

# Plasthirst: The Potential of Water Dispenser Reverse Vending Machine in Plastic Bottle Waste Management

Mark Lester G. Jimenez<sup>1\*</sup>, Cathlyn Joy M. Nazal<sup>1</sup>, Sebastian Lee H. Canlas<sup>1</sup>, Nel Eiram D. Sadie<sup>1</sup>, Reyvin Angeline L. Sombillo<sup>1</sup>, Mary Joy M. Castor<sup>1</sup>, Althea B. Amora<sup>1</sup>

<sup>1</sup>Senior High School Department, Pasig National High School, Candaba 2013, Philippines

\*Corresponding author: [mark031606@gmail.com](mailto:mark031606@gmail.com)

**Abstract:** Plastics are commonly used for convenience, but improper disposal significantly harms marine ecosystems. Despite the presence of trash bins, plastic waste remains unmanaged, prompting researchers to develop Plasthirst, a machine that dispenses 200 ml of drinking water for every plastic bottle deposited, thereby promoting proper waste management. The study involved building a functional prototype using an ESP32 microcontroller, integrating components, and ensuring safety before pilot testing. A descriptive analysis evaluated Plasthirst's response time and dispensing accuracy, as well as the factors influencing students' utilisation of this machine. Meanwhile, correlational analysis revealed a very weak, non-significant relationship between bottle size and amount of water dispensed,  $r = -0.06$ ,  $p(0.81) > 0.05$ . However, a strong, significant positive correlation was shown between the number of bottles deposited and the amount of water dispensed,  $r = 0.99$ ,  $p(0.00) < 0.05$ . All measured factors significantly influenced students' engagement with Plasthirst. Based on the findings, the researchers recommend adding a 1–2-second delay to give users more time to deposit bottles and suggest upgrading to infrared or weight sensors to improve detection and adjust water dispensation based on bottle size. Testing the machine with at least five bottles is also advised for a more detailed analysis. Additionally, incorporating a QR code that links to educational material on recycling could further improve environmental awareness and user participation. Finally, following the proposed developmental plan is expected to enhance Plasthirst's overall efficiency and impact.

**Keywords:** *Plasthirst, Machine, Plastic Bottle, Drinking Water, Sustainable Product*

Conflicts of interest: None

Supporting agencies: None

Received 25.07.2025; Revised 16.11.2025; Accepted 27.11.2025

**Cite This Article:** Jimenez, M. L. G., Nazal, C. J. M., Canlas, S. L. H., Sadie, N. E. D., Sombillo, R. A. L., Castor, M. J. M., & Amora, A. B. (2025). Plasthirst: The Potential of Water Dispenser Reverse Vending Machine in Plastic Bottle Waste Management. *Journal of Sustainability and Environmental Management*, 4(2), 101-110.

## 1. Introduction

Plastics have become an integral part of daily human life, playing a significant role in various aspects. Plastics are widely used in packaging, agriculture, healthcare, fashion, and even household use. However, their widespread use has led to environmental concerns, particularly regarding plastic waste management (Ilyas et al., 2018).

Although plastic is convenient for people, it poses serious risks to their health and the environment. The majority of plastic products are polymer compounds made through condensation or addition polymerisation. If plastic products are used for extended periods, this can lead to chronic poisoning in humans. Furthermore, a significant amount of plastic waste is disposed of annually due to the relatively low cost of production and short lifespan of

plastic products, which has a negative impact on the environment (Pan et al., 2020; Ferronato et al., 2024).

According to the United Nations Environment Programme (2022), although plastic has many useful uses, consumers have become addicted to single-use plastic products, which have detrimental effects on the environment, society, economy, and public health. Around the world, up to five trillion plastic bags are used each year, and one million plastic bottles are purchased every minute. Roughly half of all plastic produced is intended for single-use before being thrown away. Approximately 400 million tons of plastic waste are produced annually. These single-use plastics are widely available and add to the world's plastic pollution problem.

Food wrappers, plastic bottles, grocery bags, straws, plastic lids, other plastic bags, cigarette butts with plastic filters, foam containers, and plastic take-out containers

were among the top ten trash items gathered on International Coastal Cleanup Day in 2017. After cigarette butts with plastic filters (2.4 million items collected) and plastic wrappers (1.7 million items collected), plastic beverage bottles came in third place with 1.6 million items collected. Every item on the list is composed of plastic (Carrig, 2018).

Furthermore, according to World Bank Group (2021), the Philippines' handling of plastic waste is a significant problem. An estimated 20% of the 2.7 million tons of plastic waste produced annually in the country—roughly 540,000 tons—end up in the ocean. According to a study by Herbie (2023), the Philippines remains a significant source of marine plastic pollution, accounting for more than 36% of the global oceanic plastic waste.

