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Performance of SEAGOP (Sea Garbage Obtaining Pump Bin) in Magapo, Mati City, Davao Oriental, Philippines

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ABSTRACT. The observation that there are too many plastics floating in the seawater of Magapo-3 led the researchers to develop and conduct this study to address floating marine debris problems. The researchers devised a version of Seabin V5 and called it, SEAGOP: Sea Garbage Obtaining Pump-bin to help control the growing issue of floating marine debris. This model was made of light materials which can help in maintaining its balance while on the water. Its core materials were sensors and SMS, which helps in notifying the person in charge if the bin was already full. It is a pump for sucking in the garbage and powered by batteries to keep the pump working. After testing and observing SEAGOP for seven days, it was able to collect 205 pieces of different waste materials, with the five most common floating marine debris: cellophane (31%), plastic wrappers (30%), leaves (8%), plastic bottles (6%), and face masks (5%). Furthermore, the results of the detection and SMS notification rate during the trials were 100% reliable. The device was further evaluated using the standard of ISO 9126 and resulted in an average of 4.68 functionality, 4.3 reliability, 4.9 usability, 4.6 efficiency, 4.46 maintainability, and 4.36 portability out of five. Results revealed that SEAGOP performed well in collecting floating marine debris, detecting, and sending SMS notifications when the bin is full. This can be further upgraded and funded by the local government to help minimize floating marine debris in the coastal areas of the Mati City.

Keywords: *Davao Oriental, floating marine debris, marine pollution, Mati City, SEAGOP*

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INTRODUCTION

The throw-away culture of people with their daily use of plastics has made significant parts of the world's oceans polluted with plastic, endangering marine life and food chains (21st Century Challenges, 2016). This disposal of plastics resulted to plastic pollution in the ocean, which is a worldwide issue as plastic waste is widespread and accumulates on a variety of surfaces, including land, ocean surfaces, sea beds, and even in the deepest sections of the ocean, changing the landscapes over time (Barnes et al., 2009; Superio and Abreo, 2020). Because of their presence in the ocean, marine creatures may confuse floating trash as food, resulting in choking or obstructions when swallowed. Oversized objects, like fishing gear, can strangle animals or keep them from swimming or diving, which can both be fatal. Toxic compounds can be transported via the food web by consuming plastic waste; therefore, marine pollution also affects humans (Ocean Health Index, 2012). In addition, more than 260 species were known to have ingested or been entangled by plastic debris (Hardesty et al., 2015). Abreo et al. (2016) confirmed the presence of plastic in Deraniyagala's beaked whale (*Mesoplodon hotaula*) in Maco, Compostela Valley, Philippines, which justifies the claim that marine animals are prone to plastic ingestion. Such dangerous possibilities are alarming; thus, this study was concerned with mitigating the wastes found on coastlines by making an improvised "seabin" device.

According to Jambeck et al. (2015), the coastal population of the United States in 2010 generated the most plastic waste of any country with 13.8 million metric tons (MT) and which is equivalent to 113 million people, which resulted to hailing the United States as the world's second-largest exporter of plastic scrap both inland and oceanic according to the European Union (Law et al., 2020). In Southeast Asia, common garbage found in the ocean in 2017 were plastic bottles and caps, food wrappers, straws, and shopping bags which ranked nine of the top ten items collected (Tullo, 2018). Furthermore, the Philippines is the third largest contributor of plastic to the marine environment with 8 million metric tons (MT) of plastic that hit the world's oceans every year (Urban Link, 2020). Furthermore, in Puerto Princesa, the common wastes found in the sea were plastic bottles, cigarette packs, discarded fishing equipment, rubber slippers, and fluorescent lamps. These toxins coming from solid wastes were polluting the marine environment thus, it can cause reduced oxygen levels and can kill marine life (Enano, 2019). As a result of the nation's failure to reach its goal for better solid waste management, trash accumulated on land, blocked canals, spilled into the ocean, and moved to the oceanic environment (Sarmiento, 2018).

