



A SURVEY OF MARINE POLLUTION IN WESTERN COAST OF KERALA AND EFFECTIVE UTILISATION OF THE RECYCLED WASTE FOR ROAD PAVEMENT

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ABSTRACT

Marine based plastics contribute to one of the major sources of plastic waste pollution across the globe, for which many solutions have been proposed. However, there is very little emphasis on the development of waste treatment options, as most of the solutions focus on the collection and prevention of plastic waste.

In this case study, I've developed a questionnaire to investigate the issues surrounding the involvement of fishermen, Self- help groups and organisations who have adopted the strategy to use plastic waste as a substitute for road pavement.

As there is a lack of proper technology for the treatment of marine plastic globally, the present research intends to drive more people to this area. The survey aims to create awareness and encourage implementation of technologies and research in the field. This in turn, it is hoped, will increase public risk perception about plastic pollution and its adverse impacts.

KEYWORDS: *Plastic, waste, Pollution, Questionnaire, environmental impacts, development.*

1. INTRODUCTION

1.1. Marine Plastic Waste Scenario

The marine environment is prone to the accumulation of plastic waste, which directly impacts aquatic life as well as the water quality- it is one of the major global environmental concerns today (Rochman, 2018; Ronda et al., 2019; Villarrubia-Gomez et al., 2018). Due to the influence of inter-continental pollution sources, coastal areas are plastic pollution hotspots (Alfonso et al., 2020), creating a major threat to their vast biodiversity and ecosystem services (Soto et al., 2021). Sources show that more than 8 million tons of plastic make their way into the sea every year (Jambeck et al., 2015) and by 2045 plastics will supersede fishes in the ocean (MacArthur et al., 2016). There are alarming concerns over the impacts of the plastic burden in the oceans on marine organisms as well as the resultant impacts on humans and other habitats that consume the marine organisms (Naidoo et al., 2020). Our failure to manage plastics efficiently and the long-term durability have led to marine plastic debris becoming a significant problem in recent times (Thompson et al., 2009). A recent report on 'Marine plastic debris and microplastics' by the United Nations Environmental Program (UNEP) revealed the fishing industry as a significant contributor to marine litter in the oceans (Kershaw Peter, 2016). Without a doubt, public awareness and response, environmental factors play a vital role in influencing pollution management (Steel et al., 2005).

1.1. Waste Plastics in Indian Road Pavements

India's road network consists of about 114,158 kilometres (km) of national highways, 761,217 km of state highways and district roads, and 4.2 million km of rural roads. (GoI, Road Transport and Highways dept., Road Statistics, 2020). In 2013, the Prime Minister's Rural Road Program (PMGSY) was required to initiate innovative approaches on at least 15% of the length of rural roads in all the states proposed for PMGSY funding. This condition was intended to (i) cut down construction costs; (ii) conserve non-renewable natural resources by using environment-friendly materials; and (iii) utilization of waste materials by maximizing the use of locally-available materials, industrial wastes,



new materials, and environment-friendly (“green”) technologies in road construction (National Rural Roads Development, GoI, 2020).

In the construction of flexible pavement, bitumen plays the role of binding the aggregate together by coating over the lump. It's shown that its resistance towards water is poor and the costly. Heavier loads, high traffic volume and tire pressure-demand higher performance pavements (Vasudevan et al., 2006). Using plastic waste as a bitumen modifier in road surface mixes can potentially improve the performance of road laying while reducing the use of virgin materials at the same time (Al-Hadidy & Yi-qiu, 2009a, 2009b; Attaelmanan, Feng, & Al-Hadidy, 2011; Gawande, 2013; Gawande et al., 2012; Kalantar et al., 2012; Rokade, 2012; Zhang et al., 2016).

