



# Design & Development Marine Trash Collector

<sup>1</sup>Mr. Yash Dyanesh Wakate

<sup>1</sup>Student, Department of Mechanical Engineering Sanjay Ghodawat University, Kolhapur, Maharashtra, India

**Abstract :** This paper focuses on the design and fabrication of a marine waste-cleaning machine to address the alarming pollution levels in India's rivers, which are heavily contaminated with sewage, toxic materials, and debris. Inspired by government initiatives like "Namami Gange" and "Narmada Bachao," the machine is designed to clean the river water surface efficiently while reducing manpower and time consumption. Operated remotely and powered by a direct-drive motor, it automates the collection of visible debris, particularly plastic waste, and pollutants. Despite its simplicity and lack of advanced sensors, the design allows for quick replication and adaptability across various water environments. Furthermore, the project incorporates an educational component to raise awareness about marine pollution and promote community-driven environmental stewardship. By empowering local communities to actively participate in preserving their aquatic ecosystems, this initiative fosters a sense of responsibility and contributes to grassroots efforts in safeguarding marine and riverine health.

*IndexTerms* - Marine waste cleaning machine, Pollution control, Environmental conservation, Plastic waste removal etc.

## I. INTRODUCTION

Pollution is the introduction of harmful substances into the environment, which can have both positive and negative effects depending on the nature of the substances and their impact. These substances can exist in three states of matter: solid, liquid, and gas. Regardless of their state, pollutants can harm the environment, wildlife, and human health. The most commonly recognized forms of pollution are air, water, and land pollution. However, other types such as noise pollution, light pollution, and plastic pollution are also significant and have detrimental effects on the planet.

Pollution, as referenced, often results in adverse consequences for the environment, wildlife, and human well-being. While human activities are a primary source of pollution, it is important to note that natural events can also contribute to it. For instance, forest fires and volcanic eruptions can simultaneously cause air, water, and land pollution. On the human side, activities like deforestation and coal mining are major contributors to environmental degradation, leading to widespread air and land pollution.

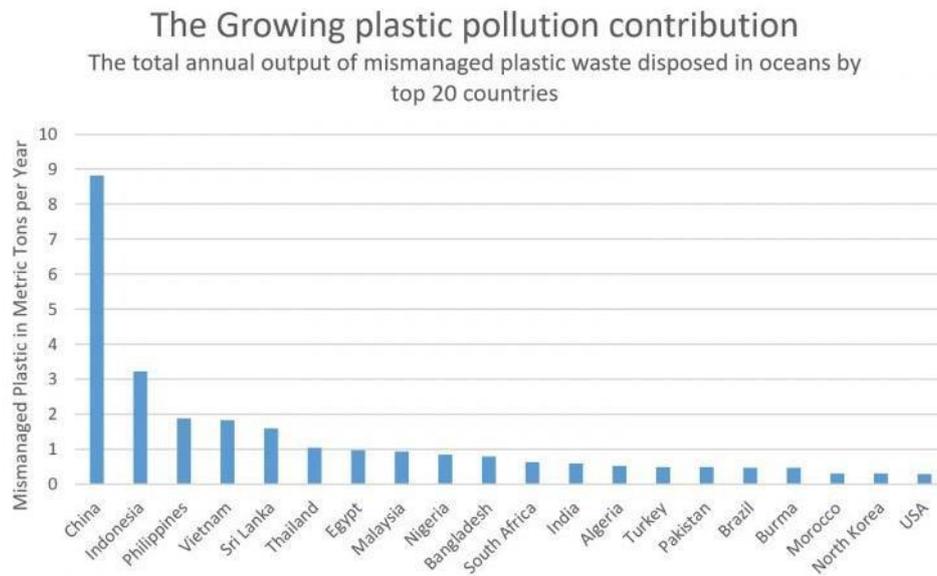
Among all the types of pollution, plastic pollution has emerged as one of the most pressing global challenges. Plastics, although beneficial in many ways, have become a significant environmental threat due to their non-biodegradable nature and excessive use. The history of plastics dates back to 1284, when the Horners Company in England began using tortoiseshells to create natural plastic products. This material, sometimes referred to as "thermoplastic" or "natural plastic," was valued for its flexibility and durability.

