Future Strategies in Plastic Waste Management in Sri Lanka

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Abstract— Because of their natural properties such as inertness and low bulk densities, plastics have been commonly used in both water and food packaging, making them ideal moving materials, and low risk to pollutants. Plastic bottles and sachets, particularly urban areas, have become prevalent throughout the world. The packaging revolt was not backed by proper policy on plastic waste management, which left plenty of cities in Sri Lanka littered with plastic waste; creating horrible visual disorders, and other community health issues. Increasing environmental awareness and decreased landfill potential in most developed countries have prompted plastic recycling programs. Nonetheless, only 5-25% of plastic waste is actually being recycled. The paper addresses the opportunities for the treatment of plastic waste. It is concluded that the current rate of environmental degradation is likely to continue unless long-term remedial measures are taken in the country for the management of plastic waste.

Index Terms— disposal of plastic waste. materials, packaging, reuse,

1 INTRODUCTION

In almost every field of human operation today, plastics have made a significant contribution–food, medicine, transportation, plumbing, electrical and heat insulation, packaging, household and electronic goods manufacturing, furniture, and other products of every day or limited use. Plastics in medical products such as disposable syringes, tablet, and capsule blister packaging, joint replacement prostheses, inter venous (IV) fluid tubes, blood bags, catheters, heart valves, etc. have significantly helped to support human life. The human body is implanted with medical devices made from plastics.

The packaging is one of the plastic's most important applications. In reality, in packaging applications, about 40 percent of plastic materials worldwide are used. In creating a sustainable, hygienic, energy-efficient, cost-effective and environmentally friendly packaging process, plastics have contributed. Plastics versatility has allowed food products such as milk, spices, edible oil, bread, pastries, rice, wheat flour, snack foods and various types of medicines to be efficiently pilfered, hygienic and cost-effectively packaged. Plastics are used to package toiletries, cosmetics, and a host of other consumer products of every day and special use used by everyone–rich or poor in urban areas cities or in the villages.

This was possible because of the following plastic product attributes:

i. Clean and hygienic–immunity to toxic and chemical,
ii. Light and unbreakable weight,
iii. Good barrier properties-shelf-life boost
iv. Superior resistance to effects,
v. Sterilizable and immune to the growth of bacteria and other microbial
vi. Transparency as well as opacity
vii. Low consumption of fuel because of low weight and loss of material loss during transport.

It is hard to ignore the importance of plastics to human contribution with the above-mentioned properties. Plastic-based packaging ensures that the safest, hygienic and unadulterated material product to the masses.

Despite all these advantages, under the scope are plastics packaging in the general and plastic bags / carry bags– which are part of the packaging process. Collection of medical, safety and environmental issues are blamed on plastics. For urban cities, the non-biodegradability of plastics is due to causing problems for waste management and blocking the drains. The solution to the problem of waste management is the separation of dry and wet solid waste at the source for which it is very important to have an effective mass awareness campaign. Establishing an effective system for solid waste management coupled with promoting the establishment of recycling centers would help address the problem of Municipal Solid Waste. To manufacture products for commercial use, plastics can be reused, though the concept of resource management. Using recycled plastics, many useful items have been produced and numerous people are working in small, micro, and informal sectors in these activities. Sri Lanka produces 7,000 MT of solid waste per day and the Western Province accounts for almost 60% of waste generation. An average of 1-0.4 kg of waste per day is produced by each person. Only half of the waste generated is collected, according to the Waste Management Authority and the Central Environmental Authority [1]. Recycling means that the unused and discarded plastic waste does not linger on the side of the road, nor is it taken to the landfill.

In addition to traditional recycling, which is common in Sri Lankan, it is also important to promote alternative methods of plastic recycling. Low-end, mixed and coming plastic waste can be safely used in cement kilns for co-processing. It is possible to produce industrial fuel from all forms of mixed plastics waste. Asphalt roads were built with plastic waste. All these processes in Sri Lankan conditions have been successfully tried and developed. Sri Lanka surfaced the first asphalt road mixed with non-recyclable plastic waste, a Colombo-based engineering firm said in a suburb of the capital using an internationally accepted method [2]. Adherence for abiding by safe norms while recycling, as stipulated by the regulatory authorities, is a must. Proper education, facility, incentives, and awareness can achieve this goal.