1.2. *Suchitwa Sagaram* Mission (Clean sea) by Government of Kerala

Global concern amongst the general public and policymakers has rapidly increased with the growing concern on the impacts of plastics (Avio et al., 2017; Borrelle et al., 2017; Mæland and Staube-Delgado, 2020). To help mobilize the international community to abate marine plastic pollution, several initiatives and actions at many levels (global-regional-national) have been put forth (UNEP, 2018a). *Suchitwa Sagaram* (Clean Sea Mission) - a flagship initiative by the Government of Kerala, have come up with successful missions in accomplishing plastic waste management initiatives in 2017. The initiative aims in cleaning the ocean by removing all forms of plastic materials and also pledging to stop the illegal dumping of waste. Such initiatives pave way for the future generations to keep hope in our climate and environment and to put forth valuable efforts in leading a sustainable life. However, in most cases such efforts are unrecognized and the emergency of the situation is often overlooked.

This study develops a measurement instrument for Clean Sea Mission activities organised at the local level by the Government of Kerala. The paper is structured as follows: section two describes the method of a questionnaire survey conducted among the actively involved groups in the mission. The group includes the fishermen community, Self- help group (SHG's) and the organisation involved in the construction and maintenance of roads, with the plastics collected from the ocean. Section three mostly describes the results of the survey, analyses the major factors influencing the results and the causes for the gaps among the government and different groups set for the study. Conclusions and recommendations are included in the last section where the government can enhance the system for the betterment of the mission.

2. RESEARCH METHOD

There are lumps of plastic waste in the ocean that have been formed over the years which need to be collected and processed. As of 2018, over 250,000 tons of marine plastic had been removed from the oceans worldwide, but there wasn't evident information available regarding the waste post-collection (Schneider et al., 2018). When compared to the total mass of plastic waste entering the oceans every year, this recovered mass is very negligible. Novel collection methods and advancements in existing techniques need to be addressed at the local as well as at the national level to increase the collection rates. Environmentally ethical waste management techniques (basically reuse, repair, recycling or disposal) need to be addressed and implemented to treat the marine debris, and in particular, the dirty plastic, once it is recovered from the ocean.

Kerala is a state widely known for the vast variety of seafood and an enormous amount of fish is included in the daily diet pattern of its people. The future is not far when plastic could seep into the human food chain, with the drastic increase in the amount of plastics in the ocean day by day. This concern has been taken up as a mission known as the *Suchitwa Sagaram* put forth by the Fisheries department of the Government of Kerala in the year 2017 (Logical Indian, 2018). This initiative promises that plastic materials in the ocean or the ones which get entangled in the nets while fishing will be cleaned.

Based on several characteristics of the Clean Sea Mission, there are many activities associated with it. Some of the activities include a) collection of waste plastics from the ocean by fishermen; b) assembling, separation and shredding of the different kinds of plastics by the *Kudumbasree* Self-help group members and c) Conversion of the shredded plastics used along with bitumen for road tarring purposes by Public Works Department (PWD) of Kerala. The following features have been set for measurement of the survey, statistics and assessment of the people associated with the project-

- 1) Concern about the marine plastic pollution
- 2) Awareness and importance of a safe and healthy marine environment as socially valuable
- 3) Ability to identify and negate the main threats for the marine life
- 4) Government involvement in the activities



- 5) Readiness to take a personal part in the marine environment concerning activities to prevent, protest and protect.



Fig1: Coastal stretch of Kerala

Therefore, the interaction of the “concern-awareness-understanding- actions- improvements” is identified as the key for the output. In this paper, the clean sea mission activities are divided into these components. To measure the aspects of Marine Environmental issues and activities associated with it, a questionnaire consisting of several questions to assess the effective involvement of fishermen, SHG’s, agencies and organisations have been conducted. A detailed interview has been conducted with the *Kudumbasree* Self-Help Group (SHG) which played a vital role in the segregation of plastics of various kinds (which were in turn put in the shredding machine for road tarring purposes). A set of questionnaires have been prepared for the survey with the fishermen, which include the following details: a) background information of their fishing career, b) challenges they faced so far in their career, c) environmental concerns, d) the involvement and activities by *Suchitwa Sagaram* initiative by the Government of Kerala and few general questions concerning the ocean plastic pollution, waste disposal, health, behaviour and threats to the ocean environment. And the final set of questionnaires were to the organisation involved in the Road construction works with the recycled plastics. The structure of the questionnaire is summarised in Table 1, Table 2 and Table 3

a) Table 1: Structure and questions of the questionnaire for the interview with Self-Help Group (SHG)