Hence, continents like Australia and Europe have diligently pursued solutions for the environmental and ocean sustainability problems. They have been deploying seabins or mechanical/robotic garbage collectors in the ocean (860 seabins) and successfully launched the new Seabin V5 project that collects 3,612.8 kg of floating solid waste in the ocean. Seabin V5 is a floating marine debris collector that was designed to be attached to a dock in the marina. This device can be used as a submersible water pump at the bottom of the container, allowing the can to absorb water from the surface. The absorbed water passes through the filter and comes out in the bottom, leaving marine debris inside the filter (Sreekandan, 2018). Furthermore, this unit was also specialized in absorbing petroleum-based surface oils, detergent, and other liquid pollutants predominant in most marinas worldwide since it was equipped with oil absorbent pads. This unit is also intended for marinas, docks, yacht clubs, and commercial ports, where it collects all floating marine debris (Wärtsilä Corporation, 2017). This Seabin project created novel upstream solutions for cleaner, more sustainable marinas, ports, rivers, public waterways, and, eventually, oceans. These technologies had the potential to intercept mismanaged waste like macro and micro-plastic debris, as well as microfibers before they reached the ocean.

In Mati City, with much concern about the rising solid waste problem globally, the city government took part in celebrating International Coastal Cleanup through its Solid Waste Integrated Management (Swim) program, and it was recorded that the gathered wastes from the coast weighed 1,245.3 kg in 140 trash bags (Perez, 2018). Furthermore, a study conducted by Tuano et al. (2019) entitled "Suyop: Washer Motor-Pump Seabin" found that within five days, the device with a 13.5 liters storage bucket was able to collect marine litter successfully. It was able to collect 44 pieces of junk food wrappers, eight (8) pieces of cellophane, four (4) plastic bottles, 42 cigarette butts, four (4) light cartons, and five (5) pieces of household cleaning plastics. Based on the results of the performance of their Seabin, the proponents concluded that their machine works effectively in collecting plastics in the marina.

The presented studies explored ways to improve the seabin project, making it even more convenient to clean the sea. Other manufactured seabin was powered by a small water pump that created a water flow; collected wastes get caught in the flow and fell into the catch bag. The catch bag is made of a recycled plastic mesh so water could escape while trapping the debris; then, as the bag fills, it can be emptied again as the operator is notified then the process of collecting waste starts again as seabin does its work. The main goal was to prevent plastics from entering waterways or clogging canals by collecting marine and riverine plastic wastes (Schmaltz et al., 2020). In addition, this device was able to capture harmful plastics and debris and absorb harmful oils from the water (Adhwaryu and Alam, 2021).

Moreover, the use of Arduino is essential in this project. The Arduino is an open-source, user-friendly hardware and software platform made for building electronic projects. People may create and build gadgets that interact with their environment using Arduino (Arduino, 2021). In terms of waste disposal, Arduino software worked quite well (Cuasay, 2019). Through this, proper waste disposal in many countries went well because the ultrasonic sensors that were mounted in the trash collectors detected the level of marine debris in each bin and automatically sent a notification if it was full (Yusof et al., 2017).

The presented seabins only explored improving their storage capacity, checking the capability of the device to be placed not just in ports but in the shorelines, and attaching an Arduino-based monitoring device for the Seabin. The cited V5 Seabin was designed for calm water areas only. However, in this study, the researchers modified the design into a floating device to deploy such a device in a more exposed ocean area that could adapt to the height of tides and stronger waves. Moreover, with the provided advantage of Arduino in automated waste collection, this study employed structural improvements and a durable seabin machine that can capably address the local problem in Mati. Devising this machine for commercialization would greatly help the sea as it helped collect and decrease the floating marine debris, preventing marine creatures from getting poisoned or killed.

The major goal of this study was to create a practical tool for gathering marine debris that offers practical solutions to minimize the amount of plastic in the ocean, which is the biggest environmental issue on earth. Specifically, the study aimed to develop a prototype of a seabin or sea garbage obtaining pump bin that could collect the marine debris on the sea, detect the pump bin when it is full, and send a Short Message Service (SMS) to the programmed numbers. In terms of the prototype's performance, the researchers would evaluate the SEAGOP following the ISO 9126 standard evaluation on specific characteristics such as functionality, reliability, usability, efficiency, maintainability, and portability.

