

ECO-BRICKS AS A SUSTAINABLE SOLUTION FOR PLASTIC WASTE MANAGEMENT IN THE TOURISM INDUSTRY

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Abstract

Plastic usage has risen due to its affordability, convenience, and versatility, but it has taken a toll on the environment. Single-use plastics, in particular, contribute significantly to this environmental impact. The tourism industry in Sri Lanka has been identified as a major source of plastic waste. Previous research has proposed various methods to address this issue, but the problem persists due to the lack of an effective solution. This research explores the globally recognized practice of eco-bricks as a potential solution. The objective of the research is to formulate guidelines for policymakers, industry stakeholders, and environmental practitioners to adopt the eco-bricks concept for sustainable tourism by recycling plastic waste. To do this, secondary data was utilized, drawing from prior research, academic databases, peer-reviewed journals, conference proceedings, and online platforms. Analysis of the collected data revealed methods proposed by previous research, such as using alternatives, regulations, biodegradables, waste plastics for construction, recycling, etc. However, each method has weaknesses, leading to the introduction of the Eco-bricks concept. Eco-bricks address the shortcomings of existing methods, making them a promising solution for plastic waste in the tourism industry.

Key words: Plastic waste, single use plastic, tourism industry, eco-bricks, and sustainability

1.0 Introduction

The tourism industry is a rapidly expanding sector of the global economy. In post-COVID-19 epidemic situations, the tourism industry is showing promising development (UNWTO 2022). According to World Travel and Tourism Council reports, the world tourism industry will contribute 7.6% of the world GDP in 2022. It is a growth of 22% compared to 2021 (WTTC 2023). The tourism industry has a significant impact on the world economy by being among the top 5 economic sectors.

Tourism plays a major role in the Sri Lankan economy. Tourism is the third driver of foreign exchange earnings in Sri Lanka, after migrant workers' remittances and garment export earnings. Sri Lanka Tourism Development Authority reports show that the tourism industry in Sri Lanka is once again showing rapid growth after 2018. According to it, 1 million tourists would have come to Sri Lanka by October 2023 (SLTDA 2023).

The impact of the tourism industry goes beyond foreign exchange earnings. It generates new job opportunities as well as brings new foreign investments to the economy. In this way, the tourism industry has positive effects on the economy. There are, however, negative implications as well. Disposing of polythene and plastic waste into the environment is one of them.

At present, the whole world is emphasizing sustainable development, especially based on the UN 17 sustainable development goals. Plastic and polythene waste can be considered major challenges faced by countries in achieving sustainable development goals. Plastic and polythene in the tourism industry seem to be two of them.

Table 01. Sustainable development goals relate to polythene and plastics.

Goal	Target
06. Clean water and sanitation	6.3 By 2030, improve water quality by reducing pollution, eliminating dumping, minimizing the release of hazardous chemicals and materials, reducing the proportion of untreated waste water, and substantially increasing recycling and safe reuse globally.

11. Sustainable cities and communities	11.6 By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management.
12. Responsible consumption and production	12.4 By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water, and soil in order to minimize their adverse impacts on human health and the environment. 12.5 By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse.
14. Life below water	14.1 By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.

Source: Department of Economics and Social Affairs, United Nations

The above-mentioned goals deal with the use of polythene and plastic. In addition to this, Goal Number 03: Good Health and Wellbeing, Goal Number 13: Climate Actions, and Goal Number 15: Life on Land are also related to the objectives. Accordingly, it is essential for a country to properly manage the use of polythene and plastic in the implementation of sustainable development goals.

The amount of polythene waste generated annually in Sri Lanka is 1.59 MMT (Centre for Environmental Justice, 2021). Previous research studies have revealed that the tourism industry has a direct impact on the increase in polythene and plastic waste. Also, it appears that the management of plastic and polythene used in the tourism industry is extremely limited in Sri Lanka's path towards sustainable development. In this way, the adverse effects of disposing of polythene and plastic in the environment are directly affecting the tourism industry, which is developing rapidly in Sri Lanka. Therefore, there is a strong need to properly manage the polythene and plastic generated in the tourism industry.

The researcher realized that various research papers have presented different proposals to manage the use of polythene and plastic in the tourism industry. However, at the present time, there are very few successful proposals for practical solutions to the use of polythene and plastic through previous research related to various environmental or development, industry, and

business sectors. Therefore, this research paper will contribute to filling that gap.

The tourism industry faces a critical challenge in effectively managing plastic waste, with existing methods falling short of providing sustainable and comprehensive solutions. The inadequacies of current waste management practices necessitate an in-depth examination of alternative approaches. Specifically, there is a gap in the literature regarding a viable and environmentally friendly solution tailored to the tourism sector.

Thus, the research problem of this study is, “Is the concept of eco-bricks a novel and sustainable solution for plastic waste management in the tourism industry?”

Therefore, the research focuses on critically analyzing existing literature to ascertain the viability of eco-bricks as an innovative and sustainable approach for plastic waste management within the tourism industry. This research aims to identify and address gaps in current plastic waste management practices, explore the environmental impact of eco-bricks, and propose an implementation framework that aligns with the unique needs and challenges of the tourism sector.

Thus, the objective of the research is “to provide insights guiding policymakers, industry stakeholders, and environmental practitioners in adopting the eco-bricks concept for sustainable tourism by addressing plastic waste management.”