	Measurement	Expected Outcome
1.	How many people are there in your group? How long have you been working with the group?	Strength
2.	a) What is your opinion on the clean sea mission? b) What were your major responsibilities? c) Did the government provide all the necessary amenities, support and infrastructure?	Duties and Responsibilities
3.	a) How was your daily schedule? b) How was the payment done? (daily/hourly) c) Did you have regular meetings with the authorities?	Government intervention and involvement

4.	a) Did you face any challenges throughout the process? b) What do you think have changed over the past four years, from 2017 to 2021, any notable improvements or disappointments?	Challenges, changes
5.	What do you think about marine plastic pollution? a) Did you observe anything around the issue? b) Do you think there is a viable solution to reduce dumping?	Concern/ awareness

3. RESULTS AND DISCUSSIONS

The results were categorized into different sections. Interviews were conducted with fishermen, *Kudumbasree* Self Help Group members, agencies, and organisations involved in the tarring of roads with the waste plastics collected from the ocean. The results are mentioned in detail in the following discussion part.

3.1. Interview with the *Kudumbasree* Self Help group (SHG)

Kudumbashree is the poverty eradication and women empowerment programme implemented by the State Poverty Eradication Mission (SPEM) of the Government of Kerala. The name *Kudumbashree* in the Malayalam language means ‘prosperity of the family. As part of the *Suchitwa Sagaram* Mission, more than 800 fishing vessels head out from the harbour every day, 40 boats head back daily carrying the waste plastic they net alongside the fish. The fisheries department has set up waste collection centres close to the fish landing points in most sites. The wastes are collected, washed, segregated, separated and put to the shredding unit by the *Kudumbashree* women employed at the collection centres. Thirty women are employed at the Kollam Harbour to sort and dry the retrieved plastic, which is then processed and converted to usable products at a plant set up by the harbour engineering wing.



Shredding and sorting plastic waste in shredding units

(Source: china dialogue; Image: Shailendra Yashwant)

3.1.1. Concern about the marine plastic pollution

Macro plastic pollution is a global concern and is recognized as one of the most severe forms of pollution in shorelines, oceans and freshwater bodies. From the project clean sea mission more than 100 tons of plastics has been removed from the ocean so far which includes plastic bags, plastic bottles, discarded nets, plastic ropes and other plastic items. It is a bulk amount that has been brought by our fishermen.

The interview was conducted among the thirty women working with the SHG, each of them has shared different stories of their hardships and how such initiatives get them going. Sheela, a widower with two children works in the shredding unit set by the mission. She pays her daughter’s college fees from the amount she earned



through the Self- Help Group (SHG) activities. She says that at times it gets hard making ends meet and there were times she and her children stayed hungry for days without a proper meal. Mary, who works with the segregating unit shares her story about her sick husband and three children. Her husband, a fisherman, got paralysed five years ago from a devastating cyclone that almost took his life. Since then, she has been struggling with the hospital bills, household, and children's education, all of which is partially met by the activities and events conducted by SHGs.

What is your opinion on the accumulating plastic waste in the ocean?

It is unbelievable, the amount of plastic waste the fishermen used to bring daily in the first few years of the program. We were astounded by the huge amounts and were confused about how to go about it, but experts from various fields have guided us to effectively make use of the waste plastic. We have to judiciously use the resources God provides us, but the waste collected from the ocean determines how unsympathetic we are to our mother earth.

What is your opinion on the Suchitwa Sagaram mission? What were your major responsibilities?

We are a group of 30 women employed for the initiative put forth by the Fisheries department of the Government of Kerala. This is indeed an excellent initiative showing the concern for our planet and to keep our ocean clean as well as protecting our marine ecosystem. Our major responsibilities include cleaning the huge lump of plastics brought by our fishermen, drying the plastics and segregating them according to the norms given by the authorities, and scraping it in the shredding machine installed by the authorities. The shredded plastic is then collected inside huge sacks which were then taken for road construction purposes.

3.1.2. Challenges and difficulties

Did you face any challenges throughout the process? What do you think have changed over the past four years (from 2017- 2021)?

