4A03 – Group 4
Final Product Proposal
The Autonomous Garbage Can

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Introduction and Description of the Opportunity

Every week, millions of Canadian households drag heavy garbage bins from the garage to the curb and back again. For seniors, people with mobility challenges, and busy families, this chore is inconvenient and sometimes unsafe, especially in winter conditions. At the same time, existing options either keep costs low but require full manual effort, such as standard plastic bins, or provide convenience at very high ongoing cost, such as concierge waste services. Our project, the Autonomous Garbage Can, addresses this gap by turning a standard residential cart into a self driving bin that travels between the garage and the curb on its own, then returns after collection. The system uses a sealed drive pod with motors, encoders, an IMU, low-cost curb and garage markers, and basic safety sensors. The owner teaches two waypoints once, then schedules pickup days through a simple mobile app and one button interface.

Over the term we have already built a strong foundation for this opportunity. Our preliminary market and intellectual property assessment sized the Canadian target market at roughly nine point three million single detached homes and identified an initial serviceable market of about two point three million homes, with an early adopter reachable market of about thirty-five thousand homes in the first five years at a planned price of seven hundred fifty dollars. Our preliminary technical assessment defined clear minimum viable product requirements, mapped out a realistic technology path using off the shelf components, and showed that core functions such as curb docking and safe navigation are technically feasible with manageable risk. Our preliminary business and financial assessment then demonstrated attractive unit economics, high gross margins and a positive net present value with a staged launch and modest volumes. Building on this work, this proposal requests funding to build and test a full minimum viable product of the Autonomous Garbage Can, and to run focused pilot deployments with early adopters in Canadian single detached homes.

Market Sizing and Target Market Analysis

The market opportunity for the Autonomous Garbage Can is substantial, with a Total Addressable Market (TAM) of approximately 9.27 million Canadian single-detached households, (16.5 million homes [1], and 52.6% of them being single-detached [2]) representing roughly $6.95 billion in potential sales at a $750 price point. From this, the Serviceable Available Market (SAM) was defined as the 25% of households most likely to adopt early smart-home technologies, giving a reachable pool of 2.32 million homes or $1.74 billion in potential revenue. Using realistic adoption rates, geographic filters, and expected marketing reach, the Serviceable Obtainable Market (SOM) is estimated at 34,749 households over the first five years, translating to roughly $26 million in achievable sales. This progression from TAM to SOM demonstrates that, while the overall market is large, the portion realistically capturable in the early years is focused and financially attractive. Growth of over 10% is also expected in the market, as the use of technology in households rises, and the demand for automation increases.

The initial target market within this opportunity includes elderly homeowners or individuals with mobility limitations who benefit most from automated curbside movement, middle- to upper-income homeowners who actively adopt smart-home technologies, and busy working families who value convenience and time savings. Property managers and landlords also represent an early segment, as they may require reliable, automated waste handling across multiple properties. These groups benefit the most from what the product offers, since it directly addresses their needs. This makes them the most likely early adopters and the customers who can help the product gain traction in its first years.

Customer Identification and Value Proposition

The primary customers for the Autonomous Garbage Can are Canadian single-detached homeowners who manage curbside waste, representing roughly 9.3 million households. Of these, about 2.3 million live in driveway-based suburban environments suitable for curb-to-garage automation, with an estimated 35,000 early adopters over the first five years. Key early segments include seniors and people with mobility limitations, busy families, and tech-savvy homeowners seeking convenience and automation.

These groups purchase the product because it removes a recurring, inconvenient task that existing bins do not solve. For mobility-limited users, manually moving a heavy bin, especially in winter poses real physical risk. Busy households appreciate eliminating a weekly chore and avoiding missed pickups, while weather-exposed homeowners value a system designed specifically for Canadian traction and durability.