Interestingly, the origins of natural rubber can be traced back to 1600 BCE, when Pre-Columbian civilizations in Mesoamerica used rubber from natural sources to make balls for ritualistic games. In 1839, Charles Goodyear revolutionized the use of rubber by developing vulcanized rubber, a process that involved adding sulfur to improve its strength and elasticity. Around the same time, a German physicist advanced this research and developed innovative materials, including polystyrene (PS), which is now widely used in packaging for its protective properties.

Later, in 1872, polyvinyl chloride (PVC) was discovered by Eugen Baumann. PVC gained immense popularity in the United States during the 1920s due to its versatility and fire-resistant properties. Today, PVC and other plastics are ubiquitous in various industries, but their widespread use has come at a significant cost to the environment.

Plastic pollution, in particular, has escalated to alarming levels, with a substantial portion ending up in the oceans. Research indicates that certain countries contribute disproportionately to this issue, as highlighted in various studies and reports. These contributions have led to severe consequences for marine ecosystems, wildlife, and the overall health of our planet.

In summary, pollution in all its forms poses a significant threat to the environment and human well-being. While natural events contribute to pollution, human activities remain the dominant cause. Plastic pollution, in particular, is a critical challenge that requires immediate attention and global cooperation to mitigate its impact.



**Figure 1. Contribution of Plastic Pollution**

## II.LITRATURE REVIEW

As stated earlier in the introduction of this study, the most common type of pollutions can be categorised into three; Land pollution, Water pollution and Air pollution. These pollutions have become the major factor that caused destructions to the surrounding environment which mainly created by human activities. Apart from this, the pollution may also occurred by natural causes.

According to [5], the pollutions always concentrated in the metropolitan cities and suburban areas due to large number of population resided in the area. On the other hand, the rapid growth of industrialization at that time had caused the pollution becoming a universal problem.

Pollution has been always an issue in China [6]. The most common problem is water pollution. A recent study had shown that over half of the river sections in remoted areas in China are rated as hazardous for human contact. In reference to [7], there are several risk valuations been made. One of the risk valuation is as illustrated through pollution case in Guangxi province of China. The problem was caused after an enormous dump of garbage. This happened in September 2016 where a quarter size of a whole shipment loaded with household garbage was dumped into the river. However, this situation was captured and noticed by nearby villagers. After some reports made, an instant action had been made by the local department of environmental protection by launching an emergency water quality monitoring of the river. The Guangxi Environmental monitoring centre had also conducted a thorough investigation through the monitoring data after identification of water damage in the river.

Another case study was taken from reference [8], where synthetic material such as the disposal of plastic has been seen as a threat to the surrounding and its widespread throughout the environment has caused the destruction of Anthropocene; an act of human activities which has an influence on the environmental impact hence the future of the earth system.

A recent study has been conducted according to [8] that in 2010, there was an estimation between 4.8 and 12.7 million tonnes of land-based plastic which was not properly managed and mishandled had been insinuated to the oceans. Due to this case scenario, it has been noted that the plastic pollution had delivered an obvious unfavourable effects on the organisms, ecosystems, human health and socioeconomic factors including aquaculture, tourism and navigation.

The latest evaluation made from reference [8], at least 5 trillion plastic debris was recorded drifting on the surface of the ocean. This Marine Plastic Pollution (MPP) had been extended to five subtropical ocean gyres as well as the Arctic Ocean; accumulation at the convergence zones. The accumulation of large scales of marine plastic was the result of aftereffect of the wind flow, the currents of the ocean as well as the thermohaline circulation. Thermohaline circulation can be defined as a flow of heat fluxes and freshwater across the sea surface and the interior mixture of heat and salt [9]. Apart from this convergence zones, there is comparable concentration in the subtropical gyres. It has been recorded that this was the result of the heavily populated areas in the Mediterranean Sea, South China Sea, Gulf of Mexico and Bay of Bengal.

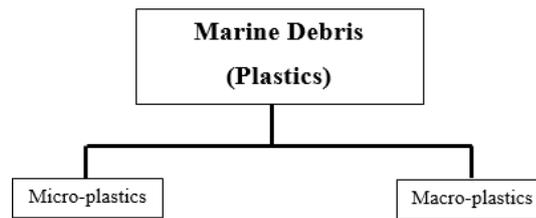
As indicated by [8], the biological pathway of living marine organism that had ingested the marine plastic cannot be reversed and stopped as it has a noteworthy impact in the worldwide dispersion of plastic particles. Factually demonstrated that this plastic served as an effective substrate for sessile species; Tube Worms, Bivalve Mollusks and Barnacles just as for motile life forms. Apart from that, it additionally affirmed that plastic could host very harmful viruses, microbial communities and bloom species which also known as "Plastisphere". Beside this, the marine plastic could act as a vector to transport the alien species which is invasive [8]. Regardless of the little size of the plastic, every particle has the ability to convey living organisms and to re-disseminate destructive substances which may alter ecosystem composition and its functionality as well as changing their genetic diversity.