Additionally, because many plastic products are single-use items designed to be thrown away, such as water bottles and takeout containers, plastic is used and eventually thrown out. These are used quickly and then thrown away. This waste may wind up in the ocean if it is not managed or disposed of appropriately. Plastic does not break down like some other types of waste. This implies that plastic can persist indefinitely and negatively impact marine environments. Furthermore, not all plastics float in the ocean, but some do. A large portion of the plastic breaks down into tiny fragments known as microplastics as it is thrown around (National Oceanic and Atmospheric Administration, 2024).

A study by Idumah and Nwuzor (2019) shows that the intrinsic inability of petroleum-based plastics to biodegrade has made them a dangerous environmental hazard because of their frequent presence in the waste stream. Plastic waste has persistently polluted the environment and caused serious problems, such as clogged drains and rising health problems. Their widespread presence in the waste stream presents serious problems, particularly in the absence of efficient waste management. Many nations amass plastic pyramids that need to be disposed of properly, but because waste disposal is expensive, many turn to careless plastic dumping, which contributes to plastic pollution.

Furthermore, as the world's capacity to handle the rapid growth in the production of disposable plastic products is exceeded, plastic pollution has emerged as one of the most urgent environmental concerns. In developing Asian and African countries, where waste collection systems are frequently ineffective or nonexistent, plastic pollution is most noticeable. Even developed nations struggle with properly disposing of plastics, especially those with low recycling rates Parker (2024).

Additionally, plastic pollution poses a major threat to the ecosystem. When plastics break down, microplastics are created that enter the food chain and harm aquatic life by getting into soil and water systems. Additionally, discarded plastic bottles contribute to urban waste, which clogs drainage systems and degrades the environment (United States Environmental Protection Agency, 2023). Landfills are frequently used to get rid of these plastic wastes. However, disposing of plastic waste in a landfill only

delays the problem's resolution. According to earlier research, leachate and landfill waste are two possible sources of microplastics (Wan et al., 2022).

Additionally, numerous trash cans are available for collecting plastic bottles; however, O'Connor et al. (2013) asserts that merely providing trash cans for plastic bottles may not be sufficient to improve plastic waste management. Recycling rates were not considerably raised by altering the appearance of common areas or adding more recycling bins. This suggests that components beyond mere container presence, such as user involvement and knowledge, are critical to the effective management of plastic waste.

In line with the premises above, the researchers developed *Plasthirst*, a Reverse Vending Machine that allows people to exchange their plastic bottles for drinking water. Research has shown that incentive-based recycling programs significantly increase the number of individuals participating in waste management activities. According to White et al. (2019), providing financial or non-financial incentives, such as discounts or freebies, increases engagement in environmentally friendly behaviors like recycling.

This study is also supported by Yang and Thøgersen's (2022) findings, which show that external incentives serve as initial motivators for pro-environmental actions. However, people may eventually develop an innate desire to continue recycling even in the absence of incentives. This suggests that while *Plasthirst* provides water as a reward, it may also help students to acquire long-term environmental awareness and habits. Extrinsic motivators can eventually lead to autonomous motivation, where people internalise the advantages of recycling and continue the behaviour even in the absence of explicit rewards, according to Deci and Ryan (2000), the Self-Determination Theory.

In the context of Philippine schools, a water-based incentive is particularly appropriate, as the country is grappling with some of the hottest temperatures, which present substantial public health challenges and heighten students' need for hydration (Garcia, 2024). Thus, by offering drinking water as a reward, *PlasThirst* not only encourages recycling behaviour but also responds to a practical necessity, making the incentive both functional and contextually meaningful.

The goal of this plastic waste management system is to prevent plastic bottles from ending up in the ocean or waterways by encouraging people to collect them, separate them from biodegradable materials, and dispose of them properly. Additionally, this study aims to ascertain how well the *Plasthirst* works to enhance school plastic waste management.

By embracing this innovative step, this will help the community to have effective plastic waste management by motivating the recycling behaviour of the people by rewarding them every time they collect their plastic bottles into the machine.

variable is the amount of water dispensed. Moreover, the water pump remained constant for each experiment.

## 2. Materials and methods

### 2.1. Research Design

This study utilised a pre-experimental and descriptive research design, the simplest form of research design that helps researchers begin to answer complex research questions. They are termed ‘pre-experimental’ because they do not adhere to the strict standards of true experimentation, particularly in terms of control and randomisation (Kumar, 2025). This study tests the relationships between the number of plastic bottles deposited and the amount of water dispensed, and between the size of the plastic bottle deposited and the amount of water dispensed.