However, with modern methods, certain forms of plastic waste such as multi-layer laminates, EPS are not easily recyclable. Sometimes when different types of plastic waste are mixed in the waste stream together with different groups of plastics, which are otherwise easily recyclable individually, what we call, plastic waste intermix, recycling is difficult. The waste pickers typically abandon these forms of plastic waste, creating a waste management problem. In Sri Lanka, solid waste management infrastructure, especially in urban areas, is extremely inadequate. The general public's poor littering habit has exacerbated the problem.

Life Cycle Impact Analysis (LCIA) is an important and sophisticated analytical method for assessing a product or activity's overall environmental impact on the planet. The total of the environmental impact of a product or operation from its origin, produce, transport to the market place, use and reuse, recycling and disposal for the disintegration or recovery of energy or the basic components of the item for the production of the same or other material for use–shows the indication of the product or activity’s environmental friendliness or otherwise, compared to an alternative.

2 PLASTIC AND THEIR APPLICATION

The various types of plastics and their major applications are as follows:

Thermoplastics: These plastic forms are flexible when heated, they may be molded or pressurized when they are in plastically condition, and then solidify and retain shape or mold when they are cooled. Some may thermoplastics are as follows with their uses and properties:

Terephthalate polyethylene (PET): Other common characteristics are, Clear and solid, strong and stable, chemically and heat-resistant, good oxygen and carbon-dioxide barrier properties. The packaging is used in soft drinks and mineral water bottles, in clothing fabrics, films, food containers, transportation, construction, and machinery industries (subject to fire), etc.

Polyethylene high density (HDPE): some common characteristics: i. Great ability to process, excellent rigidity and impact strength balance, excellent chemical strength, crystal crystalline melting point (130-135^{0}C) and good water vapor blockage. ii. Used to make products for molded blow (various tubes, bottles of water), pipes, molded injection materials, films (carrier bags), etc.

PVC: The properties are, Polyvinyl chloride: Polyvalence, energy saving, time and weather adaptability, longevity, fire resistance. It is used in building and manufacturing, packaging, medical, agricultural and transportation industries. Also used for cabling, chairs, clothing, home appliances, film and sheeting, bottles, etc. Additionally.

Polyethylene Low Density (LDPE): LDPE characteristics are:

i. Simple process performance, low density, semi-crystalline type, low melting range, low softening, strong chemical strength, excellent dielectric characteristics, low humidity barrier, low abrasion and resistance to stretching.
ii. It is used in the manufacture of carrier bags, heavy bags, bags, little bottles of squeeze. Used also in milk packaging, cable and tube insulation, etc.

Polypropylene (PP): the properties of PP: Low density, high chemical resistance, resistance to environmental stress, high melting point, good processing Low cost dielectric characteristics, creep resistance. Used to make bottles, medical tubes, pipes, boards, paints, movies, furnishings, house products, luggage, toys, hair-dryers, fans, etc.

Polystyrene (PS): Some of the features of polystyrene are:

Smooth to opaque, rough, hard, high visibility surface with fats and solvents. Glassy surface. Used for the manufacture of power and communication devices, e.g. switches, plugs, plates, spiral shapes, circuit boards, separators and housings. Also used in pots, toys, tiles, circles, cups, cups, tumblers, milk containers, and more.

Other Plastics: Except for these six types, many other varieties of plastics are often in use in the engineering industry. Types cover polycarbonate (PC), nylon and acrylonitrile butadiene styrene (ABS).

Thermosets: Thermosets are products which cannot be reshaped / softened until set with fire. Thermosets: It contains phenol, melamine and urea formaldehyde, unsaturated polyester, epoxy and polyurethanes. These products cannot be processed by recycling.

3 PLASTIC WASTE AND MANAGEMENT

The plastic waste management is to be designed to take adequate account of the plastic waste generated from various sources. Fig. 1 shows the different causes of plastic waste [3].