The plastic has become rapidly in use since the end of Second World War due to its durability as well as its lower cost of production [10]. Since then, plastic has been on production and currently its production exceeds 280 million tonnes per annum. Based on the same reference, it is believe that estuaries are the main source of transporting the plastic to ocean and of course due to other factors such as industrial outlets and recreational fishing activities. There has been a research made in South Africa that the marine debris is the source of foods by seabirds in the mid of 1980s.

From the reference [11], the plastic pollution has been greatly produced and the source of input to the marine environment have drastically increased. The reference is also once again express that the marine debris such as plastics are being ingested by the marine

animals resulting in direct mortality and range of sub-lethal effects such as laceration and gastrointestinal blockage. Estimated over 260 species of animals have been reported to have ingested the plastic debris [11].

Studies from [12] stated that the Marine Plastic Pollution (MVP) composed of macro and micro-plastic was considered severe as the authorities have limited resources and services on the island of Caribbean and Atlantic Ocean. Beside tourism, fisheries and shipping are another contributing factors of plastic marine debris. Reference [12] has identified that Henderson Island as the most severely polluted in the world.



**Figure 2.** Classification of marine debris (plastics).

According to reference [12], the severe plastic pollution on the Henderson Island was the result of direct influenced by marine current systems of the South Pacific Ocean. As the superficial ocean currents and wind keep on blowing to this island, most of floating plastics drifted for a long-distances to Henderson Island, overtime more plastics were accumulated.

On the islands of Atlantic Ocean; the Atlantic Ocean basin proper and the Caribbean Sea, the micro-plastics were categorised into different types; most probable source and its type of material; fragments, fishing materials, single use items, non-disposal user objects and Styrofoam and foamed plastic [12].

Reference [12] suggests that the marine-based source of the debris was macro-plastic debris in island of Atlantic Ocean. Mostly found was mainly derelict fishing gear. Some researchers have studied the plastic pollution in the Falklands found at least 40 types and 38 out of 40 types of plastics were mostly sighted on the beaches used by on board fishing vessels around the island. In addition to this, over 27 types of plastics insinuated to be directly thrown into the sea [12].

Marine plastic pollution has been known to be a serious environmental problem nowadays. In reference to [8], this pollution was considered as hazardous as it can clearly be seen after the effect range and obvious impacts on the marine wildlife. Reference [13], described a high profile topic in recent years is the “Great Pacific Garbage Patch” where plastics are accumulated in the ocean’s world as well as in the north Atlantic Sub-tropical gyre. According to reference [13], it was estimated around 79,000 tonnes of plastics were found on the sea water surface. Based on the two studies made on the same reference, the size of the plastics had increased four times since 2014. It had been said that, there is also distinct increased in the mass of the plastic; the sea water is getting denser with floating plastics and debris but there is no indication of extending the surface area.

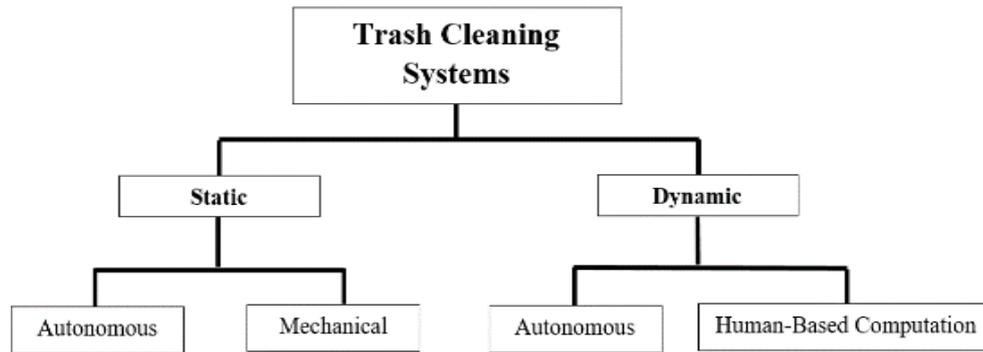
The second to be considered as the largest of garbage dumping area is Garbage Island which was discovered in the Gulf of Thailand. In the recent years, it [14] has been stated that this floating garbage island was spotted near the Bang Saphan district in Prachuap Khiri Khan. In addition to this [15], it was statistically estimated about 2.66 million tonnes of plastics had been tossed into rivers annually and majority of them came from Asian countries such as China, Myanmar and Indonesia.