2.0 Methodology

This study focuses on using secondary data to investigate how eco-bricks can be used to manage plastic waste in the tourism industry. The method we're using involves thoroughly looking at existing literature and gathering insights from various academic sources to meet our research goals. The main data source for this research is a detailed review of literature related to the use of plastics in the tourism industry, plastic waste management in the industry, eco-bricks, and how they could be applied in the tourism sector. The author referred to academic databases, peer-reviewed journals, conference

proceedings, and online platforms in a systematic way to collect relevant information.

3.0 Literature Review

Polythene and Plastics: Plastic was first introduced by Leo Backland (1907) in New York. At the same time, the use of plastic is spreading worldwide due to its low cost, ease of use, and versatility. Plastic, which was spreading rapidly, has given successful solutions to the problems of forest pollution and turning over soil for brick production. But in the hundred years since the beginning of plastic use, it has severely affected the environment. Here, the strong focus is on single-use plastics (Centre for Environmental Justice/Friends of the Earth Sri Lanka 2019).

Simply put, single-use plastic is plastic that is used only once. Compared to other plastic waste, the disposal of this single-use plastic waste is quantitatively very high. Nowadays, single-use plastic is very common, and it is integrated into human life by being used for various purposes (Centre for Environmental Justice/Friends of the Earth Sri Lanka 2019).

Table 02. Types of Single Use Plastics

Type of Single Use Plastic	Examples
Polyethylene terephthalate (PET)	Water bottles, dispensing containers, biscuit trays
High-density polyethylene (HDPE)	Shampoo bottles, milk bottles, freezer bags, ice cream containers
Low-density polyethylene (LDPE)	Bags, trays, containers, food packaging film
Polypropylene (PP)	Potato chip bags, microwave dishes, ice cream tubs, bottle caps, single-use face masks
Polystyrene (PS)	Cutlery, plates, cups
Expanded polystyrene (EPS)	Protective packaging, hot drink cups

(Source: United Nation Environmental Program)

According to the plastic pollution facts report of the Plastic Ocean Organization, approximately 380 million tons of plastic are produced by

mankind every year, of which 50% is single-use plastic. That is, single-use plastic. These wastes take a very short time to use but remain in the environment for hundreds of years (Plasticocean.org).

Polythene and plastics in the Tourism Industry: The tourism industry has been identified as the industry with the highest use of single-use plastics. As previous research papers show, the global tourism industry contributes directly to the increase in global plastic and polythene consumption. According to reports from the One Planet Organization, plastic waste discharge into the environment increases by around 40% during tourist seasons. The majority of the impact here is on the coastal region. The reason for that is the release of plastic into the environment by tourists who visit the beach. Also, the report further points out that the waste used by the tourists traveling in the country is also a reason for the accumulation of polythene in the vicinity of the coastal area. According to them, the plastic waste from domestic use enters the coastal zone through rivers. According to the report, the tourism industry contributes to the increase in plastic pollution in the world's oceans (OnePlanetNetwork.org, 2023).

Furthermore, according to the report of the UN Environment Program's "How can tourism fix its plastic problem?" the tourism industry is a key driver of the global plastic crisis. According to them, 8 out of 10 tourists visit the coastal areas. The reports show that 8 million tons of plastic waste accumulate in coastal areas due to their influence. The waste used by hotels, shampoos, toothbrushes, and combs, as well as the waste added to the sea by cruise ships, have directly affected the increase in the amount of plastic waste in the coastal region. They further point out that the link between tourism and plastics is no coincidence (UNEP 2023).

Also, the research paper "Tourism Industry and Plastic Waste Policy" by M. M. de Oliveira, R. S. R. Sampaio, and P. R. P. Sampaio identified plastic waste disposal through tourism as a contributing factor. They point out that policies should be formulated to properly regulate the tourism industry in order to find solutions to that problem (M. M. de Oliveira, R. S. R. Sampaio, and P. R. P. Sampaio, 2023).

Finally, these reports show that the global tourism industry has a direct impact on global plastic and polythene waste disposal.

This is the case both in the world and in the Sri Lankan context. "Challenges of reducing polythene and plastics in Sri Lanka: According to Hemakumara G. P. T. S. and Madhusankha T. G. S. (2023) Sri Lanka's tourism industry is under pressure to dispose of plastic waste in Sri Lanka. According to the report, the use of polythene and plastic is common in different parts of Sri Lanka. Among them, it is pointed out that there is a tendency for plastic and garbage waste to accumulate in places that have attracted tourist attractions, such as Adams' Peak, Anuradhapura, Kataragama, and religious places (Hemakumara G. P. T. S. and Madhusankha T. G. S., 2023).

Further, according to Handunnetti D (2019), "Microplastics waste fouls up beaches on Sri Lanka's southern tourism coast" research paper, it has been found that only 60% per sand sample and 70% per water sample of the southern coast contain plastic. This situation is most common in Ambalangoda, Weligama, and Dondara, where there are more tourist attractions. Among them, Weligama becomes the most plastic-polluted beach by count (157 microplastic items per square meter) as well as weight (5.98 grams per square meter). The researchers have identified tourist activities as the main reason for this (Handunnetti D.,2019).

Also, according to Charles Cole's "Marine Plastic Pollution: Opportunities for Sri Lanka" research paper, tourist activities have mainly influenced the accumulation of Ella Garbage Dump (Cole C.2020).

Further, according to the research paper "Partnership to reduce plastic use in the tourism sector in Galle, Sri Lanka," conducted jointly by the Institute for Global Environmental Strategies (IGES), Japan, and the Human and Environment Link Progressive Organization (HELP-O), Sri Lanka, The tourism industry has contributed to the accumulation of polythene and plastic waste in Sri Lanka. Also, due to the poor management of plastic and polythene in the tourism industry, plastic accumulation in Sri Lanka's waterways and seas is common (IGES and HELP-O 2023).