MATERIALS AND METHODS

The study was to innovate from the previous work, create a bigger seabin, improve its range from the coastal areas, and the ability of the machine to notify through SMS when the bin is full. The innovation approach dealt more with the aim of making significant improvements to a certain part that was already invented (Bhasin, 2012). Seabin is a floating device that can collect waste in the water. This was originally invented by Pete Ceglinski and Andrew Turton (ITU News, 2019). In this study, the device was modified and named "SEAGOP: Sea Garbage Obtaining Pump Bin." Also, this research was designed to identify the common marine debris found in the coastal area of Purok Magapo, Mati City, Davao Oriental. Magapo is a coastal residential area. The presence of marine debris was visible in the sea as a result of human activities. Magapo-3 is located at Barangay Central, Mati City. Geographically, Magapo-3 is located near the sea, adjacent to Magapo-2, Magapo-1, Kalagundian, and the neighboring puroks from Magsaysay (Figure 1). However, the lack of proper sewage systems in this area has resulted in waste being improperly disposed to the ocean, leading to significant pollution. This pollution is exacerbated by waste from nearby communities. Mati City's Baywalk Park and Pujada Island are popular tourist destinations located near Magapo-3. These areas are threatened by the activities in the community, which also poses a danger to the local ecosystem and marine creatures. The inhabitants of this community depend on fishing as a primary source of income, making it essential to protect the marine creatures that sustain their livelihood.

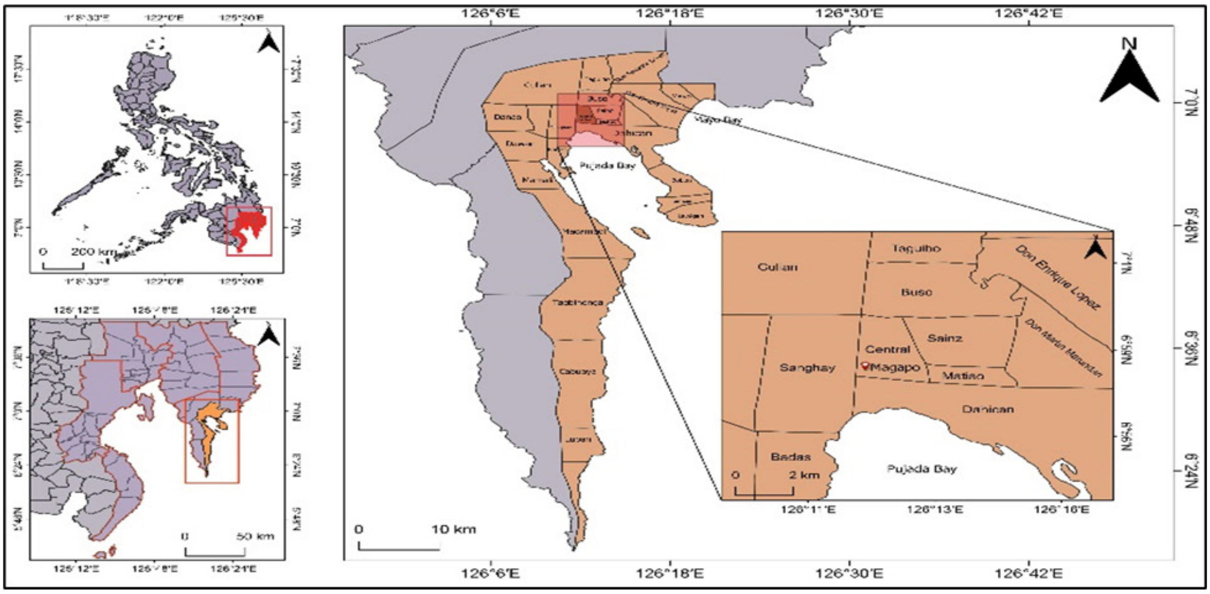

Figure 1. Magapo, Mati City Davao Oriental, Philippines.

The materials used in this study were divided into four sets: pump, raft, seabin, and sensor. Materials for the pump included 12 volts water pump, battery, and power bank; wood and water drums for the raft; polyvinyl chloride (pvc) plastic hose, pail, and net for the seabin. The sensor materials further included the following with their corresponding description: Arduino Uno R3 Board served as the device that connected and communicated to other various devices when the sensor indicated that the bin was full; breadboard arduino electronics, an apparatus that lets the operator insert some wirings or LED that was used in the sensor, and the GSM module; Ultrasonic ranging sensor served as the sensor in detecting a full bin; jumper wires arduino dupont line was used to connect the wirings used in the sensor and the GSM module; GSM GPRS module SIM800L V2 was responsible in sending the message to the researchers and beneficiaries indicating that the bin is already full; arduino diode bulb that when light up indicated that the bin is full and also allowed the researchers to know whether the sensor was able to detect a full bin and if this coincides with the function of sending SMS notification. In making the

SEAGOP with SMS notification, the research procedures employed the ADDIE model, which first appeared in 1975 and was created by the Centre for Educational Technology at Florida State University (Muruganantham, 2015). It followed the process, consisting of phases: analysis, design, development, implementation, and evaluation.