In reference [16], Port of London Authority (PLA) introduced “drifted service” for the past several years. The service helps to collect an estimated around 250 tonnes of debris and rubbish annually in tidal Thames. Statistically recorded in 2011 and 2012, there were 248 tonnes and 239 tonnes were discarded from the river respectively. The rubbish was collected by using the fyke nets for the trials. Further trials were conducted by using different fyke nets in the river Thames. According to [16], amongst the rubbish collected includes sanitary products such as plastic backing strips, used condoms and wide range of plastic wastes. As stated in [16], there was a total of 8490 rubbish collected and counted during the trial fishing programmes

Reference [19] stated that, a similar situation occurred in Yangtze River, China. The trash started to accumulate and increases in quantity after the Three Gorges Dam was completed in 2003. The trash initially spotted on the upstream of the Wanzhou area and starts to piling up. Variety of the trash can be found such as crop debris, construction waste, plastics and garbage. Due to this problem, the river transportation became inaccessible.

Plastic pollution is inevitable. It can happen everywhere. Malaysia is also one of the Asian country that suffers from plastic pollution. In reference [20, 21], there is many types of floating debris found in the Klang River such as plastic bottles, woods and trash. While in Bangkok, Thailand [22], the debris can be seen during the high tides. The debris composes of plastic bottles, foams and other types of trash. Even during the rainy season, there would be huge amount of aquatic weeds found in the Chao Phraya River. The reference also stated that the debris would wash down to Samut Prakan province from Sappasamit Canal.

Not just in Malaysia and Thailand, Philippine has also experienced plastic pollution. Reference from [23] stated that the most common trash found in Manila Bay is plastic bags. Based on the reference, there was about 23.2 percent of plastic bags were collected out of 1594 litters of garbage at the area. Other types of trash can also be spotted such as cigarette butts, sponges and clothes.



**Figure 3.** Classification of trash cleaning systems.

### III. DESIGN

#### 3.1. Design of Conveyor Belt Assembly:

- 1) Total length of belt = 0.5 m
- 2) Height of inclination = 0.250 m
- 3) Weight of belt = 4.7 = 5 kg
- 4) Coefficient of friction = 0.5
- 5) Weight on conveyor = 5kg
- 6) Total weight = 5 + 5 = 10kg
- 7) Belt pull = total weight x coefficient of friction  
= 10 × 0.5  
= 5 kg

- 8) Gravity pull =

$$\frac{\text{Belt pull}}{\text{length of belt}} \times \text{height}$$

$$= \frac{5}{0.5} \times 0.250$$

$$= 2.5 \text{ kg}$$

- 9) Total pull = belt pull + gravity pull  
= 5 + 2.5  
= 7.5 kg

#### 3.2 Power calculations:

Required power = Total pull x linear speed Linear speed considered as 10 rpm

$$\text{Linear speed} = \text{Circumference of shaft} \times \text{rpm}$$

$$= \pi \times 0.075 \times 10$$

$$= 2.355 \text{ m/min}$$

Therefore,

$$\text{Required power} = \text{Total pull} \times \text{linear speed}$$

$$= 7.5 \times 2.355$$

$$= 17.662 \text{ kg. m/min}$$

$$1 \text{ Hp} = 4573.17 \text{ kg. m/min}$$

$$\frac{17.662}{4573.17}$$

$$\therefore \text{Required power} = 4573.17$$

$$= 0.0038 \text{ Hp}$$

$$1 \text{ Hp} = 0.7457 \text{ kW}$$

$$\frac{0.0038}{0.7457}$$

$$= 0.0050 \text{ kW}$$

$$= 5 \text{ watt}$$

For safe working,

Consider factor of safety = 2

Therefore,

$$\begin{aligned} \text{Required power} &= \text{Actual Power} \times \text{factor of safety} \\ &= 5 \times 2 \\ &= 10 \text{ watt} \end{aligned}$$