The mission is not processing the way it used to in 2017 due to fund shortages and insufficient support from the government. The *Kudumbasree* workers were not paid regular wages, most of the time their wages took more than 5 months to process. In many cases, there weren't enough collection points to segregate the waste plastics which takes considerable effort to wash and convert to a form that can be further used for recycling.

What are the improvements to be made?

Major improvements needed are the constant support from the government as well as from the public. This is not just an issue concerning an individual or a particular group, this is a national issue that has to be dealt with utmost importance. The lack of awareness of the urgency of the issue and insufficient allocation of government funds for such global issues is the key problem. We (SHGs) hope that all these will be taken into consideration once the pandemic is over.

3.1.3. Government intervention

The government has been a constant support during the initial year of the project. All necessary amenities, training and infrastructure were provided for the smooth sailing of the program. The situation has changed in the past 2 years, there was a gradual dip in government involvement. SHGs were not provided wages for months and several incentives were also dropped. The situation has worsened due to COVID-19 as further raises in registration, deposits and licence fee were introduced.

As per the UN report, just 10 months since the launch of the *Suchitwa sagaram* scheme, the fishermen have removed 25 tonnes of plastic from the Arabian Sea which includes 10 tonnes of plastic bags and bottles.

**Clean Seas staff carry washed marine waste.***(Source: china dialogue; Image: Shailendra Yashwant)***b) Table 2: Structure and questions of the questionnaire for the survey with fishermen**

	Measurement	Expected Outcome
Section 1	Personal Background-	
1.	Name, City, Age	Influencing factors
2.	How many years have you been Fishing? a) How often have you visited the ocean in the past 1 year? b) Did you observe any change in the pattern of the sea behaviour/climate in the past few years? c) What do you think have changed in the ocean behaviour in your fishing career so far?	Determine sea behaviour/ climate change patterns.
3.	What are the major challenges you have faced in your fishing career to date?	Determine the role of local self-Government Organisations
4.	What is the major equipment you use for fishing? Is it made up of plastic? How many times do you use it for fishing?	Devices used for fishing
Section 2	Ocean/ environmental concerns-	
5.	What are your major concerns about the ocean? (What do you feel needs to be done or addressed by the government?)	Awareness/ concern
6.	Where do you think the ocean pollution comes from? What could be the major factor in your opinion?	human activities both on land and on the ocean as the major source of pollution
Section 3	Clean sea Mission in Kerala-	
7.	Have you heard of the 'Suchitwa Sagaram' Mission? Have you been a part of it? a) If yes, how was the mission going on in 2017 and 2020?	Awareness / Comparison/ Government Involvement



	<p>b) What do you think were the issues you faced? Were you paid regularly?</p> <p>c) Was there any other mission by any other department, (other than <i>Suchitwa sagaram</i>) previously or at present as part of Marine conservation?</p>	
Section 4	General questions-	
8	What do you think of building hotels/ resorts near a public beach?	safe coastal environment concerns
9	Do you know the following terms? (coral reef, Exclusive economic zone, marine protected area, overfishing, marine litter)	Familiarity with ocean-related environmental terms
10	Have you heard of global warming and carbon footprint?	Awareness/ Concern
11.	<p>Below is a list of some problems our oceans are facing, which ones do you think are a result of human activities?</p> <ul style="list-style-type: none"> ● Plastic/ trash ● Pollution ● Overexploitation of fishing resources ● Marine engineering/ oil drilling ● Unsustainable aquaculture 	Recognition of human activities as the key threats to the marine environment
12.	<p>Which one of the following two statements do you agree with more?</p> <ul style="list-style-type: none"> ● Marine resources are so plentiful that every human being should use them freely ● Marine resources are limited; we need to set some rules controlling the use of marine resources even though this has some negative effects on human lives 	Recognition of marine resources depletion and the need to protect them
13.	Protecting and taking care of the oceans has a major impact on the global economy. (Do you agree?)	The marine environment is globally valuable, and its contribution to the global GDP
14.	It's not only our activities in the marine environment that affect life in the sea, it's also the things we do on land. (Yes/No)	Human relation to the ocean even when we are far from it
15.	Do you think ocean problems can also affect human's health? Are there any health problems for your family members or you?	The interconnectedness of humans and the oceans
16.	Do you think our daily activities can contribute to marine environment protection or if that was a matter of the government?	Personal role in marine environment protection
17.	<p>What are the major organisations related to marine-related activities which you are aware of? Can you name a few?</p> <p>a) Do they contact you regularly?</p> <p>b) Do you have meetings often on the clean sea mission or other related environmental activities?</p>	Inclusion, awareness