Analysis Phase

It was observed that improper disposal of solid waste was often overlooked by people in the community, which caused some negative impacts on the community and the ocean itself. The solid waste, if not properly collected and disposed of, ends up in the ocean, gets mistaken as food by marine animals such as turtles, dugong, whale and fish. It also has a significant impact on human health since ingesting plastic waste and subsequently absorbing the toxins that are adsorbed on its surface can pass dangerous substances along the food chain into animals that humans consume. Researchers from past studies had yet to be able to fully explore the capabilities of Seabin machines. To aid this gap, the researchers devised an improved model of the Seabin machine, which was mounted with special sensors that can send a notification when it is full. This study can help lessen the problems cited.

Design Phase

The researchers sketched a model of the seabin machine (Figure 2). The machine should be able to cope with the water current so that the machine would be able to survive and prevent itself from losing important parts. When the sketching was done, the researchers thought that the structural components of the machine were already stable so that the system would be able to control its own movement while in the water.

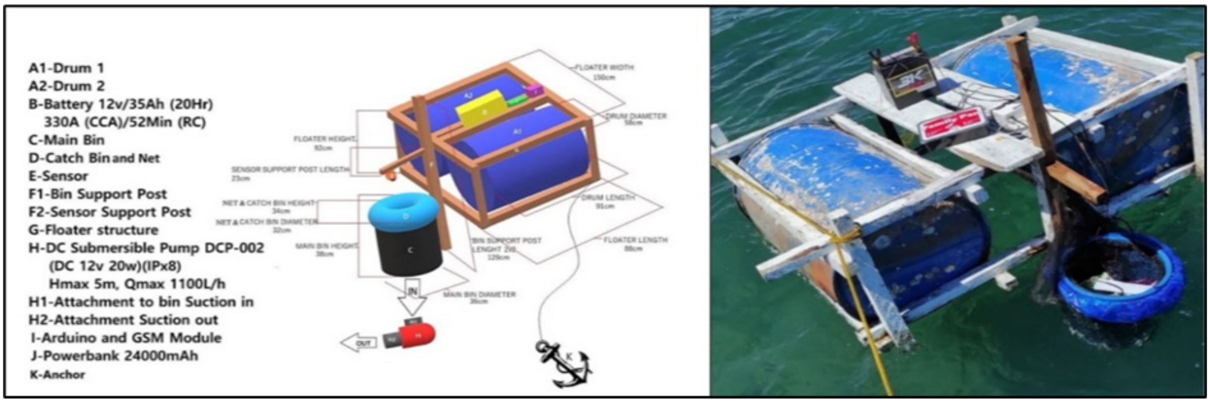

Figure 2. Prototype design and the actual improved Seabin now called SEAGOP in this study.

Development Phase

After the layout, each structural component was then mounted in its specific places (Figure 3). The Arduino microcontroller or the sensor parts, battery, and pump were secured in a container. The Seabin device, made up of a container bin, net, and pipe, was mounted in a mini raft that was made of a drum framed with wood and was anchored under the water. The sensors and the batteries were placed in the middle to avoid them from getting wet as an extra precaution and to prevent the machine from losing its parts. After mounting the sensor in the device, the sensors would then be connected to the laptop or a computer through portal USB. In this way, the researchers would be able to develop the sensors by programming them with the use of command codes that were suited for the machine. The researchers utilized Arduino programming software. Since the software was an open-source software and hardware company, some of the codes were adapted from the internet. The machine was then tested to see if it worked properly.