According to the calculations, Motor for the conveyor assembly was selected with the following specifications: -

Input Voltage Range (DC)	6V to 15V
Rated RPM (at 12V)	10
Gear Reduction	810K
Rated Torque (N-cm)	680
No- Load Current (A)	0.4
Full Load Current (A)	2.047
Shaft Diameter (mm)	6 mm
Motor Body Diameter (mm)	37
Motor Body Length (mm)	94
Motor Shaft Length (mm)	27mm
Motor Shaft Type	D cut without hole

### 3.3 Calculations for the floating of the prototype:

For floating of the whole assembly, we used PVC pipes which were joined to the prototype. So, to float the assembly we had to calculate the diameter of the PVC pipes.

As we know,

For floating of any body, we have to calculate the buoyancy force which will be exerted on the floating element, Therefore,

$$\begin{aligned} \text{For water} \quad \text{density of water} \times \text{gravity} \times \text{volume} &\geq \text{For pipe} \quad \text{density of PVC} \times \text{gravity} \times \text{volume} \\ \rho \times g \times v &\geq \rho \times g \times v \end{aligned}$$

Hence the only affecting quantity in the equation is the volume.

$$= \frac{\pi}{4} \times 150^2 \times 900$$

4

$$= 15904.81$$

$$= 15.90 \text{ kg}$$

For floating the pipe will be submerged 2/3 of its portion (circumference)

$$\begin{aligned} \therefore 15.90 \times \frac{2}{3} \\ = 10.6 \sim 11 \text{ kg} \end{aligned}$$