3.2. Survey with the Fishermen

The interview was conducted either via phone or personally meeting the people. Each of the questions connected to their activities was asked. They had the freedom to respond about their experience, ocean-related concerns, issues, and even suggestions for the general public on the judicious use of resources and the rapid depletion in aquatic life forms due to the intake of plastics in marine organisms. The answers were analysed in the marine environment context and also were able to identify a safe marine environment as socially valuable. Most of them have been actively involved during the devastating *Kerala floods 2018*, the floods which took a toll on their career, habitat and lives of many.

How often have you visited the ocean in the past 1 year?

Small scale trawlers go fishing once or twice a week, they own non-mechanised boats which don't go very far from the coast. Fishermen with mechanised boats go quite far for about 4 days fishing at a stretch and return after 6 days. Nowadays, due to COVID-19, Cyclone- one after the other and on top of that monsoon trawling ban have ruined their life and career. Most of their houses have been demolished by severe cyclones. So, the fishermen and families were relocated to relief camps, also the catch these days is very low, fishermen are not able to meet their monthly expenses and have starved for days without food and money.

Do you agree that protecting and taking care of the oceans has a major impact on the global economy?

Kerala being a coastal state, fisherfolk form an important sector of the population. There could be lakhs of fishermen in the marine as well as in the inland sector. In all these fishing villages throughout the state, fishing and related aspects provide a livelihood to the vast majority of the population. So, the government must take care of the sector with utmost supervision and protection like any other sector which plays a vital role in the state economy.

3.2.1. Concern about the marine plastic pollution

Findings show that 89% of the interviewed fishermen were very deeply worried about the accumulation of plastics in the ocean. Every time they go for a catch, they used to bring tons of plastic waste along with the fish, they never considered it a serious issue before the *Suchitwa sagaram* mission was launched in 2017. The general public awareness is such that the modern wastewater treatment facilities can remove up to 99% of microplastics, the microplastics released through the effluents are significant due to their sheer amount, so it'll never degrade once it reaches the ocean instead become tiny bits of microplastics which the fish mistakenly consider as their food and eventually get into the food chain. Thus, microplastics readily enter the marine environment and may accumulate in seas and freshwater bodies.

What are your major concerns about ocean pollution?

We are the section of people who reside along the coast. We fisherfolk look up to the ocean as sacred, (always referred to as the *Kadalamma, Kadal* (Malayalam term) meaning the sea and *amma* meaning 'mother', representing the fertility of a woman. Deaths in the sea are regarded as the wrath of the mother, which is attributed to violations of any tradition.) we don't do any harm to her. But it is unbelievable how these wastes are stacked up in the ocean. We are often the marginalised section of society, but we don't slaughter our ocean by dumping plastic wastes. Our Kerala coastal stretch is about 600km, we are obtaining tons of plastic waste just from the Kollam coast (a district in Kerala), the situation could be impertinent towards the northern coast. The government should ban the use of plastics or at least impose strict rules and enforcement on the use of plastics.

What do you think have changed in the ocean behaviour or the amount of fish from your catch in your fishing career so far?

It is unbelievable to say how much it has changed, the change would be massive. Over the past few years, marine fish production has declined drastically. Central Marine Fisheries of India (CMFRI) have revealed an 11% - 15% decline in overall fish catch in 2019, compared to the previous year. There must be something going on, as we have observed a rise in sea surface temperature which is eventually changing the nature of oceans, which may, in turn, affect the ocean life and its food chain.