Our value proposition is a simple, reliable autonomous system that eliminates the need to drag bins to the curb, with no subscription and minimal setup. The product combines the low cost of a standard bin, the mechanical assistance of powered caddies, and the convenience of concierge waste services, without their drawbacks. It travels its taught route independently, docks and charges automatically, operates safely with sensors and speed limits, and returns after pickup, delivering practical convenience at a one-time purchase price.

Competitive Analysis and Product Strategy

Households today rely on a mix of low-cost hardware products and higher-cost services to manage curbside garbage, each with clear trade-offs. Standard plastic bins from brands like Rubbermaid and HDX are durable and inexpensive but remain fully manual with no automation, reminders, or safety features. Premium pest-resistant carts such as the Toter Bear Tough models add reinforced lids and improved animal protection but still require homeowners to drag them to and from the curb each week. Effort-reduction tools like the VEVOR dolly, DJ Products WasteCaddy, and Verhagen Leiden V Move L reduce physical strain but still require hands-on control, offer no route memory, and provide only partial automation. Storage sheds and enclosures from Outdoor Living Today, Lifetime Products, and Tozey hide bins and protect them from weather and pests, though issues such as door alignment or cosmetic wear can appear over time and customers must still roll bins out on pickup day. At the high end, concierge services from U Pak and Miller Waste Systems remove the chore entirely but involve recurring monthly fees and can suffer from missed pickups or scheduling inconsistencies. In a separate category, commercial smart systems like the CleanRobotics TrashBot provide AI-based sorting and monitoring but are large, expensive, and impractical for residential curbside use. Overall, existing solutions are either low cost but fully manual or high convenience but expensive and service-based, and none deliver affordable residential automation.

In this landscape, the Autonomous Garbage Can is positioned as a new category that combines the one time purchase of a physical product with the convenience typically associated with concierge services. It keeps the familiar form and capacity of a standard residential cart but adds autonomous travel between garage and curb, taught waypoints, automated docking and charging, and safe operation with sensors and speed limits. This offers more convenience and accessibility than premium static bins or sheds, while avoiding the recurring fees and reliability issues associated with service based offerings. Our product is deliberately placed in the middle of the spectrum, removing the trade off between low cost and convenience by delivering both in a single owned device.

Our competitive strategy focuses on value innovation and building a defensible long-term position in residential autonomous waste management. The product eliminates the weekly bin-moving chore, reduces the chance of missed collection days, and improves accessibility for seniors and people with mobility limitations, while remaining far cheaper over time than private waste services. To sustain this advantage, we emphasize three elements: a strong intellectual property portfolio with utility patents covering the mechanical drive system and sensor-based navigation methods, industrial design protection, and branding; protection of key navigation, docking, and fault-handling software as proprietary trade secrets; and early brand building to establish first-mover recognition in the autonomous garbage can category. Together, these choices position the Autonomous Garbage Can not as another bin, but as a practical residential robot that fully automates the curbside garbage task at a defensible and sustainable price point.

Technology

The Autonomous Garbage Can integrates several key technologies that enable safe, reliable garage to curb automation at a consumer-friendly price. Our preliminary technical assessment has already demonstrated that these components are feasible using widely available off-the-shelf hardware while preserving the core navigation, safety, and weather-resilience requirements.

Locomotion System: A sealed differential-drive module powers the bin using two geared DC motors with wheel encoders, high-traction outdoor wheels, and an electronic brake. This configuration provides controlled movement across typical driveways and winter conditions, with enough torque and traction for slopes and uneven surfaces.

Navigation and Guidance: Navigation is achieved through a cost-effective dead-reckoning approach that combines wheel encoder data with a 9-DoF IMU. The homeowner sets two waypoints: garage and curb, via the mobile app. Low-cost reflective or magnetic markers at both endpoints ensure repeatable, centimeter-level docking accuracy without requiring expensive LiDAR or camera-based SLAM systems.

Safety and Perception: The system includes ultrasonic or time-of-flight sensors to detect nearby obstacles, along with bumper switches and tilt sensors to trigger emergency stop behavior. A lid or weight sensor confirms that the bin has been emptied so that it can return home automatically. Movement is limited to under 1 m/s and restricted to the homeowner's property for safety.