## IV. MODELLING

### 4.1 Assembly Drawings:

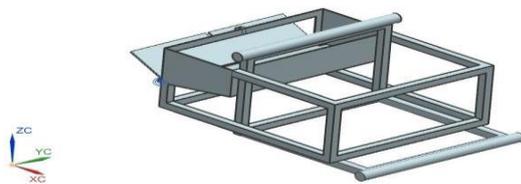


Fig 4: Assembly drawing 1

### 4.2 Part drawings:

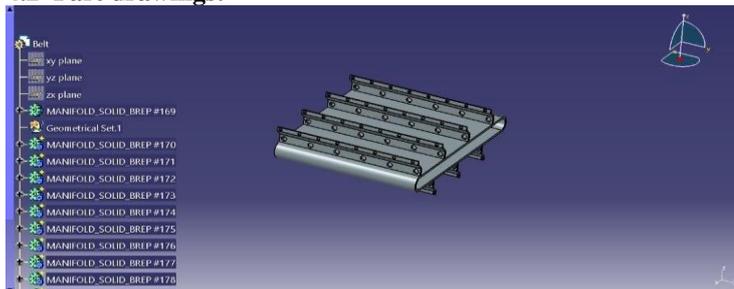


Fig 5: Conveyor belt with plates

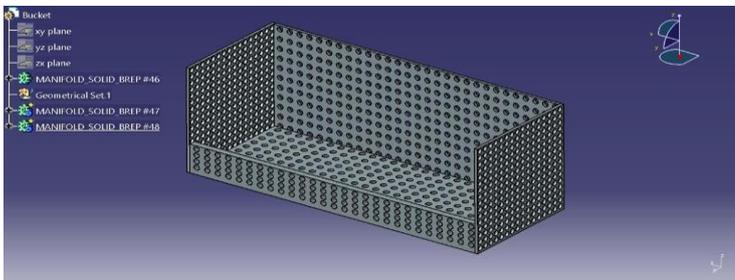


Fig 7: Bucket of perforated sheet

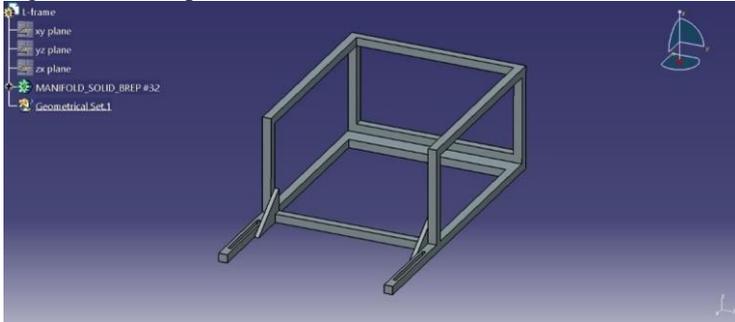


Fig 8: Frame of the Assembly

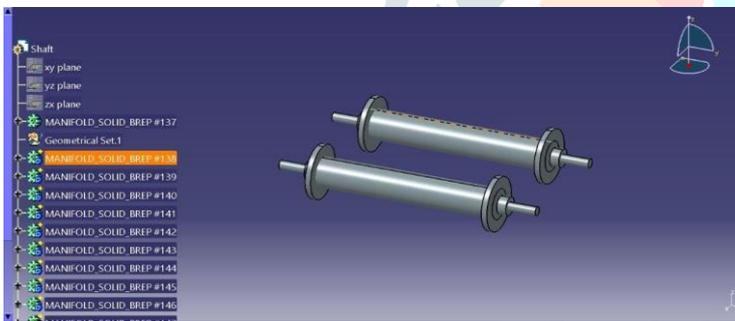
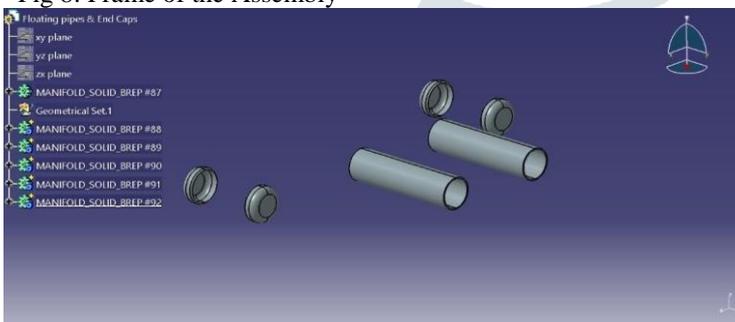


Fig 9: Floating PVC pipes with end caps

Fig 10: Shaft for the conveyor assembly

#### 4.3 Drafted CAD Drawings:

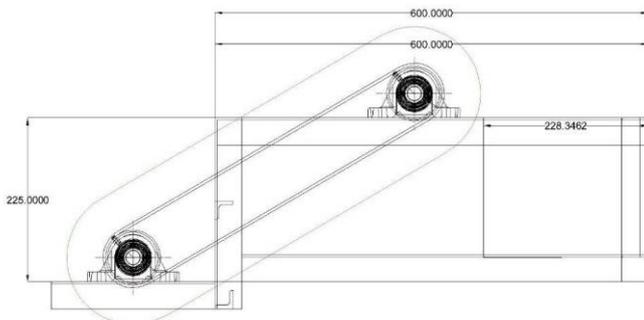


Fig 11: Assembly drawing

#### V. MANUFACTURING

First of all, we selected the material as per our requirements. Materials like shaft, hollow pipes, angle plates, belt, metal sheets, etc. Then we started actual manufacturing process from manufacturing conveyor shafts, on which conveyor belt is placed.

### 5.1 Conveyor shaft -

To optimize the weight of the assembly and reduce the load on the motor, two hollow shafts with an outer diameter (O.D) of 76 mm were selected. These shafts were cut to a length of 420 mm, and four circular discs were welded at both ends of each shaft. The circular discs, fabricated using a laser cutting process on a metal sheet with a thickness of 12 mm, serve as structural support for the assembly. Hollow pipes were welded to the discs, enabling a direct connection of the motor drive to the shafts for efficient power transmission. Machining operations, including turning and knurling, were performed on the conveyor shafts to enhance their functional characteristics and ensure precise integration with the overall system. This structural configuration not only minimizes weight but also facilitates seamless motor operation and efficient debris collection.



Fig no. 12- Conveyor shaft

### 5.2 Conveyor belt & blades –



Fig no. 13- Conveyor belt & blades

The belt for the assembly was cut to precise dimensions of 1150 mm x 400 mm (L x B). Markings were made on the belt for hole placement, ensuring both efficient water drainage and secure mounting of blades. Holes of 10 mm diameter were drilled throughout the belt at equal spacing. Simultaneously, metal sheets were cut and bent to form blades designed to pick up waste from the water and deposit it into a bucket. The blades were shaped through a two-step bending process: first at 90°, followed by a 45° bend at the edge, achieving an optimal blade configuration. Additional holes were drilled into the blades to allow water to flow through seamlessly. The blades were then mounted onto the belt using nuts and bolts for secure attachment. Finally, the belt ends were joined in a circular format using riveting, creating a continuous loop for efficient waste collection.