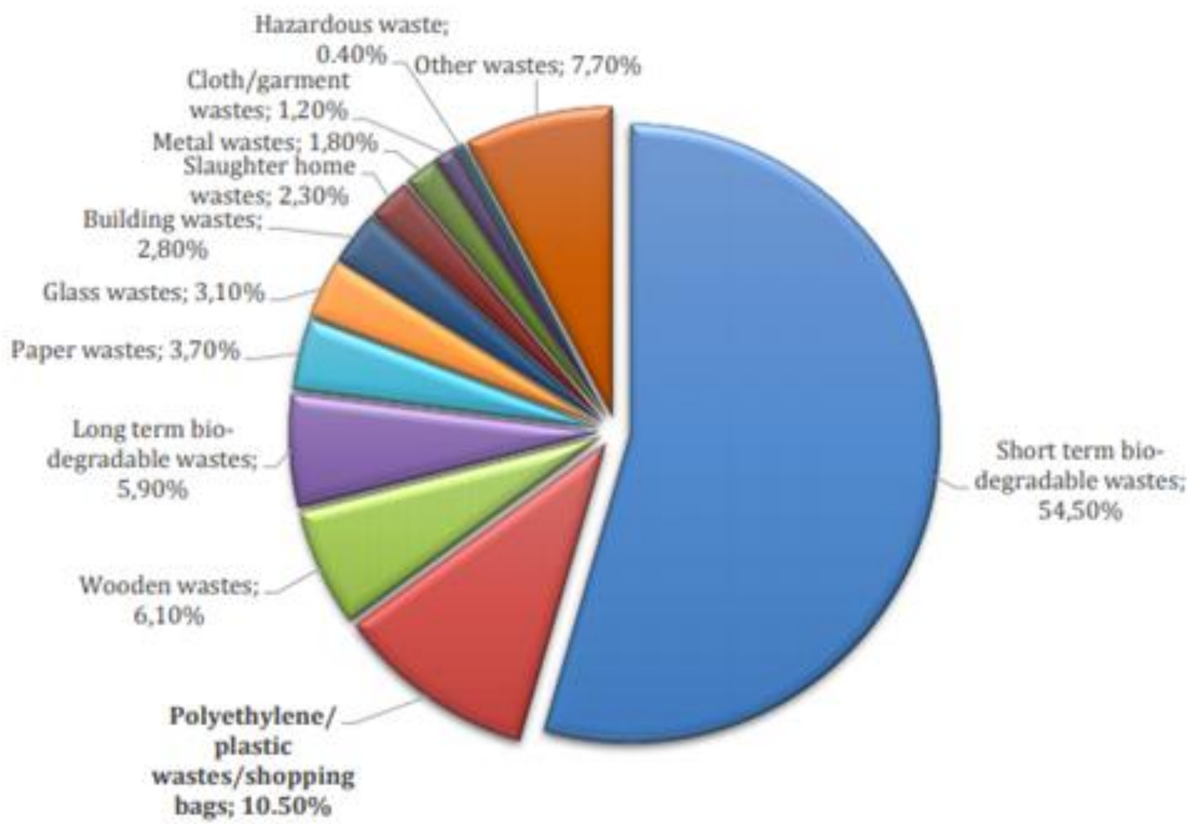

Fig. 1. Sources of Plastic Waste

Fig. 2 provides an overview of plastic waste disposal. Here you can review the traditional and modern methods used for plastic waste treatment [4].

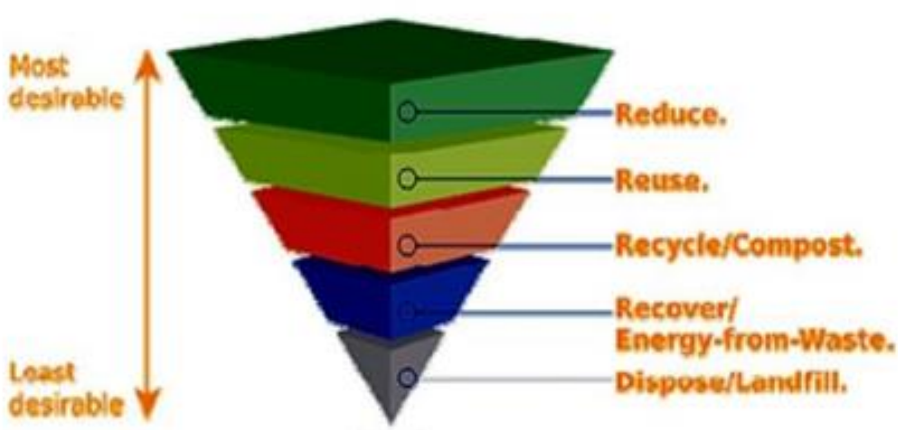

Fig. 2. The Solid Waste Management Hierarchy

The overview of the plastic waste management is given in the Fig. 3.