Power and Battery System: The drive system is powered by a 12–24 V $LiFePO_4$ battery pack with an integrated battery management system (BMS), selected for cold-weather performance, long cycle life, and safety. A weather-resistant charging dock installed in the garage aligns the bin automatically using physical guides and recharges it between collection days.

Control Electronics and Software: An STM32-class microcontroller coordinates motor control, navigation, real-time scheduling, docking logic, sensor fusion, and fault handling. Bluetooth Low Energy (BLE) provides pairing and onboarding experience, allowing homeowners to teach the route, configure pickup schedules, and run diagnostics directly from their phone. This embedded software, particularly the docking, scheduling, and safety logic, is part of our defensible internal IP and a central component of our competitive advantage.

Enclosure and Integration: All electronics and moving components are housed in an over molded, gasket-sealed drive pod that bolts onto standard residential carts, achieving IP54 weather resistance and protecting against dust, rain, and snow. Injection-molded plastics and modular mounting allow durability and manufacturability at scale.

Recurring Product Cost: As established in our technical and business assessments, the recurring manufacturing cost per unit is approximately $130 CAD, including plastics, motors, sensors, the battery and charging dock, control electronics, assembly, packaging, and shipping. Because the product is a one-time purchase with no subscription, this recurring cost reflects our steady-state cost of goods sold rather than an ongoing service obligation.

Technology Access and Integration: We combine internally developed software and mechanical design with commonly available off-the-shelf components. The core intelligence: the navigation logic, docking control, safety behavior, and scheduling is designed and built in-house. Hardware elements such as motors, sensors, IMUs, BLE modules, and batteries are sourced from standard consumer-robotics suppliers, keeping costs low and reducing technical risk.
All components integrate into a sealed, modular drive pod that mounts onto a standard residential cart. The firmware coordinates the locomotion, sensing, docking, and charging into one unified system, resulting in a durable, manufacturable product designed specifically for Canadian curbside environments.

Intellectual Property and Regulatory and/or Privacy Issues

To protect the Autonomous Garbage Can and prevent direct competition, the project relies on a combination of utility patents, trademarks and trade secrets. The core IP strategy focuses on patenting the autonomous driving system, which consists of sensor-based navigation, the mechanical driving system and the software required for the bin to locate where it must stop and return to. This combination of software and mechanical components does not currently exist in any patented trashcan product. The closest comparable technology is the Rezzi Smartcan, which demonstrates a conceptually similar autonomous bin, but it has no viable product or patented technology [3]. An older patent had been filed, US2007/0209846A1, which was a patent for a remote-controlled motorized garbage can. This technology did not directly align with the idea, as it required the user to control the can, thus making it manual. Additionally, this patent has been abandoned since its filing, thus removing it as a blockade for our concept [4]. Competitor patents from Simplehuman focus on motion-sensor lid mechanisms and container aesthetics [5], which are more tailored towards indoor garbage bins, thus preventing them from posing a threat to the Autonomous Garbage Can.

Because there is a clear difference between our method of operation and preexisting technology in this market, the team has strong freedom to operate and a clear path towards securing a new utility patent centred around the autonomous driving technology for an outdoor garbage bin. In addition to utility protection, the product name and branding associated with the product will be protected through a Canadian trademark filing.

Several key regulatory approvals are required before entering the Canadian consumer electronics market. Since the product uses motors, batteries, and wireless communication, it must meet standard Canadian safety and radio-compliance requirements before commercial sale. This includes electrical safety certification for the charging station and the electronics from the Canadian Standards Association [6], as well as battery safety validation for the $LiFePO_4$ battery pack from the Canadian Standards Association[7], and finally, radio-frequency approval for the Bluetooth communication feature under Innovation, Science, and Economic Development regulations[8]. Addressing these approvals early is essential, as certification delays were identified as one of the highest-impact risks during the risk analysis stage.