3.2.2. Awareness and importance of a safe and healthy marine environment as socially valuable

The survey however has been narrowed down such that, one could conclude that about 80% of the plastic debris in the marine environment are land-based sources of plastic debris. The densely populated or



industrialised places being the major sources due to littering, unbridled use of plastic bags and enormous disposal of solid waste. The survey also found that large quantities of plastic debris derived from raw manufacturing materials were transported onto beaches following accidental spillage during handling and other processes mainly from major industrial towns, especially in the Kollam district of Kerala. Plastics are transported from their sources by river systems and wastewater treatment stations to the ocean. In addition, extreme weather conditions (e.g., hurricanes or flooding) increase the transfer of land-based debris to the sea.

What is your opinion on the 'Suchitwa sagaram' mission by the Government of Kerala?

The mission set by the Government of Kerala has put a realisation to the amount of plastics that are accumulated in the ocean beds each day and the question on how to overcome the issue has been put forward. It was then that the fishermen were assigned to bring along the plastics back to the harbour along with the fish that they catch. Previously, they would dispose of the plastic debris that would get caught in the nets which then remains in the sea. They now pay extra attention to the plastic that would tangle in the net. Also, the government has provided incentives for the amount of plastics that we fishermen bring back. Nowadays, we hardly get any response or attention from the mission organisers.

Do you think ocean problems can affect human health?

We are not so sure about how it may affect our health, but it does have a severe impact on the marine ecosystem. We could observe a drastic reduction of fish in the ocean over the past few years. There were times when we used to make enough for a month's survival, but this is not the case now. We barely get going for a month and the expense is too high these days.

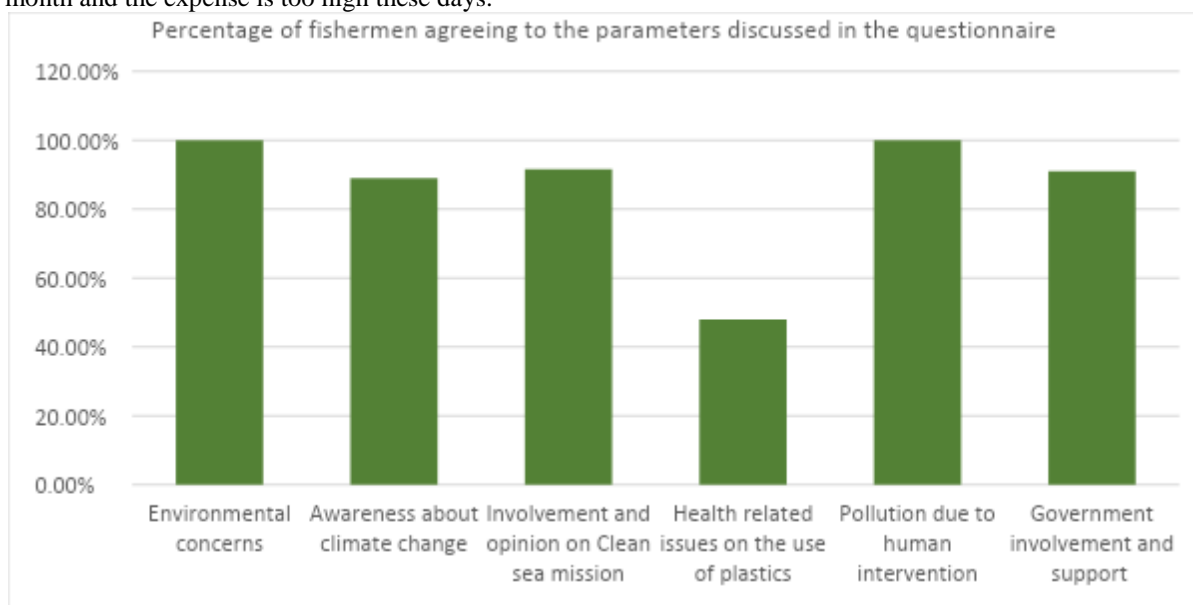


Fig: Responses from the interviewed fishermen

3.2.3. Government involvement

When the project was launched in the year 2017, the government wholeheartedly supported the authorities associated with the program which gained active involvement from the fishermen community as well as the SHGs. The initiative gained widespread recognition at the local, national as well as in international levels by the United Nations Environmental Program (UNEP). The participation from the fishermen was mostly self-driven due to the urge of keeping the ocean and surroundings clean. Over the years due to fund crunch, the program has taken a major toll and the involvement and incentives which were provided in the beginning had no follow-ups from the concerned authorities.