Finally, according to the above reports, tourism has directly affected the increase in the amount of plastic and polythene waste in the world as well as in the Sri Lankan context. Researchers have identified single-use plastics as the main reason for the increase in the amount of plastic waste used in the tourism industry. Because tourists stay at a destination for less time, they are used to using single-use plastics to make their daily activities easier. As a result, a large amount of single-use plastic is added to the environment at the end of the trip.

Already existing methods: The 3R concept is a globally accepted concept for waste management. 3R stands for reduce, reuse, and recycle. It outlines the factors of reducing the use, reducing the amount added to the environment by reusing the used items, and preventing them from adding to the environment by recycling the used items. These three steps are followed for waste management in any country. Previous research papers indicate that many different measures related to the 3R concept have been adopted to manage the use of plastic waste in the Sri Lankan context. They are as follows (Srinivas,H. 2015).

Using Alternatives: The most commonly presented method in previous research papers is the use of alternatives. Some of them are as follows:

- i. Use glass bottles instead of plastic bottles.
- ii. Creation of pan containers and various storage containers from natural materials like bamboo.
- iii. For the use of coconut coir mats
- iv. Use cloth instead of table mats made from plastic.

But as the research paper "Ban on Polythene Bags and Lunch Sheets in Sri Lanka: Impact, Challenges, and Alternatives" points out, the main problem here is that most of these alternatives are quite expensive, difficult to use, and less available (Fernando et.al 2020). Furthermore, as shown in the research paper "Challenges of Reducing Plastics and Polythene in Sri Lanka: A Case Study of the Attanagalle Divisional Secretariat," alternatives have not been successfully used in Sri Lanka. Also, successful and safe options are rare (Fernando et.al 2020).

Regulations: As a result of the plastic waste problem becoming a state problem, the government has also directly intervened in this matter. According to the research paper "Why Sri Lanka Should Ban Single-Use Plastics," the government of Sri Lanka has made various regulations in different situations to control the use of plastics. They are as follows:

- a) 1994: Mrs. Srimani Athulathmudalige (the former Minister of Environment) implemented a polythene ban for high-density polythene (HDPE) bags with less than 20 microns in thickness.
- b) 2007: Mr. Mainthreepala Sirisena (former Minister of Environment), under Section 23W of National Environmental Act No. 47 of 1980 Gazette Notification No. 146615, for less than 20 microns in thickness.
- c) 2008: A conservation levy for HDPE bags. Under the Environmental Conservation Levy Act, No. 26 of 2008.
- d) 2017: Set of regulations to stop HDPE bags, Luch sheets, and other polythene bags.

But none of these regulations have achieved 100% success. Because almost all of these are failed regulations. The first regulation introduced by Srimani Athulathmudalige was withdrawn due to pressure from plastic manufacturers and traders in 1994. Similarly, the regulations enacted in 2007/2008 have been annulled by the people by filing a fundamental rights petition in the Supreme Court. Finally, Mr. Hector Kobbekaduwa has stated that the regulation enacted in 2017 failed by about 60% (Liyanage, C. 2020) (Centre for Environmental Justice/Friends of the Earth Sri Lanka 2019). Thus, it appears that the imposition of government regulations will not achieve successful results.

Biodegradables: Previous research papers have identified the use of biodegradables as a successful solution. Biodegradable bags as well as biodegradable plastics have also been suggested (Kaluarachchi et.al, 2020). As shown by the researchers, the use of these biodegradables reduces the damage to the environment from non-biodegradables. Currently, many organizations are promoting the use of biodegradable bags.

e.g. Producing small biodegradable mesh bags which can be used several times by John Keels, and Introducing large reusable biodegradable green bags

to store the items bought from supermarkets and giving a discount when they bring them back again. (Kaluarachchi et.al, 2020).

"Plastics Recycling Facts: The Truth About Recycling Plastic Bags" According to the report, the problem here is that the reactions of these non-biodegradables to the environment have not yet been investigated. Further, it has been found that most of these decompose very slowly in the environment. Therefore, according to those reports, the use of biodegradables does not achieve 100% successful results (RTS Corporation 2020).

Waste plastics for construction purposes: According to the research paper "Current plastic wastage and introducing new innovations to minimize plastic wastage in Sri Lanka" (2020), Sri Lanka has researched whether plastic waste can be used in the construction industry. As a successful result, research has been done in Sri Lanka to see if a way of using garbage waste can be used in the construction of roads, which is currently spreading all over the world. According to the research paper "Study on Use of Waste Plastic in Road Construction," it has been found that all types of plastic waste can be put into a proper recycling process and used as a necessary raw material in the construction of highways. But the researcher has discovered that the following problems exist:

- a) Toxics present in the CO-mingled plastic waste would start leaching. Since plastic will react with surrounding gases like CO₂, CO, etc., toxic chemicals will appear when lying.
- b) In the presence of chlorine, it will definitely release noxious HCL gas. Because particles like PE, PP, and PS contain chlorine, they will react with the surrounding water and release HCL gas. Therefore, when lying, we must take extra care.
- c) It opined that the first rain would trigger leaching. As the plastics will merely form a sticky layer (R.M.S.K. Ranathunga).

According to the above facts, this is somewhat harmful to humans. Also, this process seems to incur some costs.