Privacy considerations stem mainly from the mobile application used for setup and scheduling. Since the system intentionally avoids cameras, cloud connectivity, and real-time data streaming, the privacy footprint remains relatively small. However, the app still collects and stores user-specific information such as driveway route data, pick-up schedules, and a basic connection to a mobile device. To protect this information, all data will be stored locally on the device or user phone whenever possible, secured through encryption, and accessed only with user permission. Compliance with The Personal Information Protection and Electronics Documents Act (PIPEDA) ensures that user data is handled responsibly and the privacy risks and minimized [[9].

Business Model

The Autonomous Garbage Can follows a one-time purchase model with a selling price of $750 and no required subscription fees. This suits the target market of middle to upper-class homeowners, seniors, and property managers who value convenience and are willing to invest in smart-home solutions. Customers are reached through online direct sales and retail partnerships with stores such as Walmart, Home Depot, and Canadian Tire, which is important for accessibility and product visibility.

Profitability comes from strong margins, as the estimated COGS of $130 includes motors, sensors, electronics, the LiFePO4 battery, and the charging dock. A margin of over $500 provides room for marketing, promotions, and retail expansion. The business model also relies on partnerships with electronics suppliers, battery manufacturers, plastic moulding firms, and contract assembly facilities to support scalable production. Future revenue could come from optional accessories like improved charging docks, cooling systems to reduce odour, or protective covers for harsh weather.

Financial

Based on the provided supporting information, the Autonomous Garbage Can represents a strong investment opportunity due to its high margins, growing market demand, and long-term scalability.

With an average selling price of $750 and a recurring COGS of approximately $130 per unit, the product achieves an estimated gross margin of 82.7%, which is significantly higher than typical consumer hardware margins. This large margin provides flexibility for marketing, distribution, and retailer partnerships while still maintaining strong profitability.

In addition, the market for smart waste technologies is expanding rapidly. According to Grand View Research, the global smart trash bin market is currently valued at $64.36 million USD and is projected to reach $162.02 million USD by 2030, growing at a rate of 12.4% [10]. This growth rate is strengthened by a broader technology adoption trend within society. As households increasingly embrace automation devices, the demand for products that make people's lives easier rises. Every year, society becomes busier and busier, and any chance to remove redundant tasks is an opportunity many would take advantage of. This creates a long-term trajectory for the Autonomous Garbage Can to reach more consumers every year.

MVP Build

For the MVP stage, we propose building a fully functional engineering prototype of the Autonomous Garbage Can that demonstrates the complete curb-to-garage workflow under real residential conditions. Rather than focusing on aesthetics, this MVP focuses on validating core performance: navigation accuracy, winter traction, safety behavior, docking reliability, and user setup. The build will include a working drive pod containing the motors, encoders, IMU, battery system, safety sensors, microcontroller, and BLE module, all integrated into a sealed enclosure mounted onto a standard residential cart. A paired garage charging dock will also be constructed, using mechanical alignment guides and reflective markers to enable consistent docking and automatic recharging. Alongside the hardware, we will develop the full navigation and safety firmware, including waypoint teaching, dead-reckoning movement, obstacle stopping, docking logic, scheduling, and fault handling. A basic mobile app will support onboarding, route teaching, and pickup-day configuration. Once assembled, we will conduct a structured pilot test with 5–10 households to evaluate real-world performance across different driveway lengths, slopes, and weather conditions. This MVP stage ensures that the system is safe, reliable, and technically feasible before committing to a full production design.