The independent variable in this study is the number and size of plastic bottles deposited, while the dependent

### 2.2. Materials and Cost

The materials for this study were gathered in many ways. Products such as plywood, Lumber, wire, hose, switches, and black paint are bought from local markets and hardware stores, while the water pump, ESP32, LED lights, ultrasonic sensors, breadboard, solar panel, and pulse width modulation were bought from an online store. The other tools and equipment, such as hammer, nails, soldering iron, pliers, scissors, cutting pliers, electric tape, and wood saw, are borrowed. Lastly, the PVC box containers and water gallon were provided by the researchers’ acquaintances at no cost; therefore, these materials are not included in the cost table.

**Table 1:** List of Materials Used in Developing the Plasthirst

Materials	Quantity	Price
ESP32 Microcontroller	1pc.	Php 350.00
Ultrasonic Sensor	1 pc	Php 90.00
F-F wire	20 pcs.	Php 90.00
M-M wire	20 pcs.	Php 90.00
F-M wire	20 pcs	Php 90.00
Breadboard	1 pc.	Php 65.00
LED light	15 pcs.	Php 75.00
Water Pump	1 pc.	Php 145.00
Lithium Battery	1 pc.	Php 450.00
Solar Panel	1 pc.	Php 300.00
Pulse Width Modulation (PWM)	1 pc.	Php 159.00
Black Paint	500 ml.	Php 450.00
Total:		Php 2354.00

Table 1 provides a comprehensive list of materials required to develop Plasthirst. The cost of each material is also documented in this segment.

### 2.3. Procedures

This part presents the process of preparing and creating the Plasthirst. This segment also provides a step-by-step procedure for testing the machine's effectiveness and reliability.

#### A. Planning and Designing

Step 1. Identified the key components on building the Plasthirst.

Step 2. Defined how the machine should work and its purpose.

Step 3. Made a sketch plan as a guide throughout the process of building the Plasthirst.

#### B. Collecting Materials

Step 1. Selected suitable materials considering their quality, durability and cost.

Step 2. Gathered the needed tools and equipment for building the machine.

Step 3. Prepared personal protective equipment (PPE) to ensure the safety of the researchers.

#### C. Production of the machine

##### C.1. Programming the System

Step 1. Identified how the components work to analyse correct coding.

Step 2. Programmed the esp32 microcontroller with other components to develop the control system.

Step 3. Added and programmed LED lights to give an indication to the users about the ongoing process inside the machine

## C.2. Creating the Frame and Cover

- Step 1. Measured and marked the needed length of materials
- Step 2. Cut the plywood and lumber according to their size using a wood saw.
- Step 3. Attached the cut materials to each other using nails.
- Step 4. Created a hole for plastic bottle deposit.
- Step 5. Added the required frame inside the machine for the placement of the system, sack, and gallon of water.

## C.3. Perform Electrical Wiring

- Step 1. Connected the wirings of other components to the esp32 microcontroller using a soldering iron.
- Step 2. Connected the wiring of the water pump to a 12v battery.
- Step 3. Added a relay module to safely turn on and off the water pump and avoid short circuits.

## D. Checking and Adjusting

### D.1. Initial Evaluation

- Step 1. Checked the proper arrangement of the system and other components.
- Step 2. Conducted initial trials to check how the machine performs.

### D.2. Fixing Visible Problems

- Step 1. Identified the errors and problems from the initial trial
- Step 2. Made necessary adjustments to fix the problems.
- Step 3. Checked the improved version of the machine and prepared for final testing.

### D.3. Final Evaluation

- Step 1. Took a close look at the Plasthirst and checked how well it works based on its dispense, monitoring accuracy, and precision.
- Step 2. Evaluated the machine's function if it works properly and prepared for trials.

## E. Testing of Plasthirst

### E.1. Testing the Response Time of Plasthirst

- Step 1. Prepared plastic bottles to be deposited.
- Step 2. Conducted 5 trials with plastic bottles and used a timer to measure how fast the machine can recognise when a bottle is dropped.
- Step 3. Paid attention and took note of Plasthirst's speed and reaction time measurements.
- Step 4. The researchers utilized descriptive statistical approach to measure the mean and standard deviation of Plasthirst's response time.

### E.2. Testing the Dispensing Accuracy of Plasthirst Based on the Size of Plastic Bottles

- Step 1. Prepared plastic bottles with different sizes to be deposited.
- Step 2. Conducted 3 trials with plastic bottles and used a measuring cup to measure how accurate the amount of water dispensed was according to the size of the plastic bottle.

Step 3. Paid attention and took note of Plasthirst's accuracy measurements.

Step 4. The researchers utilized descriptive statistical approach to measure the mean and standard deviation of Plasthirst's accuracy.