Further, as indicated in the research paper "Current plastic wastage and introducing new innovations to minimize plastic wastage in Sri Lanka" (2020), Sri Lanka has started a process of recycling used pet bottles and producing polyester fiber.

Ex: MAS Holdings collaborated with the Sri Lankan Navy, Eco Spindle, and Sri Lankan Cricket Team and successfully cycled up waste plastic recovered from the beaches of Sri Lanka to produce the official jerseys to be worn by Sri Lanka's national cricket team during the 2019 ICC Cricket World Cup.

Recycling is another solution given by previous research papers for plastic waste. At present, about 170 plastic and polythene collectors and recyclers are registered with the Central Environment Authority of Sri Lanka (Kaluarachchi et.al, 2020). But problems arise about whether these institutions are functioning properly. According to the research paper "Challenges of reducing polythene and plastics in Sri Lanka: A case study of Attanagalle Divisional Secretariat" (2020), recycling is only a temporary solution to plastic waste. It is very well confirmed that Sri Lanka is facing a plastic waste crisis even while the recycling centers registered with the Sri Lankan government are operating. According to the Ecobrick organization, recycled plastic cannot be recycled after use. Therefore, after being recycled, they are released into the environment. Further, previous research papers have proposed the following solutions also,

- a) Educating People
- b) Environmental Sound Management
- c) Establish new plastic collecting centers
- d) Beach or river cleanups
- e) Promote plastic-free zones

Table 03. Already implemented methods to overcome plastic problem in Sri Lanka according to the 3R concept.

Method	3R
i. Using Alternatives	Reuse Method
ii. Regulations	Reuse Method

iii. Using Biodegradables	Reuse Method
iv. Educating People	Reuse Method
v. Promote plastic free zone	Reuse Method
vi. Environmental sound management	Reuse Method
vii. Recycling Plants	Recycle Method
viii. Waste Plastics for construction purposes	Recycle Method

(Source: Authors Analysis)

According to the above table, it appears that plastic reduction methods are the most commonly used in Sri Lanka. Out of the 3Rs, reducing takes a significant amount of time. It cannot be achieved in a short period of time. Moreover, as identified by the author, reducing the use of polythene plastic in Sri Lanka is like getting involved in an economic crisis. Sri Lanka currently earns 2.8 billion rupees in foreign exchange through the import and export of polythene. 232 industries in Sri Lanka are engaged in this work and engaged in plastic manufacturing (Kaluarachchi et.al, 2020). Therefore, reducing the full use of plastic in Sri Lanka creates economic shocks. Also, reducing use is a solution to generate new waste, but not a solution to the waste released into the environment that is currently being used. The use of plastic in Sri Lanka is very high. According to the article "Plastic Waste Management Country Situation Report: Sri Lanka" (2021), it is confirmed by the fact that Sri Lanka has reached fifth place among the countries that use a lot of plastic in the world (Centre for Environmental Justice 2021). We already consume a lot of plastic. Reducing the use of new plastic is not a solution to the plastic waste consumed. Therefore, re-use methods should be used to find that solution. Reduce the generation of new waste by using Reduce while minimizing the environmental impact of used plastics through reuse and recycling. Thus, waste can be successfully managed in Sri Lanka.

But we discussed above that recycling is a temporary solution to plastic. Also, there are no successful recycling methods in Sri Lanka. Even though there are

more than 170 waste plastic recycling centers, we are still facing the garbage problem, which shows that the recycling process is not working properly in Sri Lanka.

According to all the above facts, it appears that in Sri Lanka, the waste that has already been used and released into the environment can be successfully remedied by reuse methods. But the researcher's analysis shows that no reuse method has been presented that has achieved successful results even now. Therefore, through this research paper, the researcher hopes to introduce the concept of Eco-bricks, which has been identified as a successful Reuse method that is currently being used all over the world, to the Sri Lankan tourism industry.

The Concept of the Eco-Bricks.

Introduction to Eco-Bricks:

Eco-bricks, sourced from eco-bricks.org, epitomizes a straightforward and conscientious approach to taking personal responsibility for plastic waste, diverting it away from mainstream industrial processes, and preserving our biosphere. At its core, an eco-brick stands as a robust testament to sustainability—an empty PET bottle densely packed with meticulously cleaned and dry-used plastic. These eco-bricks are painstakingly crafted by hand, adhering to a set density, with the primary purpose of sequestering plastic and forming versatile, reusable building blocks (ecobricks.org).

This hands-on process of making eco-bricks serves a dual purpose: it not only prevents plastic from degrading into harmful toxins and micro plastics but also acts as a barrier, keeping it away from energy-intensive and high-emission industrial processes. Beyond their ecological impact, eco-bricks operate as an educational tool, deepening our awareness of plastic-related issues and fostering an understanding of regenerative alternatives—a concept coined as "plastic transition(ecobricks.org).

The utilization of eco-bricks extends to both short-term and long-term applications. In the short term, they find purpose in modular units, Lego-inspired furniture, and open spaces. In the long term, eco-bricks contribute to

the construction of enduring structures such as earthen gardens. Throughout their creation and application, eco-bricks embody regenerative principles and embrace a visionary approach—an ode to the Earth's example of securely sequestering loose carbon to enrich and sustain the biosphere (ecobricks.org).