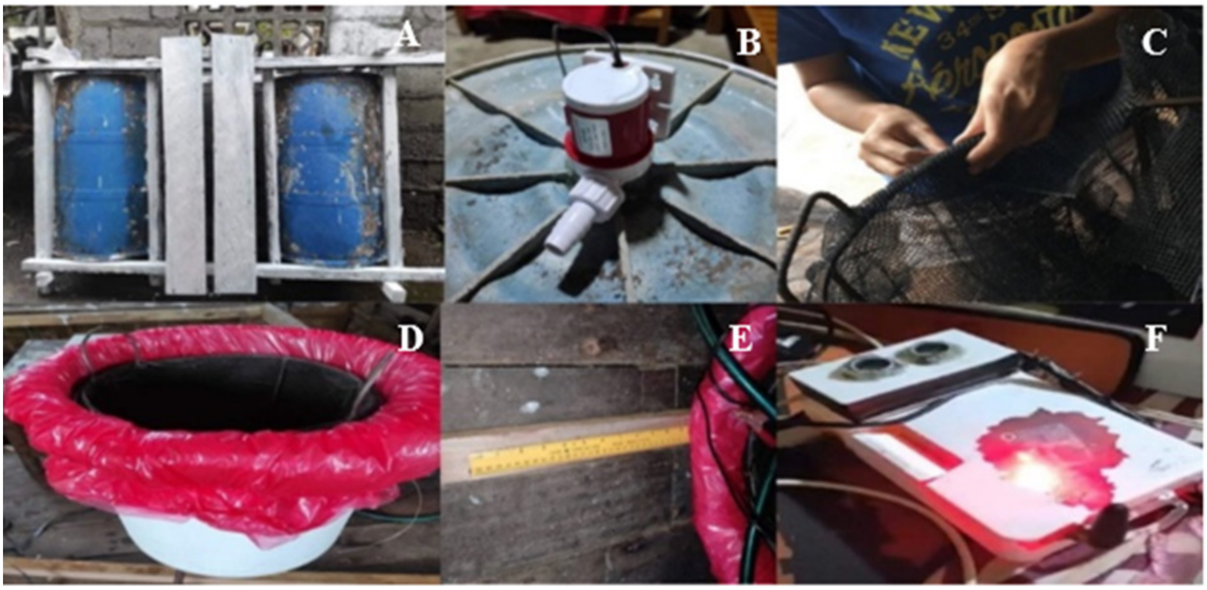

Figure 3. The development phase of SEAGOP: (A) Structuring and painting the floater; (B) mounting the water pump into the catch bin; (C) making of the catch bag; (D) installing the parts of the bin; (E) ensuring the distance from the bin to the sensor; (F) making and calibrating the sensor.

Implementation Phase

In this phase (Figure 4), the scope of the activity was examined simultaneously to reduce the chances of error during the operation of the machine. The main part of this system was the flow that was used to estimate the amount of motion the object underwent while in the water. The system performance of the machine improved with the use of SMS in sending a notification if the bin was full. After the calibration of the programmed sensors, the researchers tested the prototype by placing it in seawater. After the succession of calibration tests of the programmed sensor, the device's collection capability was tested. Herein, the researchers checked the functionalities of the device, including its suction of water, detection when the bin was full, and its SMS notification System. Furthermore, this phase was a crucial part wherein if one of the needed functionalities was not able to function well during this phase, the researchers would need to repeat the iteration process until such time the device passed the evaluation stage.

Figure 4. The implementation phase of SEAGOP: (A) Deploying the floater into the water and installing the adjustable bin; (B) acquisition of samples.

Evaluation Phase

In this phase, the device was ready and set for the conduct proper of the study (Figure 5). The SEAGOP was tested for seven days, five hours each day for the monitoring of the garbage collection and twice a day for the detection and SMS notification test. The effectiveness of the device's collection, identification of when it was full, and capacity to send SMS notifications were all evaluated.

Figure 5. Final testing, observing, and detecting of SEAGOP: (A) Start of SEAGOP marine debris collection; (B) segregating and recording the collected garbage; (C) SMS Notification of the recipient; (D) SMS notification of another recipient (e.g. purok president).

RESULTS AND DISCUSSION

Table 1. Collection of Marine Litters (5 hours - observation for seven days).

Marine Debris	Days							Total	Percentage %
	1	*2*	*3*	*4*	*5*	*6*	*7*		
Cellophane	7	7	9	23	4	5	8	63	31
Wrappers	7	12	4	20	6	6	7	62	30
Cigarette butts	4	0	0	0	0	0	3	7	3
Plastic bottle/container	2	4	2	1	0	3	1	13	6
Glass bottle	1	0	1	1	0	1	0	4	2
Plastic bottle caps	1	3	0	0	0	1	0	5	2
Face masks	1	3	2	2	1	0	1	10	5
Foam (styro)	1	1	0	0	0	0	0	2	1
Balloon stick	1	0	0	0	0	0	0	1	<1
Slipper	1	0	0	0	0	0	0	1	<1
Tin can	1	0	0	0	0	0	0	1	<1
Cigarette box	0	2	0	0	0	0	1	3	1
Leaves	0	2	1	3	6	0	5	17	8
Apple net	0	1	0	0	0	0	0	0	<1