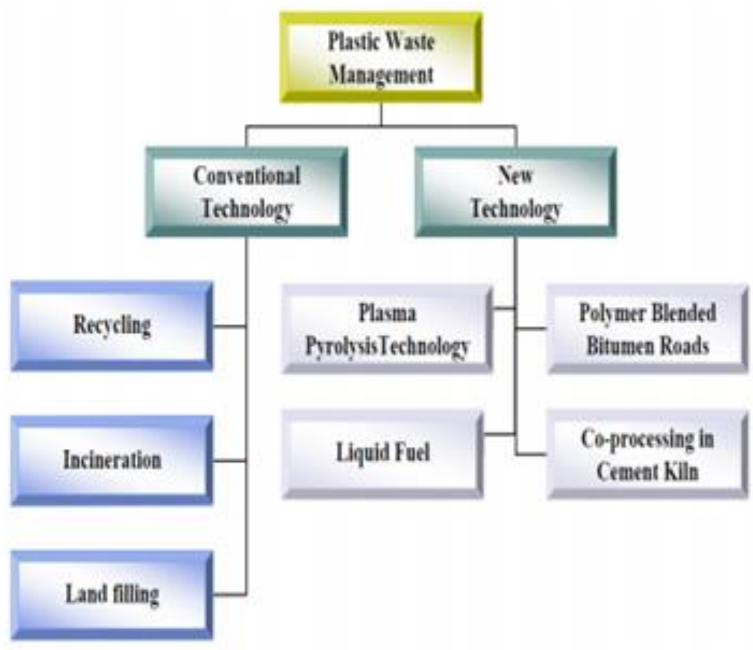

Fig. 3. Overview of Plastic Waste Management

Conventional plastic waste management technology

Conventional waste management systems include recycling, waste disposal, and incineration. Conventional plastic waste management technologies.

Plastics recycling by environmentally-friendly processes:

Plastics processing must be carried out in such a manner that emissions through the process are reduced and the quality of the plant is thus increased and electricity is saved. Four general forms of primary, secondary, tertiary and quaternary plastic recycling technologies have been categorized.

Primary recycling involves scrap / waste refining into a component with characteristics like the original product.
In the **secondary** recycling process, waste plastics were recycled into items with characteristics distinct from the initial plastics.
Specific chemicals and fuels are generated as part and/or as a separate waste from plastic scrap in **tertiary** recycling.

Quaternary recycling restores the energy content of recycled plastics by burning / incineration. Throughout Sri Lanka, this method is not in operation.

Stages The recycling process involves: Collection The recyclers have to pick the recycled material.
Dividing The plastic waste should be segregated in compliance with the code defined in the guidelines CENTRAL ENVIRONMENTAL AUTHORITY Ministry of Environment & Natural Resources [5].

Processing The pre-consumer waste is recycled immediately upon collection and sorting. Wash, scrap, compost, extrusion and granulation of the post-consumer waste (used plastic waste).

Landfilling: This is a conventional waste management approach, but some countries have limited space for constructing landfills. A well-managed landfill site results in minimal instant environmental damage beyond the impacts of recycling and transportation, although there are long-term risks of soil and groundwater contamination with few additives and the breakdown of plastics materials, which can turn out to be persistent organic pollutants [6]. A major drawback from a mitigation feature of landfills is that there is no recycling of any of the material resources used for plastic production— the material flow is linear rather than cyclical. A landfill tax is available in the United Kingdom, which is now set to increase annually in order to increase the opportunity to dump waste from landfills to recycling activities [7].