Which were the major organisations which took a considerable step forward for the smooth sailing of the Suchitwa Sagaram program by the Govt. of Kerala?

1. *Suchitwa Mission, Kerala* - Financial support for the establishment of plastic shredding unit at fisheries harbour and training to members of SAF
2. *Clean Kerala Company* - Technical support before and after the establishment of the shredding unit.

3. *Harbour Engineering Department (HED)*- Providing area and electrical connection for installation of Plastic shredding unit at fisheries harbour
4. *Society of Assistance to Fisherwomen(SAF), Department of Fisheries, Kerala* - Running of the shredding unit including manpower, salary to the workers, electricity charges, etc.
5. *Boat Operators Association, Kollam District* –
 - a. Overall Monitoring and running of the project.
 - b. Bringing and collecting plastic from the sea.
 - c. Deployment and sufficient manpower to look after the programme.
6. *NETFISH-MPEDA* - Supply of eco-friendly bags for waste collection, awareness stickers to fishing boats and conducting awareness training for fisheries

3.2.4. Readiness to take a personal part in the marine environment concerning activities to protect the planet

Bunch of extremely kind and down to earth human beings who were ready to take up the daunting task wholeheartedly over government Intervention. The govt. has provided sufficient facilities and supplies for the smooth sailing of the program during the initial year when the program was launched. Over time, due to various reasons the support from the Government and related authorities declined and the fishermen could no longer risk their life and the hard-earned money for a cause where the government and people by themselves were the least interested.

What is your opinion on climate change?

We are killing our planet in a way, the unbelievable amount of waste brought from the ocean is a clear example of how we treat our planet. There is a gradual decline of fish in the ocean, which could also be the result of climate change and global warming on our planet. This is an emergency where the government and public have to take key steps in controlling the illegal use of plastics through strict restrictions and awareness programs. The general public isn't aware of the issues surrounding the use of plastics, the environmental harm that it causes and the very evident coastline erosion that takes place every monsoon. We fisherfolk are suffering for the harm that people do to our planet.



Fig2: Fishermen crew with litter recovered from the Sakthikulangara Harbour, Kollam, Kerala
 (Source: the china dialogue; Picture courtesy: Shailendra Yashwant)

Table 3: Structure and questions of the questionnaire – for the organisation involved in the mission.

	Measurement	Expected Outcome
1.	a) How was the shredded plastics processed? b) What were the difficulties encountered during the process?	Utilization of plastic waste
2.	a) How was the output obtained compared to normal bitumen roads? b) Do you think this is the most viable option for the rapid global challenge of plastic waste?	Comparison



3.	Do you think there could be any health-related issues revolving around the plastics being treated with bitumen?	Health issues
4.	a) Was there any change in expense structure when the waste plastics were used in place of bitumen/asphalt? b) Do you think this could be the future?	Output/ achievement

3.3. Interview with the organisation involved in the construction of roads with the plastics collected from the ocean

Plastics have been recycled since the 1970s, the quantities that are being recycled vary geographically, according to plastic-type and application. Recycling of packaging materials has seen rapid expansion over the last decades in several countries. Advances in technologies and systems for the collection, sorting and reprocessing of recyclable plastics are creating new opportunities for recycling, and with the combined actions of the public, industry and governments it may be possible to divert the majority of plastic waste from landfills to recycling over the next decades.

3.3.1. Marine plastic for road pavements

The structural problems facing the road and highway pavements of both the northern and southern parts of the state and the harm that may cause the huge amounts of plastic waste produced to the environment represent the main incentives of this contribution. The organisations involved in the process have investigated this study and the possibility of improving the characteristics of a surface course asphalt mix by using plastic waste (low-density polyethylene) as a bitumen modifier.