### E.3. Testing the Dispensing Accuracy of Plasthirst Based on the Number of Plastic Bottles

Step 1. Prepared plastic bottles of different sizes to be deposited.

Step 2. Conducted 3 trials with plastic bottles and use a measuring cup to measure how accurate the amount of water dispensed according to number of plastic bottle deposit.

Step 3. Paid attention and took note of Plasthirst's accuracy measurements.

Step 4. The researchers utilised a descriptive statistical approach to measure the mean and standard deviation of Plasthirst's accuracy.

### E.4. Determine the Significant Relationship Between the Amount of Water Dispense and Size of Plastic Bottles Deposited

Step 1. Prepared different-sized plastic bottles for deposit.

Step 2. Conducted 3 trials with different plastic bottles and measure the water dispense.

Step 3. Took note of the water dispense measurements in various sizes of plastic bottles.

Step 4. The researchers used correlation analysis to assess the relationship between the size of plastic bottles deposited and the amount of water dispensed.

### E.5. Testing the Amount of Water Dispense based on Varying Sizes of Plastic Bottle Deposited

Step 1. Prepared different numbers of plastic bottles to be deposited.

Step 2. Conducted 3 trials with different sizes of plastic bottles and measure the water dispense.

Step 3. Took note of the measurements of water dispense in varied number of plastic bottles.

Step 4. The researchers applied correlation for inferential analysis to determine the significant relationship between the number of plastic bottles deposited and amount of water dispensed.

### E.6. Assessing Factors such as Convenience, Incentives, and Environmental Awareness that may Influence Students' Utilisation of Plasthirst

Step 1. Prepared a Likert scale survey questionnaire about how factors such as convenience, incentives, and environmental awareness influence students' utilisation of Plasthirst.

Step 2. After conducting the survey, the researchers used a descriptive statistical approach to analyse the data, reporting the mean and standard deviation.

Step 3. Based on the results, the researchers interpreted how convenience, incentives, and environmental awareness affect students' utilization of Plasthirst.

E7. Creating a development plan based on the results of the study.

Step 1. Analysed and interpreted the data from the previous tests.

Step 2. Determined the strengths and weaknesses of Plasthirst.

Step 3. Identified the needed adjustments or changes to improve the performance of Plasthirst

## 2.4. Data Analysis

The researchers utilised descriptive statistics, including the mean and standard deviation, to describe Plasthirst’s efficiency in terms of response time, dispensing accuracy, and precision. It was also utilised to determine the factors influencing students’ use of Plasthirst, such as convenience, incentives, and environmental awareness.

Additionally, the researchers used inferential statistics, such as correlation, to determine the significant relationship between the number and size of plastic bottles and the amount of water dispensed by the machine.

**Table 2:** Response Time of Plasthirst

	Response Time (in seconds)					Mean	SD
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5		
Plasthirst	2.17	2.38	2.38	2.33	2.30	2.31	0.09

Table 2 shows Plasthirst's response time across the 5 trials. On the first trial of the machine, the response time is 2.17 seconds, while the second trial resulted in 2.38 seconds, similar to the third trial. The fourth trial showed a response time of 2.33 seconds, while the last recorded 2.31 seconds. Overall, The Plasthirst has a mean response time of 2.31 seconds (SD = 0.086). This implies that Plasthirst is convenient because of its quick, satisfying response time.

This is supported by the findings of Arowolo et al. (2023), who reported an average response time of 9 seconds for an automated liquid-dispensing machine. Additionally, this aligns with a study showing that quick response times are pivotal to shaping user satisfaction and loyalty. The immediacy with which a service addresses customer inquiries or needs influences the customer's perception of

## 3. Results and Discussion

### 3.1. Description of the Efficiency of Plasthirst

This item presents the results for the first question in the statement of the problem, which includes the description of response time, dispensing accuracy by size, and the number of plastic bottles deposited in the Plasthirst.

#### 3.1.1. Response Time of Plasthirst

Response time is the time it takes for the machine to process. The researchers used a stopwatch to measure the duration of the machine’s response from depositing the plastic bottle until it started to dispense water. The table below presents the description of Plasthirst in terms of its response time in seconds:

the quality. It indicates that consumers expect rapid responses, and delays can lead to dissatisfaction. (Groves, 2024).

#### Dispensing Accuracy Based on Size of Plastic Bottles Deposited

Dispensing accuracy by plastic bottle size refers to how the Plasthirst dispenses the correct amount of water based on the bottle size. To determine its accuracy, the researchers deposited one of each different size of plastic bottle and measured the amount of water dispense. The table below shows the machine's dispensing accuracy across the first, second, and third trials.