Straw	0	0	1	0	0	0	0	0	<1
Food waste	0	0	0	2	0	3	0	5	2
Banana peel	0	0	0	2	0	0	0	2	1
Charcoal	0	0	0	1	0	0	0	1	<1
Wood	0	0	0	1	0	2	0	3	1
Discarded Fishing Material	0	0	0	0	0	1	0	1	<1
Human/animal waste	0	0	1	0	0	0	1	2	1

Table 1 shows the daily catch of the Seabin in seven days. The device was already yielding considerable results in terms of collecting marine litter. The coastal area where the research was carried out was near a residential area with several fishing boats, which increases the likelihood of more trash being thrown into the sea. On most days, when there is no wind, the device can pull rubbish in from 1.5 to 2 feet.

The results reveal that the bin was operating correctly when it came to waste collection. It was clear that the SEAGOP was performing well in collecting the garbage that was floating in the water, as it displayed an astounding quantity of garbage gathered in just seven days. The daily catch of the SEAGOP was recorded in the table above over the course of seven days, after which the SEAGOP was deployed into the water for five hours each day. The SEAGOP gathered 63 pieces of cellophane, 62 pieces of plastic wrappers, 17 leaves, 13 plastic bottles, 10 face masks, 7 cigarette butts, 5 food waste, 5 plastic bottle caps,4 glass bottles,3 pieces of wood, 3 cigarette box, 2 banana peel, 2 styrofoam, 1 balloon stick, 1 slipper, 1 tin can, 1 apple net, 1 straw, 1 charcoal, 1 discarded fishing material, and 2 human/animal waste, and a total of 35 hours of labor in just seven days.

The current SEAGOP was far more likely to be reliable compared to the previous study conducted by Tuano et al. (2019) seabin, because their seabin only collected 44 wrappers, 8 cellophane, 4 plastic bottles, 42 cigarette butts, 4 light cartons, and 5 pieces household cleaning plastics, in its five-day job, it accumulated 107 pieces of garbage. Conversely, the SEAGOP collected 153 waste materials in five days and 205 pieces of garbage in seven days. This study has advantages since it has been noticed that individuals living by the sea have a reckless behavior of throwing their wastes into the water. Rosalina Inting (2023, personal communication), the purok chairman, stated that an estimated 95% of the residents do not have septic tanks, so their wastes were dumped directly into the sea. However, 90% of these wastes were collected by the city's garbage collectors, with the remaining 5% thrown into the waterways that eventually end up in the ocean, particularly by residents whose homes are built directly above the ocean or waterways or near the shoreline. Furthermore, the commonly found floating marine debris in Magapo-3 was brought in during high tide, and deposited in the area during low tide.

In addition, there were many fishing boats that stay in the area, which may be one of the causes of the increased waste within the community's vicinity. These are migratory fishing boats from other parts of the province or even the region. They docked their boats and ships nearby for an extended period of time, sometimes days or weeks. According to Lucio Jusayan (2023, personal communication), a worker on one of the fishing vessels, there were occasions when they threw cigarette butts into the sea, but these occurrences were rare. Therefore, both the residents and migratory fishermen contributed to the waste in Magapo-3.

With the gathered marine debris, the prototype has the capacity to help reduce the amount of floating solid wastes on the surface of the ocean in the area.

Seabin detection and SMS notification

Table 2. Efficacy of detection when the bin is full

Detection of full bin	Days							Success	Failed
	1	*2*	*3*	*4*	*5*	*6*	*7*		
Trial 1	1	1	1	1	1	1	1	100%	0%
Trial 2	1	1	1	1	1	1	1	100%	0%
PERCENT OF DETECTION								100%	0%

Legend: 1 - Success; 0 - Fail

Table 2 shows the assessment of the detection of the sensor when the bin is full. The sensor was tested for two trials each day for seven days. Shown above is the numerical scale for evaluating the functionality of the sensor; number 1 in the table was a numerical value of success, which means that the sensor worked during its testing, while if the sensor failed to detect, the numerical value would be 0. Although the sensor had five seconds delay, the results still showed that the sensor succeeded and never failed its detection during the 14 trials, thus gaining a 100% result on the overall success rate.