Incineration: This procedure eliminates the need for plastic waste landfilling, but there are fears that during this process hazardous materials may be released into the atmosphere. Halogenated plastics and PVC, for example, are usually found in mixed plastic waste that contributes to the possibility of release into the atmosphere of dioxins, furans and other polychlorinated biphenyls [8]. It is very important to choose the incinerators. Although it is unlikely to be done in a controlled manner to reduce pollution due to the desired standards of off-gas, i.e. dioxins and furans. This method of treatment of plastic waste is not usually preferred. The treatment costs of the gasses are more than the energy recovered.
Modern incineration technology has the answers to address any incineration problem without polluting the environment and, in many cases, recovering the calorific value of the waste incinerated. Heavily contaminated plastic waste from various waste streams can be used by waste incineration plants to recover energy. Among all the other alternatives, the cost of this recovery system is considered the highest. While contemplating incineration as an alternative, it should be noted that incineration of plastic waste will contribute to the production of highly undesirable harmful pollutants such as dioxins and furans.

3.1 New Plastic Waste Management Technologies

The new plastic waste management technologies are listed here.

Polymer Blended Bitumen Road: The road laying process using waste plastics is planned and the technique for the construction of versatile roads at various locations in Sri Lanka is being successfully implemented which Also can be executed in Sri Lanka [9]. The schematic diagram shown in Fig. 4 offers a brief description.