Path to make an Eco-brick:

Creating eco-bricks is a simple and inclusive process accessible to people of all ages. Whether you're young, old, or somewhere in between, no machinery, special skills, or experts are needed for this environmentally friendly endeavor. It's a hands-on and straightforward way to contribute positively to the environment. However, it's crucial to adhere to important guidelines to guarantee the quality and usability of your eco-bricks. These guidelines, sourced from ecobricks.org, serve as valuable instructions to ensure that your efforts have a meaningful impact.

i. Save, Segregate, Clean, and Dry Plastics.

Eco-bricks are crafted using clean and dry plastic. The initial step involves segregating plastic from all other materials. Ensure that the collected plastic is free from any remnants of food, oil, or dirt. If any such impurities are present, thorough washing is necessary. Contaminated plastic within an eco-brick can foster the growth of microorganisms and result in the formation of methane inside. Given that eco-bricks are often employed in the construction of home furniture, it is imperative to avoid producing unsightly eco-bricks, bottles that expand, and, in rare instances, caps popping off.

Equally significant is the requirement that the plastic remain dry. Moisture in plastic tends to encourage the growth of microorganisms. Eco-brick enthusiasts globally employ diverse methods to dry their washed plastic, ranging from the use of laundry machines to hanging them on clotheslines.

ii. Choose an appropriate bottle.

Before embarking on an eco-bricking journey, it's advisable to choose a specific bottle and remain consistent with it throughout the process. When it comes to construction, maintaining perfectly identical eco-brick sizes is

crucial for creating sturdy and uniform modules. Additionally, using bottles of at least a similar general size is advantageous when building structures with a combination of earth and eco-bricks. Collaborate with fellow eco-brick maker in the community to collectively decide on the preferred bottle type.

When selecting the bottle, take three factors into consideration: its availability, the volume it can accommodate, and the specific project for which you intend to use the eco-brick. This thoughtful selection process ensures uniformity and efficiency in your eco-brick making endeavors.

iii. Get the stick ready.

The choice of the right stick significantly influences your eco-brick making experience. Ideally, sticks made from bamboo or wood are considered the most effective. The stick's size varies based on the type of bottle you opt for. Aim for a stick with a diameter approximately one-third the width of a standard bottle opening—around 6mm. It's advisable for your stick to be roughly twice the height of your bottle, featuring a slightly rounded tip. Avoid sticks with sharp corners, as they can potentially damage your bottle, necessitating the restart of your eco-brick making process.

iv. Don't put "glass, metal, or biodegradables."

What you exclude from your eco-brick is just as critical as what you include. The primary purpose of placing plastic inside a bottle is to contain it; otherwise, it could freely disperse into the environment, leading to the formation of micro plastics and toxins. Materials such as cotton cloth, metal, paper, cardboard, glass, and organic matter do not break down into harmful toxins, and therefore, there is no necessity to secure them within an eco-brick. Caution should be exercised, particularly with sharp metal or glass, as they can potentially rupture the sides of the eco-brick and pose a safety risk. Alternatives exist for these materials.

v. Beginning with filling the bottom color.

Initiating your eco-brick with the addition of a bottom color holds significance in adherence to the circular design principle of eco-bricking. This approach

involves contemplating the subsequent use of the eco-brick. When utilized in a module or an earth construction, the bottom color contributes to creating patterns and designs.

To establish the bottom color for your eco-brick, select a soft plastic with a consistent color and press it down to the base of the bottle. Aim to loosely fill the bottle approximately halfway with the chosen color of soft plastic. Subsequently, use your packing stick to compress the plastic. If your bottle features "legs" or dimples at the bottom, ensure these areas are densely packed. Once all the soft plastic is adequately compressed, the goal is to have it fill the initial 1-2 centimeters of the bottle.

vi. Pack the bottle tightly and mix with plastic and polythene.

Now, it's time to proceed. Begin by cutting or tearing large plastics into smaller pieces. The smaller the pieces, the more densely packed your eco-brick will become. Fill the bottle halfway with loose plastic, then use your stick to compress the plastic around the sides of the bottle. Continue this process as you move around the circumference of the bottle. Once adequately compressed, add more loose plastic. To optimize density, it's advisable to alternate between soft and hard plastic.

Exercise caution to avoid pushing too hard. In rare instances, the use of a sharp stick, a thin bottle, or excessive lateral force may result in the rupture of the Eco brick. Should this occur, it is imperative to start afresh. Ruptured bottles are not durable and may lead to plastic leakage. Cut the bottle open, extract the plastic, and initiate the process once more.

vii. Quality-checking process

The weight versus volume of your Eco brick serves as a reliable indicator of its quality. Well-crafted eco bricks are both solid and robust, achieved through dense packing where the full volume is utilized for plastics without leaving any air or spaces inside. The Global Eco Brick Alliance (GEA) has established that an eco-brick's density should exceed 0.33 g/mL. For instance, a 600-ml bottle must weigh over 200 grams, and a 1500-ml bottle should surpass 500 grams.

Ex: A bottle with 1500 ml should surpass 500 grams.

Weight of the Eco brick = Capacity of the bottle \times 0.33 g/ml

= 1500 ml \times 0.33 g/ml

= 495g

The weight of the eco-brick made with a 1500-ml bottle should surpass roughly 500g.

Enforcing a minimum density requirement in your community's eco-bricking is crucial to ensuring the production of quality eco-bricks. High-quality eco-bricks contribute to the construction of solid and secure structures while maximizing the bottle's capacity to keep plastic out of the environment.