The SEAGOP was observed for five hours; however, within the said time, along with the vastness and height of waves in the sea, it was possible that the number of hours was not enough for the bin to be full. Thus, to test the efficacy of the device detection, researchers put samples and assumed that the bin was full for two trials to attain the sensor's accuracy. The sensor's role in the bin was important as this would detect when the wastes were ready for collection (Pardini et al., 2020). The sensor has a sound alarm and light alarm to identify if the sensor was able to detect. The presence of these two enabled the researchers to identify if the detection and sending of SMS notifications coincided with each other. Furthermore, as the result of the efficacy of detection when the bin is full was a hundred percent, this implies that the efficacy of sending Short Message Service must also be a hundred percent to attain the accuracy of the device's SMS Notification System.

Table 3. Short Message Service (SMS) notification system

Detection of full bin	Days							Success	Failed
	1	*2*	*3*	*4*	*5*	*6*	*7*		
Trial 1	1	1	1	1	1	1	1	100%	0%
Trial 2	1	1	1	1	1	1	1	100%	0%
PERCENT OF DETECTION								100%	0%

Legend: 1 - Success; 0 - Fail

Table 3 shows the assessment of the Short Message Service (SMS) notification system. The SMS notification was tested along with the sensor in the said duration. SMS notification must send a message from the time when the sensor has detected when the bin is full. The results showed that within the 14 trials for seven days, the SMS had succeeded in sending messages to the receivers or beneficiaries who have the responsibility to collect and segregate the garbage. The SMS notification garnered 100% efficacy, which means that the SMS notification system of the device is accurate.

SMS provides a one-to-one and private communication channel between the sender and the recipient, allowing the sender to directly address each member of the target audience and effectively alert them, and it was predicted to be more successful in going above the recipient's attention threshold by creating a greater sense of urgency and importance (Mihci and Donmez, 2017). This allowed the beneficiaries to be informed that there was a need to collect the trash from the bin because if not, in no long time, the trash would overflow back into the sea. Although the device was mounted with a sound and light alarm to notify, this would only sometimes apply because not all the time, the beneficiary or recipient of the message is just around the community or near the bin. Thus, SMS works as notice to the beneficiary heads, which were the purok president and youth president. They were the ones responsible for commanding their co-officials to collect and segregate the garbage.

The results from Tables 2 and 3 showed the accuracy of the device's detection and the responsiveness of the SMS notification system. These clearly show that both got a hundred percent on their efficacy means that the device's overall notification system when the bin is full was strongly efficient.

Seabin Improvements

The enhanced version of the seabin has features that were much more innovative than the past versions of seabins. The first feature was the bigger storage. With bigger storage, the SEAGOP can store up to 24 liters of garbage which is better compared to the past seabin, which could only store 13 liters of garbage. Based on the result of the daily catch, the current SEAGOP was able to collect 205 garbage while the previous one was only able to collect 107 waste materials. Therefore, the current SEAGOP had a bigger capacity and capability of collecting floating marine debris. The second feature was the ability of the SEAGOP to send an SMS notification with the help of a sensor to the beneficiaries. This feature can provide great help to the beneficiaries since this would notify them if the bin is full, reducing their burden of checking the bin from time to time. The past seabins did not have this feature, even the past versions made by the researchers. The final feature was a bigger floater. With this bigger floater, the SEAGOP can be deployed in a farther location which can help collect more floating marine debris in farther locations.