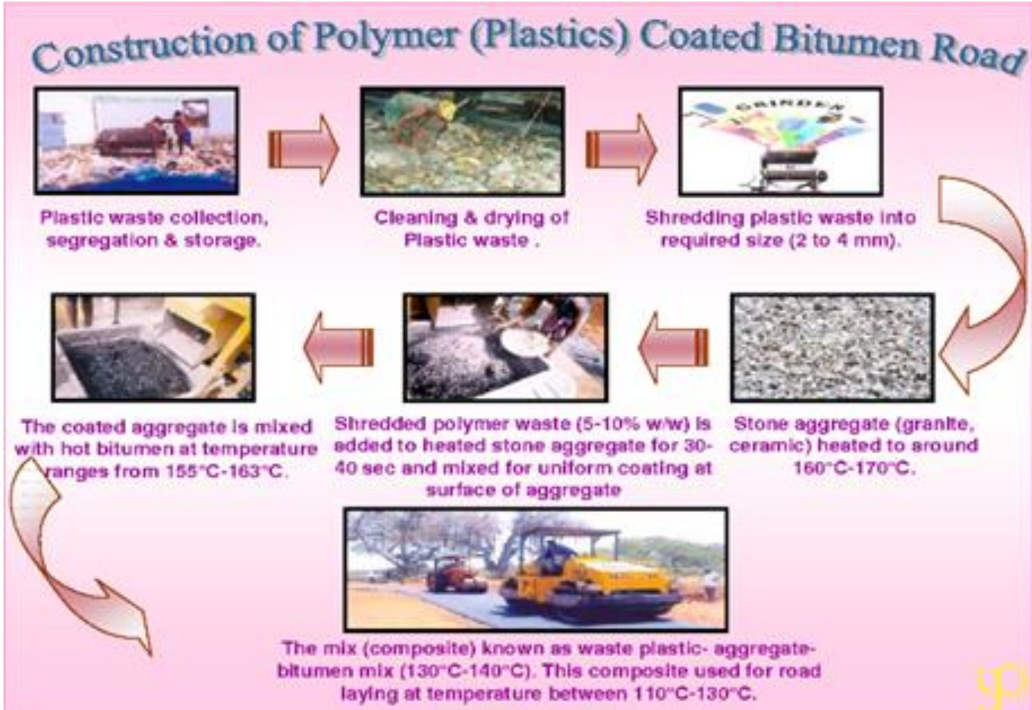

Fig. 4. Schematic flow diagram of plastic-coated bitumen road

Co-processing plastic waste in Cement Kiln. Plastic waste generated from different cities and towns is a part of municipal solid waste (MSW). It is a matter of concern that plastic waste disposal causes many issues, such as leaching effects on land and groundwater, strangling rivers, rendering soil infertile, indiscriminate burning causing environmental hazards, etc. In most cities/towns, plastic waste, which is non-biodegradable, is polluted and gives an unpleasant look. It is estimated that around Per capita waste generation in Sri Lanka is about 0.5 Kg per day where plastic waste generation is about 400 MT per day. its use as an alternative fuel in cement kilns is one of the most effective methods of recycling plastic waste for energy recovery. In addition to plastic recycling to produce new products and save energy, there are also projects aimed at turning plastic into new energy sources. Plastic is made from crude oil, the same raw material from which fuel is produced.
Not only is waste plastic used with this process, but it also helps to save the dwindling crude oil resources left on earth. The high temperature used in cement kilns provides room for the use of even some form of plastic waste contaminated with toxic chemicals such as pesticides and other hazardous materials without increasing air or water pollution. For this form of disposal, no segregation or cleaning is needed. Low-end plastic waste, which creates a problem of waste management, can provide the cement industry with vital energy. Some scientists have therefore made it their mission to transform waste plastic back into crude oil so that it can be reused for engines to drive. At a replacement rate of 10 percent, 170 cement kilns in Sri Lanka could dispose of all the plastic waste produced in the country today with the additional benefit of the use of fossil fuel- coal.

Co-processing plastic waste as an alternative fuel and raw material (AFR): co-processing refers to the use of waste materials in industrial processes such as cement, lime or steel production, and power plants or any other large combustion plants. Co-processing means combining primary fuel and raw material with the waste recycling industry and waste material. For example, waste materials used in the co-processing of plastic waste are referred to as alternative fuels and raw material (AFR). Co-processing plastic waste provides benefits for both the cement industry and the municipal waste management authorities. Cement manufacturers, on the other hand, can save the consumption of fossil fuel and raw materials, leading to more eco-efficient production. Therefore, one of the benefits of the recovery approach used in the existing plant would be to eliminate the need to invest in other plastic waste activities and safe landfilling.

Plasma Pyrolysis Technology (PPT): Plasma Pyrolysis is a technology that combines with the pyrolysis process the thermo chemical properties of the plasma. The plasma pyrolysis technology's intense and flexible heat generation capability helps it to dispose of all forms of plastic waste.

Process Technology: In Plasma Pyrolysis, the plastic waste is initially fed through a feeder to the primary chamber at 850 °C Dissociates waste material into carbon monoxide, hydrogen, methane, higher hydrocarbons, and so on. The pyrolysis gases and plastic waste are drained into the secondary chamber by an induced draft fan. In this chamber, in the presence of excess oxygen, the pyrolysis gases are combusted. Due to the high voltage spark, the flammable gasses catch fire. The temperature is held at 10500°C in the secondary chamber. The conversion of hydrocarbon, hydrogen, and CO into the water and healthy carbon dioxide. Conditions are preserved in such a way that toxic gases can be eradicated. More than 99% of organic waste is converted into non-toxic gases (CO_2, H_2O). Immediately, the extreme plasma conditions destroy healthy bacteria like bacillus stereo thermopiles and Bacillus subtilis. It is not necessary to isolate the waste, as very high temperatures ensure that all forms of waste are handled without discrimination.

Conversion of plastics waste to liquid fuel: this is not a very complex process. It can accept a wide range of plastics as feedstock, including those that are unwashed, unsorted, or difficult to recycle. Once the material has been collected, it can be cut into small pieces before use, although recent developments have resulted in the ability to directly inject larger pieces of plastic into the device. Waste is loaded with a forklift into a hopper to start the process.

Plastic car bumpers, fuel tanks, product packaging, part holders, farm film, and pharmaceutical packaging are the materials that can be filled. Once the hopper is in the reactor, natural gas is burned to generate heat and start the process. A catalyst is helping to break the plastic hydrocarbons into a shorter chain of molecules at this stage. The off-gases that will not be collected as fuel are used to generate heat and sustain the cycle. The fuel oil and diesel are transformed into a liquid state from a gaseous state that is accumulated as the process continues. They are put in fuel tanks that are temporary. An automated system manages the operation.

4 CONCLUSION

Plastic Waste Management in today's context has assumed great importance. Specific programs are being put in place to reduce plastic waste impacts in Sri Lanka. Recycling is one such plastic product waste management system. This makes environmental as well as economic and current trends show a significant increase in the rate of plastic waste recovery and recycling. Such developments are expected to continue, but both technical factors and economic or social behavior issues related to recyclable waste collection and the replacement of virgin content still pose some significant challenges. Joined efforts to increase.

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