### 5.3 Conveyor assembly -

The belt, equipped with attached blades, was mounted onto two hollow shafts to enable efficient movement. These hollow shafts were connected to a motor to facilitate rotational motion. Both shafts were designed to rotate in a clockwise direction, ensuring the smooth operation of the conveyor system. The entire conveyor assembly was securely positioned on an L-shaped angle frame, providing structural stability and support for the system during operation.



Fig no. 14- Conveyor assembly

### 5.4 Bucket -

A perforated sheet of 18-gauge thickness was selected for fabricating the bucket. The sheet was cut to precise dimensions of 4400 mm x 480 mm and then bent to ensure proper fitting within the frame. Once shaped, the perforated sheet was welded securely to the frame, providing a durable and efficient structure for waste collection and water drainage during operation.



Fig no.15- Bucket

### 5.5 Main body frame -

Metal angles with dimensions of 37x37x3 mm were prepared for the main body frame. The angles were cut into the following lengths: 600 mm (4 pieces), 225 mm (4 pieces), and 460 mm (3 pieces). A grinder was used to remove burrs and ensure smooth surfaces for welding. These angle plates were assembled to form a cube-shaped frame, serving as the primary structure of the machine. The assembly of the angle plates was accomplished using ARC welding to ensure strength and durability. The main frame houses the conveyor assembly and other mountings, while also incorporating a dumping bucket designed to collect and store marine waste or trash effectively.



fig no. 16- Main body frame

### 5.6 Floating pipes –

Two PVC pipes, each with a diameter of 6 inches and a length of 1.2 meters, were utilized as floating pipes to support the entire assembly's weight. These pipes were strategically mounted on both sides of the structure to ensure balance and stability on water. The pipes were selected for their ability to carry a total load of 46 kg and provide reliable buoyancy without any issues. The end caps of the pipes were sealed securely using an adhesive solution to prevent water ingress. The floating pipes were attached to the frame using C-clamps, which were fastened to small metal plates. These metal plates were welded to the frame, and the C-clamps were firmly secured using nuts and bolts, ensuring a robust and stable attachment.

Total Assembly after manufacturing process:



Before Paint



After Paint

## VI. EXPERIMENTATION



Fig no. 17- Testing for floating of machine

In this experiment, the prototype to float on water bodies we decided to attach PVC pipes to the machine. So, we performed an experiment to firstly check whether the pipe will carry the load which was calculated as mentioned before. While performing the experiment we took a cut piece of PVC pipe of 100mm length having a diameter of 6 inches and on that we wound wrapping paper to seal the cut piece and around that we attached a wire and a hook. On the hook we added different weights so that we can check up to what level the pipe can sustain the weight without sinking. Therefore, after performing the experiment, we observed that the pipe of 100mm in length and 6 inches (152.4mm) in diameter sustained weight till 5 kg and that it sunk when we added 6 kg weight. As for the 5kg weight the pipe submerged almost 90% of its volume. So, for floating of the prototype the pipe had to be submerged  $\frac{3}{4}$  part of its circumference. Hence the floating weight was 4kg.

## VII. CONCLUSION

The aim of the study was to investigate the main contributor to plastic pollution. It was found that the main sources of plastic pollution were mainly caused by huge dump of garbage as well as the result of tourism activities. Amongst the negative impacts of plastics pollution includes the destruction of anthropocene, unfavourable effects on the organisms, ecosystems and human health.

A number of countries have carried out various initiatives to reduce plastic pollution. These initiatives include Automatic Trash Collection Boat which is currently being established in China, Solar-powered Water Wheel Project which is carried out in Baltimore, a SeaVax from United Kingdom and many more. Although there are several initiatives that have been already practiced around the world, the demand of reducing plastic wastes on the water surface keeps on increasing as this plastic pollution is still a threat to human, living creatures and environment. Hopefully with the new proposed design, it could help to scale down the amount of plastic wastes. Apart from this, the new proposed design was created and produced so that it is applicable to be used anywhere and more importantly, it was designed to suit for the Bruneian context. However, the main important steps that need to be taken is to create awareness among the world population of the negative impacts of plastic pollution.

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