MVP Plan

The plan is to use the funding to build and validate a fully functioning Autonomous Garbage Can MVP over roughly twenty-four months, with clear milestones that show whether the product is ready to move toward commercialization. The goal of this stage is to finish with a bin that can reliably drive between garage and curb on its own in Canadian outdoor conditions and to confirm that the cost and supply chain assumptions are realistic. In the first part of the plan the team focuses on the core drive, power and safety hardware. A sealed drive pod with differential motors, high traction wheels and a basic chassis is designed and built, then tested on representative driveways to achieve simple, repeatable motion without mechanical failure. The motor drivers, bumper switches, tilt sensors and emergency stop circuitry are then integrated so the bin always enters a safe state when it encounters an obstacle, tips or receives a stop request. The power system, including the $LiFePO_4$ battery pack, battery management system and a simple garage charging dock, is added so the MVP can complete a full charge, run, return and recharge cycle. This stage ends with refined ultrasonic or time of flight sensors and mounts so the system can consistently detect obstacles and edges, giving the first feasibility check that the hardware can move, stop and recharge safely.

The second part of the plan turns this hardware into an autonomous system that can perform the full job without supervision. The team implements dead reckoning navigation using wheel encoders and an inertial measurement unit, combined with low-cost curb and garage markers. The homeowner teaches two waypoints, garage and curb, and the bin is expected to repeat this route several times in a row without manual correction. Docking at both ends is improved so that the bin lines up with the charging dock and curb in a predictable position, and an internal scheduling engine with return after empty behavior is added using a real time clock and an empty detect sensor. On a set schedule, the bin leaves the garage, travels to the curb, waits to be emptied and then returns to dock automatically, so by the end of this part the MVP delivers the core customer promise under controlled test conditions.

The final part of the MVP plan confirms that the prototype can work for real users and that it can be manufactured at the expected cost. The team develops the Bluetooth onboarding flow so a typical homeowner can pair the bin with a phone, teach the driveway route and set pickup schedules without special tools or expertise, with a user test to confirm that non technical participants can complete setup and run a scheduled trip. Structured field testing is then carried out on a variety of driveways, including different lengths, slopes, surfaces and mild winter conditions, together with environmental and stress testing of the hardware, producing a report of success rates, failure modes and required design adjustments. The last step is manufacturing feasibility work that validates the bill of materials, confirms at least two suppliers for critical parts and updates the cost of goods based on real quotations. The intended outcome is confirmation that the per unit cost remains close to the earlier one hundred thirty dollar estimate and that a realistic supply chain exists for motors, batteries, plastics and electronics. Throughout the twenty four weeks, end of stage reviews provides investors with clear evidence of progress and defined points where the project can be continued or paused based on MVP performance.

MVP Cost and Resources

The MVP requires a focused investment in hardware, electronics, software development, and testing resources. The hardware for each prototype includes motors, drivers, encoders, the IMU, ultrasonic or ToF sensors, the microcontroller, BLE module, $LiFePO_4$ battery pack, charging components, and prototype enclosure materials, which costs approximately $350 to $400 per unit. Building 5–10 units results in a total hardware cost of roughly $3,500 to $4,000. Additional expenses include approximately $2,000 for machined or 3D-printed enclosure parts and weather-sealed components, $1,500 for early PCB prototypes and electronics integration, and about $1,500 for testing equipment, replacement parts, and miscellaneous consumables. Software development, including firmware for navigation and docking, safety logic, BLE configuration, and the basic mobile onboarding app, represents the largest single cost at approximately $7,000. Altogether, the MVP budget is estimated at $15,000 to $16,000.

To execute this build, the team requires mechanical engineering support for drive pod design and enclosure work, an embedded/electrical engineer for PCB prototyping, power management, and sensor integration, and firmware developers to implement navigation, control, and safety features. A mobile developer is also needed to produce the initial setup and scheduling app. In addition to personnel, the project requires access to prototyping tools such as 3D printers, machining equipment, electronics workstations, and indoor/outdoor testing space. Finally, 5–10 pilot households will participate in real-world testing to evaluate performance in varied driveway and climate conditions. These combined resources ensure that the MVP is functional, testable, and reflective of the final product's real-world behaviour.

Risk Management

Below, five of the most significant risks associated with the Autonomous Garbage Can are outlined, along with the mitigation strategies developed to address each one.

