Programs - RoboticsCareer.org.” 2025. Roboticscareer.org. 2025.  
<https://www.roboticscareer.org/search?endorsed=true>.

integration of AI vision systems in the organization and identification of objects (1), the mechatronics involved with traversal systems such as vehicles or arms (2), and the programming and developmental skills required for both of these - in addition to programmable logic controllers (3). This process should optimally be streamlined and shortened as much as possible depending on demand — as the United States currently has approximately 3.8 million jobs to fill within the automation industry, with more to arrive, considering the rising trend in the automation field.<sup>13</sup> After passing training, companies should implement temporary mentorship programs in which a senior supervises the newly-appointed worker for approximately 2-3 weeks as they transition into a workflow to allow for ease of transition and ensure the worker is, accordingly, understanding assigned tasks and completing them without issue. Thus, applicants should also be acquainted with generative AI to streamline work efficacy regarding menial tasks, and they should also familiarize themselves with the software employed by the company as a basis for what to automate and change. Thus, the mentorship program should cover this basic necessity. Furthermore, new workers with pre-existing experience should be allowed to integrate their former knowledge in some capacity— and should be given a role of seniority according to their aptitudes in both leadership and development to allow for a more meritocratic system. Holistically, these changes should streamline developments and allow for efficient onboarding.

## ***AUTOMATED SOLUTIONS TO WASTE MANAGEMENT***

As presented in the preface, not only is a dwindling workforce a problem prominent in the waste management industry, but the cost of implementation also compounds it. However, the

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<sup>13</sup> Robotics Overview: How Robots Change Mfg - RoboticsCareer.org.” 2025. Roboticscareer.org. 2025.  
<https://www.roboticscareer.org/robotics-overview>.



Solid Waste Association of North America (hereby referred to as SWANA) could burden the cost.<sup>14</sup> However, even without fully automating the physical transfer of waste itself, SWANA has advocated for three steps to introduce Large Language Models (LLMs) and Generative AI to ease labor demands:<sup>15</sup>

- Automated Customer Support, which, if fed a general rulebook for the corporation, could streamline helping users with assistance.
- Data analysis facilitates the development of planning and insight into routing organizational efforts such as trash collection or financial management.
- Generation for posts as a means of Public Relations (PR), such as content creation.

However, the website emphasizes that companies should use generative AI to streamline human workflow rather than supplant it entirely.

Companies should fundamentally strive for these three goals to reduce labor loads. Furthermore, companies should also take action to automate garbage collection. Companies can automate collection by implementing cameras on the sides of collection vehicles – trained to identify and collect garbage cans and bags. Companies should implement human operational oversight over a few months shortly after its implementation to confirm its legitimacy as waste. A transition to an automated solution should be relatively smoother - companies can modify pre-existing vehicles within their fleet to automate collection. Companies may also resolve incorrect or haphazard garbage processors by creating a new facility called a Waste Identification and Processing Unit (WIPU ) through which garbage trucks deliver. The facility would work with these vehicles and

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<sup>14</sup> Solid Waste Association of North America (SWANA).” n.d. SWANA Website. <https://swana.org/>.

<sup>15</sup> Sroka, Nicole. 2023. “How AI Is Revolutionizing Solid Waste Management.” SWANA Website. December 11, 2023. <https://swana.org/news/blog/swana-post/swana-blog/2023/12/11/how-ai-is-revolutionizing-solid-waste-management>.

allow swift organizational work (figure 4.) Through a trained neural network on a

human-annotated dataset to

enable the AI to interpret what

easily and isn't disposable with

limited oversight, the AI would

the processed waste into two

categories and ferry them to

appropriate disposal locations. However, including the WIPU as a separate facility may not be

necessary - as private companies may opt to collaborate with SWANA and integrate the facility

into pre-existing MRFs, ultimately creating extensive facilities for garbage disposal. Considering

the extent to which energy is required to run this facility, it's encouraged that companies utilize

green energy solutions such as nuclear power to reduce the detriment of power-intensive

activities on the environment.

Holistically speaking, these solutions will require significant amounts of funding.

However, collaboration with other private companies, such as Mind Moves in the transition of

pre-existing employees within the company, as well as integrating a project management system

to streamline developments in automation— easing up workflows and allowing for a swifter

transition for all parties involved.<sup>16</sup>

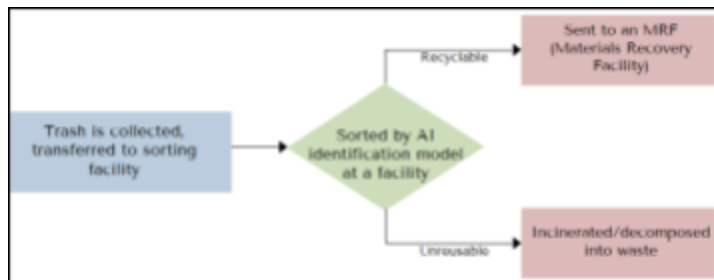


Figure 4: A proposed flowchart for the processing of garbage with a Waste Identification and Processing Unit (WIPU.)

<sup>16</sup> Services - Mind Moves LLC.” 2023. Mind Moves LLC. August 23, 2023. <https://mindmoves.co/services/>.

## ***CONCLUDING NOTES***

From both a humanitarian and a corporate-oriented perspective, waste-management organizations involved in private and public sectors must switch towards automated solutions. A transition not only eases current environmental impact from current solutions such as landfills and the amount of trash that entirely ends up unsorted, in addition to those harmed while treating waste– but also allows people to specialize in other industries and generate more profit. Automation itself is a laborious process for any company, ranging from 20,000 to 100,000 in fees– not to mention continuous maintenance, which could incur further costs that exceed the original billed amount even just for implementation.<sup>17</sup> Thus, industries seeking to revamp entire operating processes to introduce this system must cooperate– especially for one that affects the lifespan of humanity as a species on a dwindling blue dot like ours.

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<sup>17</sup> “Robot Price: How Much Does a Robot Solution Really Cost?” 2024. HowToRobot. 2024.  
<https://howtorobot.com/expert-insight/robot-price-how-much-does-robot-solution-really-cost>.

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