Eco-bricks with a density below 0.33 g/mL are too soft for use in modules and are not suitable for earth building. Soft eco-bricks compromise structural integrity, are prone to denting, and have a reduced lifespan. Additionally, low-density eco-bricks pose fire hazards due to the air pockets inside them.

viii. Cap and log

After ensuring your eco-brick is densely packed, it's time to seal it with the cap. Firstly, ensure that the eco-brick is not overflowing, leaving approximately 1-2cm between the cap and the plastic inside. The cap, made of a different plastic type (HDPE) than the bottle (PET), is the eco-brick's most fragile part. Even slight pressure against the cap can lead to cracks over time. Additionally, avoid using flip-tops or sports caps for sealing, as they are fragile and prone to breaking over time.

Once capped, it's essential to record key data for the eco-brick, such as:

- a) The eco-brick maker's name
- b) The final weight
- c) Date and year

Recording eco-bricks is vital for calculating the overall impact, monitoring quality, and preparing for building projects.

By noting the weight, you can quantify all your eco-bricks and determine the total amount of plastic you have prevented from entering the environment. Recording the name and weight facilitates quality accountability. Maintaining a record of completed eco-bricks helps you know when you're ready to progress to the building stage of your project. Recording the date communicates that you care today about the world for future generations. Store and use them.

ix. Inscribe

As you document and log information about the Eco brick, ensure to record key data directly onto the Eco brick itself. Inscribing details like weight, date, serial number, etc., onto the Eco brick indicates that it has been properly logged and registered. Use a permanent method for recording, as the ecobrick will endure for decades and even centuries. The more comprehensive the information left for future generations, the more valuable the contribution. After thorough experimentation, enamel/oil paint and nail polish have been identified as the most effective choices.

x. Store Eco bricks

Once finished, it is needed to store the eco-bricks until they are accumulated enough for the project. Store them indoors, away from direct sunlight. If possible, shield them with a cloth or tarp to prevent the accumulation of dust and dirt (PET tends to attract dust and chemicals that are challenging to remove). Stack the eco-bricks horizontally, ensuring the ends are pointed outward. This arrangement allows for easy organization by color and brand, facilitating project planning and execution. It's advisable to elevate the eco-bricks slightly above the floor to guard against potential damage by rats, known to chew on bottles. Ideally, store Eco-bricks above ground level, either on a floor or raised on a wooden platform, ensuring full protection from the sun and the elements. Stacking eco-bricks horizontally, with the bottom pointing outward, is the recommended orientation for optimal storage.

Eco-bricking Standards

The Global Eco-brick Alliance (GEA) promotes eco-brick making as a method for transitioning away from Petro-capital and sequestering plastic. Invented standards ensure that eco-bricks adhere to the principles of earthen ethics and mimic the Earth's approach to greening the biosphere.

To meet GEA standards, an eco-brick must fulfill the following criteria:

- i. Be created through a not-for-profit process for the benefit of the earth.
- ii. Manually compact and secure used plastic into a transparent, reusable building block for both short- and long-term applications.
- iii. Result in a net subtraction of plastic and CO₂ from the biosphere compared to what was added during the creation process.
- iv. Contribute to building applications that support and promote biodiversity.
- v. Enhance the ecological consciousness of individuals and the collective involved in the process.

Plastic packed according to these standards and authenticated by the GEA is recognized as a valuable ecological contribution.

Presently, the GEA acknowledges three types of eco-bricks: regular eco-bricks, cig-bricks, and ocean eco-bricks. Technical standards for each type are outlined below.

Regular Eco-Bricks

A standard PET bottle is filled with plastic. Regular eco-bricks are crafted using transparent PET plastic bottles of any size. Both the bottle and the plastic inside are kept clean and dry to prevent bacterial growth. Typically, eco-brick makers employ a wood or bamboo stick to manually pack plastic into the bottle. Plastic is cut or torn into small pieces and gradually packed, with alternating steps of adding plastic and compressing it layer by layer. The bottle is rotated during each compression to ensure uniform compacting throughout, preventing voids and achieving the required solidity for various building applications.

Completed eco-bricks must be packed solidly enough to bear the weight of a person without deformation, minimize flammability, and maximize durability and reusability.

To meet eco-brick standards, the following criteria must be fulfilled:

- i. The eco-brick is fashioned from a transparent PET bottle.
- ii. It is packed solely with cleaned and dried used plastics.
- iii. The eco-brick has a density exceeding 0.33 g/mL.
- iv. The eco-brick must have a density of 0.70 g/mL or less.
- v. It is securely sealed with a screw-down lid.
- vi. Preparations have been made to utilize the eco-brick as a reusable building block.
 - a) The label has been removed.
 - b) A bottom color has been added.
 - c) The weight has been permanently recorded on the exterior.

Only eco-bricks meeting these standards can be authenticated and considered sequestered plastic.

Cig-bricks

Plastic sequestration is specifically for cigarette filters. Cig-bricks represent a category of eco-bricks designed to encapsulate the potentially toxic plastic or acetate found in cigarette filters—a notably prevalent and harmful form of plastic pollution. Cig-bricks are exclusively crafted from the densely packed acetate filters of cigarette butts, once the paper and ash have been entirely removed.

For a Cig-Brick to meet standards, it must adhere to the following criteria:

- i. A density exceeding 0.29 g/ml.
- ii. A maximum density of 0.70 g/mL.
- iii. Exclusively packed with acetate cigarette butts, with the paper and ash removed.
- iv. The cig-brick is securely sealed with a screw-down lid.

- v. Preparations have been made to utilize the cig-brick as a reusable building block:
 - a) The label has been removed.
 - b) A bottom color has been added.
 - c) The weight has been recorded on the exterior.