**Table 3.** Dispensing Accuracy Based on Size of Plastic Bottle

Size (Volume in ml)	Amount of Water Dispensed (in ml)			Mean	Standard Deviation
	Trial 1	Trial 2	Trial 1		
230	205	200	200	201.67	2.89
295	200	200	200	200.00	0.00
320	200	210	200	203.33	5.77
500	200	200	200	200.00	0.00
1000	200	200	200	200.00	0.00
1500	200	205	200	201.67	2.89

The data presented in Table 3 showcases the dispensing accuracy of Plasthirst based on the size of plastic bottle that

was deposited. By depositing 230 ml bottle, the researchers obtained 205 ml for the first trial and 200 ml for the second and third trials, with a mean of 201.67 (SD=2.89). Next, with the 295 ml bottle, researchers obtained 200 ml in the first through third trials, with a mean of 200 (SD=0.00). For the 320 ml bottle, the researchers recorded 200 ml in the first trial, 210 ml in the second, and 200 ml again in the third, with a mean of 203.33 (SD=5.77). Next, using the 500 ml bottle, the researchers obtained 200 ml across the first to third trials, with a mean of 200 (SD=0.00). For the 1000 ml bottle, the researchers also got 200 ml from the first up to the third trial, with a mean of 200 (SD=0.00). Lastly, by depositing a 1500 ml bottle, the researchers recorded 200 ml for the first trial, 205 for the second, and 200 again for the third, with a mean of 201.67 (SD=2.89).

It indicates that regardless of the size of the plastic bottle deposited into the Plasthirst, the amount of water dispensed remains consistent. This shows that the system does not differentiate among bottle sizes when determining the

amount of water to release. This is similar to the findings of Ringel (2025) that in reverse vending machines (RVMs), the dispensing mechanism is typically designed to provide a fixed reward per deposited container, regardless of its size or capacity. This uniform approach simplifies the system's operation and encourages recycling by offering consistent incentives.

**Dispensing Accuracy Based on Number of Plastic Bottles Deposited**

Dispensing accuracy, based on the number of plastic bottles, refers to how the Plasthirst dispenses the correct amount of water depending on the number of plastic bottles deposited. The researchers examined the amount of water dispensed after depositing one, two, and three pieces of plastic bottles to assess its accuracy. Since any size of plastic bottle holds the same amount of water, the bottle's size is now irrelevant. The table below shows the machine's dispensing accuracy across the first, second, and third trials.

**Table 4:** Dispensing Accuracy Based on Number of Plastic Bottle

Number of Plastic Bottle	Amount of Water Dispensed (in ml)			Mean	Standard Deviation
	Trial 1	Trial 2	Trial 3		
1	200	200	200	200.00	0.00
2	400	400	410	403.33	5.77
3	620	620	600	613.33	11.55

Table 4 shows Plasthirst's dispensing accuracy by the number of plastic bottles deposited. By depositing one plastic bottle, the researchers obtained 200 ml from the first up to the third trial, with a mean of 200 (SD=0.00). Next, the two plastic bottles received 400 ml in the first and second trials, then 410 ml in the third trial, with a mean of 403.33 (SD=5.77). Lastly, for three plastic bottles, the researchers recorded 620 ml in the first and second trials, then 600 ml in the third trial, with a mean of 613.33 (SD=11.55).

As the number of bottles increases from 1 to 3, the amount of water dispensed increases. This indicates that the more plastic bottles are deposited, the more water will be dispensed. The results reinforce the effectiveness of the reward mechanism, encouraging users to recycle more plastic bottles in exchange for a greater water reward. This

is similar to the research conducted by O'Caroll (2024), which demonstrates that increasing rewards as individuals participate more effectively increases their involvement in pro-environmental activities.

**3.2. Relationship Between the Size of Plastic Bottles Deposited and the Amount of Water Dispensed**

This item presents the Pearson correlation to assess the relationship between the size of the plastic bottle (independent variable) and the amount of water dispensed (dependent variable). The rule of thumb for this statistical treatment was utilized.

**Table 5.** Results of Pearson Correlation Between Size of Plastic Bottle Deposited and Amount of Water

Variables	r-value	p-value
Size of Plastic Bottle Deposited and Amount of Water Dispensed	-0.06	0.81

Correlation is significant at the 0.05 level (2-tailed).

Table 5 presents the correlation between the size of the plastic bottle deposited and the amount of water dispensed, which demonstrates a very weak negative correlation between the variables,  $r = -0.06$ . This relationship is not significant, as the null hypothesis is accepted ( $p = 0.81 > 0.05$ ). These results indicate that the size of plastic bottles

does not affect the amount of water dispensed. Therefore, there is no significant relationship between the size of the plastic bottle and the amount of water dispensed.