Hardware reliability failure is a high-impact, high-probability risk because the system must withstand outdoor conditions such as rain, snow, dirt, and temperature changes. Early prototypes are especially vulnerable to overheating, wiring issues, and mechanical stress. Mitigation involves selecting durable components, using a modular design so parts can be replaced easily, and performing extensive stress and environmental testing early in the project timeline.

Navigation and sensor failure is a high-impact risks due to the product's dependence on accurate movement and docking. Environmental factors such as debris, reflective surfaces, or winter conditions can affect sensor readings or accuracy. The mitigation strategy emphasizes reliable sensors, regular calibration, and broad field testing across different driveway scenarios. The system also uses multiple sensors to cross-check data. If unpredictable movement or inconsistent readings occur, the backup plan includes upgrading to more reliable sensors and improving mounting and shielding

Supply chain instability is likely and holds a significant impact because component shortages, long lead times, or part discontinuities can disrupt the schedule. Mitigation focuses on designing around widely available, interchangeable parts and identifying multiple suppliers early in the manufacturing feasibility sprint. Critical components are ordered early to avoid delays. If supply issues arise, the project will redesign around more common parts, substitute suitable temporary alternatives, or simplify nonessential subsystems to keep development on track.

Market price resistance is a medium-impact but likely risk because the retail price of $750 may be considered too high for a portion of consumers. This could limit adoption, especially among households that do not perceive enough value in automating waste removal. Mitigation focuses on positioning the Autonomous Garbage Can toward early adopters, higher-income households, accessibility-focused users, and individuals who already invest in smart-home technologies. Clear communication of the product's convenience, safety benefits, and time savings is crucial.

Cosmetic weathering is low impact but likely risk because intense weather conditions can cause fading, scratches, or surface wear. While this does not affect functionality, it can affect customer satisfaction and perceived product quality. Mitigation involves selecting weather-resistant materials and designing surfaces that are easy to clean and maintain. It is also important that the software minimizes the time the garbage can spend outside, as opposed to being in a sheltered garage where it will not be subject to weather conditions.

Assumptions

The business depends on several key assumptions that affect both the technical and financial feasibility of the Autonomous Garbage Can. First, the estimated COGS of $130 is based on current component pricing, but some parts may have been overlooked or may change in cost. Second, the projected serviceable obtainable market of 35,000 households assumes strong adoption; if actual uptake is lower, both total market size and revenue forecasts would drop. Third, the expected 10% annual market growth rate reflects trends in automation and smart-home technology, but unforeseen factors could slow this growth and reduce future market potential.

Because these assumptions directly feed into the financial model, any deviation would significantly impact revenue and overall viability.

Summary and Next Steps

As you can see, the Autonomous Garbage Can is a strong candidate for continued investment. The market is large and clearly defined, with millions of Canadian single detached homes and a realistic early adopter segment of about thirty-five thousand households. Customers face a recurring, inconvenient task that existing products do not fully solve, and our design fills the gap between low-cost manual bins and expensive concierge services. The technical concept, which combines a sealed drive pod, dead reckoning navigation with simple markers, safety sensing and a robust power system, can be built using standard off the shelf components. The business and financial analysis supports a selling price of seven hundred fifty dollars with an estimated cost of goods near one hundred thirty dollars, resulting in strong gross margins, while the intellectual property and regulatory review suggest meaningful freedom to operate and a credible path to patents, trademarks and required certifications.

The MVP plan converts this opportunity into a focused twenty-four-week development effort that will produce a working prototype tested in Canadian driveway and weather conditions and will verify key cost and supply chain assumptions. Funding at this stage would support engineering time, prototype hardware, field testing and early manufacturing feasibility activities, with clear go or no go checkpoints at the end of each phase. If the MVP meets its milestones, the major technical and business risks will be substantially reduced and the project can advance into certification, pilot deployments with early adopters and discussions with retailers and strategic partners. If it does not, the MVP process will still have provided a structured, evidence-based answer at relatively low cost. On this basis, the recommended next step is to proceed with funding the MVP build and begin detailed scheduling, team assignment, supplier engagement and the first phase of hardware development.

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