3.3.2. Researches on Road pavement infrastructure using Plastic waste

Swami et al. (2012) investigated the use of waste plastic in the construction of Bituminous Road. They concluded that plastic waste consisting of carrying bags, cups and other utilized plastic could be used as a coating over aggregates and this coated stone could be used for Road construction.

Dr R. Vasudevan (2007) investigated that the coating of plastics reduces the porosity, absorption of moisture and improves soundness. The polymer-coated aggregate bitumen mix forms better material for flexible pavement construction as the mix shows a higher Marshall Stability value and suitable Marshall Coefficient. Hence, one of the best methods for easy disposal of plastic waste includes the use of waste plastics for flexible pavement. The use of plastic bags on roads has many benefits like the Easy disposal of waste, better roads and prevention of pollution.

Bhageerathy et al.(2014) investigated the use of Biomedical Plastic Waste in Bituminous Road Construction. They concluded that the Marshall stability value of the plastic modified mix was found to be 51 per cent more than that for the normal mix which indicates an increase in load-carrying capacity.

What were the notable impacts of the program for road pavements?

“ The plastic shredding systems established across the state as part of RRF have shredded 9,700 tonnes of plastics used in blacktopping 246 kilometres of road. One prerequisite for higher efficiency in this process is the segregation of waste at source — it is critical to ensure a smooth recovery process” says a Member of the road construction authority. As plastics are being used, a considerable amount of bitumen is saved (approx. 8%). Bitumen required petroleum, which is becoming a scarce commodity, so using less bitumen could potentially save on cost and resources.

Do you think there could be any health-related issues revolving around the use of plastics with bitumen?

There was a section of people who were against the use of plastics. Research and developments have suggested the specific plastics that must be used for road pavements and we have taken care of it with utmost importance. We have trained the SHG to segregate plastics such that they could be used for the road infrastructure, without causing further harm to our planet.



Do you think this could be the future of road pavements in India?

Road construction is one of the most conservative industries, upscaling the technology is important to improve the quality of finished roads and maintain their serviceability. According to the World Economic Forum, roads made from waste plastic are more durable against extreme weather conditions like floods and heat as compared to conventional roads. Kerala being prone to extreme floods and climate conditions, this could be a viable solution to move forward to.

From the research analysis it has been observed that from an industry point of view, sustainable development is all about the commitment to minimizing the waste generated and maximizing recycling. It is equally important to minimize the use of virgin materials through several improved design methodologies, effective use of water and energy and most importantly choosing wisely with a concern for the future generation.

Could you explain in detail the benefits from an environmental point of view?

From the project, the following has been inferred-

1. The durability of the roads laid out with the shredded plastic waste is much more compared with roads with asphalt with the ordinary mix.
2. The binding property of plastic makes the road last longer along with the added strength to withstand more loads.
3. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes.

3.3.3. Technical benefits inferred from the use of Binders with plastic waste

1. Improved resistance to cracking due to high binder content.
2. Improved ageing and oxidation resistance.
3. Reduction in construction time on site.
4. The eco-friendly method of construction, and helps maintain the balance of the environment.

Using plastic waste can help India, which has the world's second-largest road network, in curbing road accidents deaths. One-tenth of deaths that occurred in 2017 due to road accidents in the country, was due to potholes, a common feature of roads in India. Therefore, effective and planned management of waste, collection and processing is important.



Fig: Shredded plastic wastes handed over to road pavement authorities

(Source:thebetterindia)

4. CONCLUSION

The study concludes existing gaps with the communication and regular intervention of the Government with the fishermen and SHGs. People working for the cause are mostly from the Below Poverty Line (BPL) section of society. Delayed wages and unemployment can affect their livelihood and their major income source. The findings address a need for improvement of the process by adding more collection points, supporting the workers through incentives and most importantly public awareness on the judicious and thoughtful use of



plastics in the future. Moreover, awareness drives and public events on environmental conservation with utmost importance have to be addressed at the local, national as well as in international levels.

The study indicates that the win-win initiative solves two problems in one go—addressing the burgeoning waste problem and providing indigenous, innovative construction materials for the infrastructure while employing. This is an initiative that could be emulated across the country.

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