This finding suggests that the Plasthirst dispenses a fixed amount of water per transaction, regardless of bottle dimensions. Once the sensor detects a bottle within the

predefined distance threshold, it sends a signal to the microcontroller, which then executes a simple yet effective code to turn on the water pump for a predetermined duration. This process ensures a seamless, automated transaction without manual intervention. The straightforward nature of the code enhances the system's reliability, minimising errors and reducing operational complexity.

This is supported by a study showing that implementing a uniform dispensing mechanism reduces the machine's complexity and cost by eliminating the need for sensors or systems to assess the size or type of each container. This design choice effectively promotes recycling by offering clear and consistent incentives to users (Sensoneo, 2025). Similar to the Plasthirst, which utilises an ultrasonic sensor

to detect deposited plastic bottles and subsequently activate the water pump, measuring the distance to identify their presence, ensuring that the system accurately registers each deposit before initiating the dispensing process.

### 3.3. Relationship Between the Number of Plastic Bottles Deposited and the Amount of Water Dispensed

This item presents the Pearson correlation to assess the relationship between the number of plastic bottles (independent variable) and the amount of water dispensed (dependent variable). To identify the correlation level, the rule of thumb for this statistical treatment was utilised.

**Table 6.** Results of Pearson Correlation Between the Number of Plastic Bottles Deposited and the Amount of Water Dispensed

Variables	r-value	p-value
Number of Plastic Bottle Deposited and Amount of Water Dispensed	0.99	0.00*

Correlation is significant at the 0.05 level (2-tailed).

Table 6 presents the correlation between the number of plastic bottles deposited and the amount of water dispensed, showing a very strong positive correlation ( $r = 0.99$ ). Moreover, the null hypothesis is rejected,  $p(0.00) < 0.05$ . In other words, there is a significant relationship between the number of plastic bottles deposited and the amount of water dispensed.

This finding suggests a direct relationship between the number of plastic bottles deposited and the amount of water dispensed. As more plastic bottles are inserted into the Plasthirst, the dispensing mechanism proportionally increases the amount of water released. This implies that the system is designed to recognise and count each deposited bottle, triggering the water pump accordingly to dispense a corresponding amount of water. This is

supported by the study by O'Carroll (2024), which reports that, similar to the principle of deposit return schemes, each beverage container is refunded upon return of the empty containers for recycling. The consumer receives a larger reward the more containers they return.

### 3.4. Factors that Influenced the Students' Utilisation of Plasthirst

The results of a survey questionnaire are shown in this item, which describes the factors that may have influenced students' use of Plasthirst, including convenience, incentives, and environmental awareness.

**Table 7.** Factors that Influenced the Students' Utilization of Plasthirst

Factor	Weighted Mean	Verbal Interpretation
Convenience	3.82	Strongly Agree
Incentives	3.74	Strongly Agree
Environmental Awareness	3.79	Strongly Agree
Overall Mean	3.78	Strongly Agree

Legend:

Scale	Verbal Description
3.26 – 4.00	Strongly Agree (SA)
2.51 – 3.25	Agree (A)
1.76 – 2.50	Disagree (D)
1.00 – 1.75	Strongly Disagree (SD)

Table 7 presents the data showing that convenience has a weighted mean of 3.82, incentives 3.74, and environmental awareness 3.79, with an overall general weighted mean of 3.78. This indicates that all three factors had a strong influence on students' utilisation of the PlasThirst. The interpretation of all means as "strongly agree" suggests that the respondents perceived the machine

as highly convenient, were positively influenced by the water incentive, and were motivated by their awareness of environmental issues.

Among the three factors, convenience had the highest mean of 3.82, implying that the ease of using the machine played the most significant role in encouraging students to engage with PlasThirst. This may be attributed to

Plasthirst’s user-friendly operation, which made depositing bottles and receiving water efficient and easy, thereby enhancing overall convenience. This is consistent with studies such as Roy et al. (2018), which emphasise the importance of service convenience in enhancing user engagement. Environmental awareness followed closely with a mean of 3.79, indicating that students who understood the impact of plastic waste were more inclined to participate. This supports the findings of Gherhes et al. (2022), which link higher awareness levels with increased recycling behaviour. The least developed countries (LDCs) have been facing severe problems with solid waste due to

low public awareness (Khanal, 2022). Meanwhile, the incentive of receiving drinking water, with a mean of 3.74, also had a notable effect on encouraging use, in line with Abdalazeem et al. (2022), who highlighted the motivating power of rewards.

### 3.5. Proposed Development Plan

Based on the results provided, the researchers proposed development plans to fully maximise and further improve Plasthirst's overall utilisation.