Only cig-bricks meeting these standards can be authenticated and considered sequestered plastic.

Ocean Eco-bricks

Sequestration for plastic collected from beaches, oceans, and rivers. Ocean eco-bricks constitute a category of eco-bricks specifically crafted for plastics retrieved from beaches, rivers, and the ocean. These plastics are often large, chunky, dirty, and wet, making them unsuitable for regular eco-bricks. The Ocean Eco-Brick technique provides a practical, useful, and reusable building block for easily transforming these challenging plastics.

For an Ocean Eco-brick to meet standards, it must adhere to the following criteria:

- i. A density exceeding 0.25 g/ml.
- ii. A maximum density of 0.70 g/ml.
- iii. Packed with as much plastic as possible.
- iv. Sealed securely (but not airtight).
- v. Preparations have been made to utilize the ocean eco-brick as a reusable building block.
 - a) The bottle's label has been removed.
 - b) A bottom color has been added.
 - c) The weight has been recorded on the exterior.

Only Ocean Eco-bricks meeting these standards can be authenticated and considered sequestered plastic.

Uses of eco-bricks:

Eco-bricks have found diverse applications, proving their versatility in constructing furniture, gardens, play parks, and various structures, with the only limitation being one's imagination. The practicality of these applications lies in their ability to transform environmentally harmful plastic into assets for local communities.

Short-term Applications:

Short-term eco-brick applications utilize silicone or inner-tube bands for non-permanent attachments, allowing creations to last for months or several years. Typically used indoors to shield bottles from UV photo degradation, short-term applications serve to accelerate the spread of eco-bricking principles and encourage participation.

Long-term Applications:

In contrast, long-term applications employ earth and eco-brick building techniques. In earth mixes like cob, wattle, and daub, adobe is used to lay eco-bricks horizontally, completely covering them for full protection against degradation. This method results in structures that endure for years or even decades, showcasing the resilience of eco-bricks when properly integrated.

Eco-Brick Storage:

Before initiating building projects, proper storage of eco-bricks is essential. Ideal storage involves keeping eco-bricks off the ground, protected from sunlight and the elements. Stacking eco-bricks horizontally with their bottoms pointed outward allows for easy organization based on color and brand, streamlining project planning.

Milstein Modules (MMs):

Milstein Modules, with their hexagon and triangle shapes, represent an easy, fast, and fun application of eco-bricks. These configurations are used for sitting and can be combined to form horizontal surfaces for tables, beds, stages, and more. MMs can be easily slid into deployment for various events, offering versatility and space-saving storage.

Dieleman Modules (DMs):

Dieleman Modules, or DMs, transform eco-bricks into LEGO-like blocks. Sixteen eco-bricks are silicone together to create one DM module. These modules interconnect like LEGOs, enabling the construction of walls, towers, and columns without any need for glue or mortar. DMs are particularly useful for creating structures for events, as they can be assembled and disassembled rapidly.

Earth Modules:

Basic Earth and eco-brick Building principles are applied to create outdoor stools, coffee tables, and more. These modules serve as an ideal starting point for learning fundamental earth-building techniques. The construction process involves using local earth, straw, and sand as mortar for the eco-bricks, aligning with regenerative and sustainable practices.

Open Spaces:

Eco-brick Open spaces involve communities amassing thousands of high-quality eco-bricks and combining them into Milstein and Dieleman modules to create a diverse set of several hundred modules. These modules can be deployed for conferences, exhibitions, fairs, and other special events, creating customized interactive spaces.

Earth and Eco-Brick Buildings:

This method combines the principles of earth and eco-brick building to create strong, earthquake-resistant structures. It allows for curved walls, designs, and the recycling of eco-bricks at the end of construction. Utilizing 100% organic, locally sourced materials, this technique aligns with regenerative principles and ensures the longevity of eco-bricks within the construction.

Maintenance:

Maintaining eco-brick furniture and modules is crucial to ensuring their longevity and preventing plastic leakage into the biosphere. Short-term maintenance involves regular cleaning and repair, while long-term maintenance necessitates strategic planning, including yearly checkups, repairs, and a plan for the eventual destruction of the construction.

Establishing long-term maintenance agreements is crucial for preserving the integrity of eco-bricks and preventing environmental harm.

Answer each and every problem via eco-bricks.

According to the analyzed data, it is certain that almost all the existing problems with the methods identified and presented by the previous research studies will be solved through these new eco-bricks concept. Therefore, this has been identified by the researchers as the most successful solution for plastic waste.

Table 04. Answers for the identified problems by eco-bricks of previously used methods for plastic waste management.

Method	Problem	Solution from Eco-bricks
Using alternatives	<ul style="list-style-type: none"> • High Cost method • Less availability • Difficulty to use • No any safe material 	<ul style="list-style-type: none"> • Cost free method • Plastic waste is available in everywhere • Easy to make and use • Risk less method
Regulations	<ul style="list-style-type: none"> • Pressure from the manufacturers, retailers and the consumers • Create economic shock 	<ul style="list-style-type: none"> • No effect on manufacturers, retailers and consumers. • No impact on the economy
Using Biodegradables	<ul style="list-style-type: none"> • Have generally untested • Break down very slowly 	<ul style="list-style-type: none"> • Have tested and gained positive results • No bread down is needed

Recycling Plants	<ul style="list-style-type: none"> • After recycling and use, it is dumped to the environment. • Cannot be recycled again and again 	<ul style="list-style-type: none"> • No recycling is needed • If any case of leakage, the plastics can use to make a new brick
Waste Plastics for road constructions	<ul style="list-style-type: none"> • Harmful to the constructors • High-cost method 	<ul style="list-style-type: none"> • Riskless method • Cost free method
Pet bottles for polyester fibre	<ul style="list-style-type: none"> • Can use only PET bottles 	<ul style="list-style-type: none"> • Each and every plastic can be used.