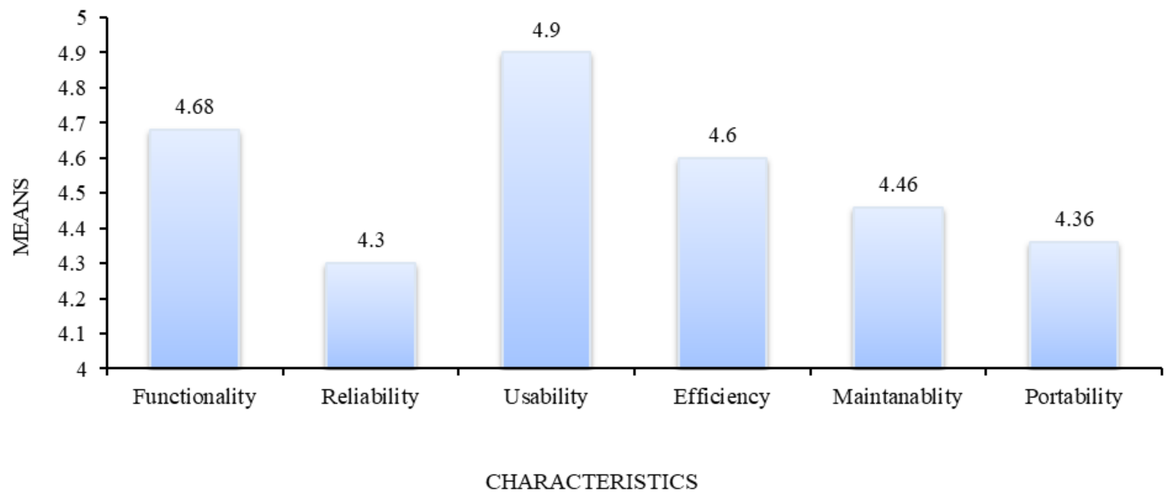

Figure 6. ISO 9126 Standard evaluation

Figure 6 showed the result of the evaluation of the whole device using ISO 9126 Standard. The device was further evaluated by five evaluators, which were the selected purok and youth officials in Magapo-3. The y-axis indicates the mean value of each characteristic, while the x-axis indicates the six characteristics that were highlighted in ISO 9126. The results showed that the total mean of each characteristic was: 4.68 in functionality, 4.3 in reliability, 4.9 in usability, 4.6 in efficiency, 4.46 in maintainability, and 4.36 in terms of the portability of the whole device.

Referring to ISO 9126 frequency table, the device's sub-characteristics were evaluated through the scale: strongly agree, agree, neutral, disagree, and strongly disagree. The functionality of the device consisted of three sub-characteristics. The first sub-characteristic was the sustainability of the device for a longer period; among the evaluators, two of them strongly agreed, two agreed, and the other one was neutral. The second sub-characteristic was the accuracy of the device's detection and SMS notification, and all the evaluators said they strongly agreed. The third sub-characteristic was the capability of the device's functionalities, four of them said that they strongly agreed, while the other one agreed. The second characteristic was the reliability of the device, and this was made up of two sub-characteristics. The first was if the device continued operating without malfunctions, among the evaluators, only one strongly agreed, three agreed, and one disagreed. The third characteristic was the usability of the device, which was made up of two sub-characteristics. The first sub-characteristic was the ease of operating the device; this garnered strong agreement from all five evaluators. The second sub-sub-characteristic is the usefulness of the device in the community which garnered four strong agreements among the evaluators. The fourth characteristic was the efficiency of the device which consists of two sub-characteristics. The first was if the device utilized materials that were easily found, three evaluators strongly agreed, and two agreed; the same evaluation was gained by the second sub-characteristic, which was about the efficiency of the device's functionalities. The fifth characteristic was the maintainability of the device which consisted of three sub-characteristics. The first was if the device parts could be easily replaced, this garnered three strongly agree, one agrees, and one neutral. The second sub-characteristic was the stability of the device in holding all the parts, especially the power sources. The evaluation showed that three evaluators strongly agreed, and two were neutral. The third sub-characteristic was the easiness of the device in terms of testing, the evaluation showed that two evaluators strongly agreed, two agreed, and one was neutral about it.

Lastly, the sixth characteristic focused on portability which consisted of three sub-characteristics. The first was the adaptability of the device, two of the evaluators strongly agreed, while three agreed. The second was the ease of installing the device, three of the evaluators strongly agreed, one agreed and one was neutral, the same evaluation was given to the last sub-characteristic referring to the transferability to other places excluding high wave areas.

SUMMARY AND CONCLUSION

Based on the results, through a seven-day observation period, SEAGOP was able to successfully collect different kinds of marine debris and was able to successfully send an SMS notification to the officials of Magapo-3. The results of the data showed that the bin performed very well when it comes to waste collection, as it collected a large quantity of garbage in seven. Thus, marking an advantage when compared to the seabin. The sensors played a key role in collecting garbage as it automatically sent an SMS notification when already full and ready for retrieval so that the waste materials would be segregated. In addition, SEAGOP with SMS notification will minimize the problem of plastic pollution in Magapo-3 which can help officials in minimizing their problems regarding garbage disposal in the area.

Hence, we recommend that this project should be funded, manufactured and reproduced by local stakeholders so that they can benefit from having clean coastal areas and prevent further marine pollution. It is also recommended that future researchers upgrade the pump bin to have bigger storage for bigger capacity and for fast and efficient garbage collection. They should also have a longer duration of observation period to see if the prototype is perfectly doing its job as a sea garbage collector and be able to assess its performance if it needs further improvements.

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