**Table 8.** Proposed Development Plan

Objectives	Action	Timeline	Person Involved	Expected Output
To distinguish the material and size of the plastic bottle deposited.	Replace the ultrasonic sensor with an infrared or weight sensor, and apply more advanced code to recognise the material inserted and its size, adjusting the code for water dispensation accordingly.	At least 1 week	Researchers, SHS science teachers, Programmer, Consumers	A Plasthirst that dispenses different amounts of water based on the size of the plastic bottle and can only be triggered by plastic bottles.
To achieve perfect dispensing accuracy	Replace the submersible pump by diaphragm water pump and add a flow meter	At least 1 week	Researchers, SHS science teachers, Programmer, Consumers	A revised Plasthirst with perfect dispensing accuracy
To develop a web application to monitor the total number of plastic bottles deposited with a digital point-based reward system	Develop a software to run the specific functions of the web application	At least 1 week	Researchers, SHS science teachers, Programmer, Consumers	A Plasthirst with a web application. Now, the total number of plastic bottles deposited in the machine can be monitored effortlessly, also granting users a digital point that can be redeemed over time.

## 4. Conclusion

The findings of the study reveal that PlasThirst demonstrates an efficient response time, quickly processing plastic bottles in exchange for drinking water. In terms of dispensing accuracy, the machine consistently releases a fixed amount of water regardless of the size of the plastic bottles deposited. Additionally, an increasing trend in the amount of water dispensed is observed as the number of plastic bottles increases. Statistical analysis shows a very weak, non-significant negative correlation between bottle size and water dispensed, indicating that bottle size does not affect output. In contrast, a very strong and significant positive correlation exists between the number of bottles deposited and the amount of water dispensed, affirming that more bottles lead to more water dispensed. Furthermore, convenience, incentives, and environmental awareness were found to significantly influence students’ utilisation

of PlasThirst, underscoring their importance in encouraging user participation and engagement.

## Acknowledgements

The researchers would like to express their profound gratitude to everyone who helped and supported them in successfully completing this study. First and foremost, they are deeply grateful to God for providing them with health, strength, wisdom, and knowledge during this research. Additionally, the researchers would like to thank their dedicated research adviser, Mr. Jonathan P. Mellona, for his unwavering guidance, support and encouragement, which have significantly contributed to the success of this study. The researchers also thank the sponsors, Ms. Lizabeth P. Jimenez, Mrs. Cristina S. Tanhueco, Mrs. Liezle S. Silva, Mrs. Monica P. Carmona, Mr. Gejay P. Jimenez and Mr. Rick Raven T. Solaina, for providing the financial support they needed to purchase necessary supplies and complete

the project. The researchers also acknowledge all the respondents and individuals who contributed their time, to answer survey questionnaires and make this study possible. Lastly, the researchers would like to thank the institution that allowed them to conduct this study.