Furthermore, the reports "eco-brick organization" and "the advantages and disadvantages of eco-bricks" show that the following advantages exist with this concept:

- i. Environmental Transformation: Eco-bricks are excellent because they turn harmful plastic, which is often disposed of irresponsibly, into something beneficial for local communities. They give a new purpose to plastic, which is usually problematic for the environment.
- ii. Utilizing Excessive Plastic: Plastic, despite being hard to dispose of, serves as an outstanding building material due to its durability and water resistance. Eco-bricks efficiently contribute to reducing the excess plastic in the world, and they are produced with lower costs and energy compared to traditional bricks.
- iii. Reduced Energy Consumption: Each eco-brick aids in reducing discarded plastic globally while being produced with less energy than traditional bricks. It's also an eco-friendly alternative compared to recycling plastic into other forms, making it an energy-efficient solution.
- iv. Raising Awareness: As you fill an eco-brick with your waste, it becomes a tangible representation of the amount of rubbish generated. This process encourages individuals to be more mindful of their consumption and disposal habits, fostering responsible behaviour.
- v. Preventing Harmful Disposal: Eco-bricks play a crucial role in preventing hazardous materials from being burned or ending up in the

- ocean. Burning plastic releases harmful CO₂, contributing to carbon emissions and global warming.
- vi. **Zero Cost and Reusability:** Eco-bricks have several advantages over traditional construction materials. They come at zero cost, absorb sudden shocks well, are reusable, easy to handle, and help repurpose plastic that poses a threat to ecosystems.

Why is this concept important for tourism?

Tourism is an industry that is intertwined with leisure and entertainment. People travel outside their usual environment to spend their leisure time productively, and it is only for a limited time. Most of the plastic waste used during the travel period is disposed of in the environment after the travel period is over. (United Nations Environmental Program and WTTC 2021) Therefore, this concept will contribute to the sustainable use of plastic generated in the tourism industry. There are several main reasons for introducing this concept into the tourism industry as:

- a) Tourism highly contributes to the plastic waste generation in Sri Lanka.
- b) Single Use Plastics are highly generated from the tourism industry.
- c) Protecting further growth in the tourism industry in the country.
- d) Eco-bricking is being a simple and leisure activity.
- e) Ability to promote as a fun activity among the tourists.
- f) Tourism industry can lead towards the sustainability by applying this concept.

It is possible to put this concept in the hands of people engaged in the tourism industry as well as tourists. It can lead the emerging tourism industry to a new sustainable dimension. Plastic waste generated by the tourism industry directly reduces tourist attractions through its impact on the environment. Therefore, this concept will be used to protect the emerging tourism industry.

4.0 Conclusion:

At present, plastic is an object that is intertwined with human life. Therefore, almost every person uses at least one plastic product per day. Among the

plastics that are used in this way, single-use plastics take a prominent place. The tourism industry has been identified as the industry with the highest use of single-use plastics. The consumption of these single-use plastics has had a severe impact on the environment. Previous research papers show that various methods related to the 3R concept are being used in Sri Lanka's tourism industry to reduce this effect. Among them, using alternatives, regulation, using biodegradables, using plastic waste for construction, and recycling take a prominent place. But the researcher identified that there are various problems with each of these methods. Due to these problems, the plastic waste crisis has not ended in the tourism industry as well as in Sri Lanka. Therefore, there is a strong need for a successful solution to the plastic waste crisis. According to the researcher, eco-bricks are a successful solution to Sri Lanka's plastic waste crisis. It is a very low-cost, low-risk, and successful method of reusing waste. Currently, many countries around the world are experimenting with this concept. According to the researcher's analysis, successful solutions to many shortcomings and problems in the waste management approaches that are already being implemented in Sri Lanka will be found through this new eco-brick concept. Therefore, this research paper confirmed that it is important to properly promote this concept in Sri Lanka.

5.0 Recommendations

Socializing as a hobby : The researcher identified socialization as a hobby as the ideal way to socialize this concept. This will make it easier for everyone, older and younger, to participate in this process. Also, socializing as a hobby will be easy, as this is a very simple, easy, and cost-free process.

Attach to community-based tourism :After socializing as a hobby, this would be easy to integrate into the tourism industry. Community-based tourism can help with that.

Building eco-brick centers :Eco-bricks can be installed at designated open-air tourist hotspots. Accepting or buying the plastic waste used by tourists through those centers, using them to create eco-bricks, providing free eco-bricks to people who need eco-bricks for new constructions, educating about eco-bricks, and setting up a small payment method for those who come to the centers and make eco-bricks.

Maintaining constructions with eco-bricks in hotels and tourists' hotspots: By making eco-bricks constructions available to tourists, their participation can also contribute to this process. Also, it will help to announce to the world that the tourism industry is moving towards sustainability.

Promoting among travel agents and hotels: Travel agents and accommodations can be mentioned as two parties that often clash with tourists. Therefore, this concept can be brought to tourists through those parties. Also, they can intervene and accept the single-use plastic used by tourists during their visit and contribute to the creation of eco-bricks, encourage tourists to create eco-bricks from the used waste, etc. For that, they can be given incentives like discounts.

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