## References

- Abdelazeem, B., Abbas, K. S., Amin, M. A., El-Shahat, N. A., Malik, B., Kalantary, A., & Eltobgy, M. (2022). The effectiveness of incentives for research participation: A systematic review and meta-analysis of randomized controlled trials. *PLoS ONE*, *17*(4), e0267534. <https://doi.org/10.1371/journal.pone.0267534>
- Arowolo, M., Adekunle, A., & MartiNs, O. O. (2023). Design, implementation, and evaluation of an automated liquid dispensing machine. *Gazi University Journal of Science*, *37*(1), 443–455. <https://doi.org/10.35378/gujs.1159197>
- Carrig, D. (2018, June 27). Top 10 trash items found littering our beaches and waterways — and the weirdest. *USA Today*. <https://www.usatoday.com/story/news/nation-now/2018/06/27/ocean-beach-pollution-plastic-trash/738173002/>
- Deci, E. L., & Ryan, R. M. (2000). The “what” and “why” of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268. [https://doi.org/10.1207/s15327965pli1104\\_01](https://doi.org/10.1207/s15327965pli1104_01)
- Ferronato, N., Maalouf, A., Mertenat, A., Saini, A., Khanal, A., Copertaro, B., ... & Mohandas, V. J. (2024). A review of plastic waste circular actions in seven developing countries to achieve sustainable development goals. *Waste Management & Research*, *42*(6), 436–458. <https://doi.org/10.1177/0734242X231188664>
- Garcia, M. B. (2024). Physical school closures as a public health response to high heat index in the Philippines: a critical perspective. *Journal of Public Health and Emergency*, *8*, 30. <https://doi.org/10.21037/jphe-24-66>
- Gherheș, V., Fărcașiu, M. A., & Para, I. (2022). Environmental problems: An analysis of students' perceptions towards selective waste collection. *Frontiers in Psychology*, *12*. <https://doi.org/10.3389/fpsyg.2021.803211>
- Groves, C. (2024). The impact of response time on customer satisfaction. *Call Management Resources*. <https://calcmr.com/the-impact-of-response-time-on-customer-satisfaction>
- Herbie G. (2023, October 10). Philippines dominates global ocean plastic pollution chart at 36%, shows study. *RAPPLER*. <https://www.rappler.com/philippines/philippines-dominates-global-ocean-plastic-pollution-chart-at-36-shows-study>
- Idumah, C.I., Nwuzor, I.C. (2019) Novel trends in plastic waste management. *SN Applied Sciences*. *1*, 1402. <https://doi.org/10.1007/s42452-019-1468-2>
- Ilyas, M., Ahmad, W., Khan, H., Yousaf, S., Khan, K., & Nazir, S. (2018). Plastic waste as a significant threat to environment - a systematic literature review. *Reviews on Environmental Health*, *33*(4), 383–406. <https://doi.org/10.1515/reveh-2017-0035>
- Khanal, A. (2022). Survey on usage of single use plastic bags in Nepal. In *IOP Conference Series: Earth and Environmental Science*, *1057*, 1. 10.1088/1755-1315/1057/1/012008
- Kumar, P. (2025). Pre-experimental Designs in Educational Research: An Overview • Teachers Institute. *Teachers Institute*. <https://teachers.institute/educational-research/pre-experimental-designs-educational-research-overview/>
- National Oceanic and Atmospheric Administration (2024). A guide to plastic in the ocean. *National Ocean Service*. <https://oceanservice.noaa.gov/hazards/marinedebris/plastics-in-the-ocean.html>
- O’Carroll, L. (2024). Consumers embrace Ireland’s first bottle deposit return scheme. *The Guardian*. <https://www.theguardian.com/environment/2024/oct/22/ireland-first-bottle-deposit-return-scheme-reverse-vending-machines?>
- O’Connor, R. T., Lerman, D. C., Fritz, J. N., & Hodde, H. B. (2013). Effects of number and location of bins on plastic recycling at a university. *Journal of Applied Behavior Analysis*, *43*(4), 711–715. <https://doi.org/10.1901/jaba.2010.43-711>
- Pan, D., Su, F., Liu, C., & Guo, Z. (2020). Research progress for plastic waste management and manufacture of value-added products. *Advanced Composites and Hybrid Materials*, *3*(4), 443–461. <https://doi.org/10.1007/s42114-020-00190-0>
- Parker, L. (2024). The World’s plastic pollution crisis explained. *National Geographic*. <https://education.nationalgeographic.org/resource/worlds-plastic-pollution-crisis-explained/>
- Ringel, W. (2025). How do container deposit schemes work. *Tomra*. <https://www.tomra.com/reverse-vending/media-center/feature-articles/how-do-container-deposit-schemes-work>
- Roy, S. K., Shekhar, V., Lassar, W. M., & Chen, T. (2018). Customer engagement behaviors: The role of service convenience, fairness and quality. *Journal of Retailing and Consumer Services*, *44*, 293–304. <https://doi.org/10.1016/j.jretconser.2018.07.018>
- Sensoneo. (2025). How does a reverse vending machine work. *SENSONEO*. <https://sensoneo.com/waste-library/reverse-vending-machine/>
- United Nations Environmental Programme (2022). Plastic Pollution. *UNEP.org*. <https://www.unep.org/plastic-pollution>
- United States Environmental Protection Agency. (2023). Impacts of plastic pollution. *US EPA*. <https://www.epa.gov/plastics/impacts-plastic-pollution?>

- Wan, Y., Chen, X., Liu, Q., Hu, H., Wu, C., & Xue, Q. (2021). Informal landfill contributes to the pollution of microplastics in the surrounding environment. *Environmental Pollution*, 293, 118586. <https://doi.org/10.1016/j.envpol.2021.118586>
- White, K., Habib, R., & Hardisty, D. J. (2019). How to shift consumer behaviors to be more sustainable: A literature review and guiding framework. *Journal of Marketing*, 83(3), 22–49. <https://doi.org/10.1177/0022242919825649>
- World Bank Group. (2021). Market study for Philippines: plastics circularity Opportunities and barriers. *World Bank*. <https://www.worldbank.org/en/country/philippines/publication/market-study-for-philippines-plastics-circularity-opportunities-and-barriers-report-landing-page?>
- Yang, X., & Thøgersen, J. (2022). When people are green and greedy: A new perspective of recycling rewards and crowding-out in Germany, the USA and China. *Journal of Business Research*, 144, 217–235. <https://doi.org/10.1016/j.jbusres.2022.01.086>



© The Author(s) 2025. JOSEM is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.