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POTENTIAL USE OF PLASTIC WASTE AS A SUSTAINABLE CONSTRUCTION MATERIAL IN SRI LANKA

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ABSTRACT

Global demand for sustainable development places a tremendous force on the construction industry to promote sustainable construction. In Sri Lanka, while there is a gradual shift towards sustainable construction, the number of projects implementing such practices remains limited, highlighting a significant gap in the industry's contribution to sustainability goals. Currently, around 90% of construction materials are obtained from natural resources, raising concerns about long-term environmental impact and resource depletion. Simultaneously, the country faces the growing issue of plastic pollution, driven by the extensive use and non-biodegradable nature of plastics. Addressing both challenges, the integration of recycled plastic waste into construction materials presents a promising and sustainable alternative. Recycled plastics can be utilised in various applications such as concrete mixtures, paving blocks, roofing sheets, interior partitions, and prefabricated components. This research explores the barriers and benefits of using plastic waste as a sustainable construction material through a quantitative approach using questionnaires, aiming to support environmental preservation and resource efficiency in Sri Lanka's construction sector.

Keywords: *Construction; Plastic; Recycle; Sri Lanka; Sustainability.*

1. INTRODUCTION

Plastic production and use began in 1950, with unmanaged plastic garbage reaching 851,493 tons worldwide by 2010 (Geyer et al., 2017). The production of plastic worldwide is increasing at an exponential rate, with waste generation expected to rise by 70% by 2050. Plastic waste is inextricably linked to key social processes such as urbanisation, development, urban planning, land management, greenhouse gas emissions, labour, social equity, public health, rural-to-urban migration, population growth, increased consumption, and climate change (Conlon, 2021). The exponential growth in plastic manufacturing and the resulting spike in plastic trash have prompted researchers and scientists to seek new and sustainable ways to reuse/recycle plastic garbage to lessen its negative impact on the environment (Lamba et al., 2022).

The construction sector is a major global consumer of both biological and physical natural resources, contributing considerably to the global economy's unsustainable growth and drawing criticism for wasteful resource usage (Muhammed et al., 2023).

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According to World Bank studies, municipal solid waste management is one of the most important services that a city can provide. This is true regardless of a country's economic situation, since it is equally important in low- and high-income metropolitan areas. Effective waste management is seen as a critical component in ensuring public health, environmental sustainability, and overall urban livability (Hoornweg & Bhada-Tata, 2012). The bulk of plastics are discarded after a single use (Suaryana et al., 2018). Most countries in the Global South often face significant challenges in handling plastic waste after it has been discarded, primarily due to limited infrastructure, insufficient financial resources, and a lack of effective waste management systems. As a result, much of the plastic ends up in open dumps, waterways, or the environment, leading to serious environmental and public health issues (Hoornweg & Bhada-Tata, 2012).

Sri Lanka has become a major hotspot for the buildup of floating plastic trash in the Indian Ocean as a result of poor plastic waste management methods and a heavily populated coastal region. The country is presently rated fifth out of the top eleven countries with the greatest amounts of mismanaged plastic trash, demonstrating the gravity of the problem and its contribution to marine pollution (Jambeck et al., 2015). The issues associated with plastic waste management have mainly gone unresolved in nations such as Sri Lanka due to a lack of trustworthy technical data required for informed decision-making and efficient planning. Understanding existing waste management systems is critical for developing countries, particularly in circumstances where environmental restrictions are generally less rigorous. Implementing scientifically based policy solutions can have a transformative impact by boosting environmental protection, increasing economic resilience, and encouraging resource efficiency (Millette et al., 2019).

Developing countries, such as Sri Lanka, confront challenges with inappropriate building materials and complex supply networks, leading to increased environmental impact (Bon & Crosthwaite, 2001). To address these critical issues, this research project will investigate the possible use of plastic trash as a sustainable construction material in Sri Lanka. The project aims to contribute to efficient waste management solutions by investigating novel ways to recycle wasted plastics in the construction industry, while also encouraging environmentally friendly building practices and increasing sustainability in the local construction sector.

2. LITERATURE REVIEW

2.1 CONSTRUCTION INDUSTRY IN SRI LANKA

The construction sector is a crucial driver of a country's economic development. Productivity is a critical component in determining its influence. Increasing productivity in the construction sector not only improves the efficiency and performance of construction operations but it also contributes significantly to a country's GDP. As a result, increasing productivity in this sector is usually seen as a critical step toward overall economic development (Durdyev et al., 2013). Sri Lanka has experienced a rise in construction activity in the postwar period, owing to increased interest and significant expenditures in large-scale capital development projects from both the government and the private sector. Research show that the construction subsector has grown significantly throughout this time period (Lamba et al., 2022). While this fast expansion offers various benefits, such as job creation, infrastructure development, and economic stimulus, it also poses considerable obstacles, such as resource restrictions, environmental concerns, and the need for better planning and regulation (Manoharan et al., 2023).

2.2 SUSTAINABLE DEVELOPMENT IN THE SRI LANKAN CONSTRUCTION INDUSTRY

As Sri Lanka faces demographic and epidemiological transitions, as well as severe budgetary restrictions, policymakers must assess the successes and challenges of achieving universal health coverage (UHC) and the Sustainable Development Goal (SDG) for health (De Silva et al., 2016). Sustainable building aims to achieve long-term development by considering environmental, social, economic, and cultural factors. It has become a focal point for nations. Population growth and economic expansion are putting significant strain on the world's resources (Ametepey et al., 2015). Sustainable construction responds effectively to current environmental and socioeconomic challenges by incorporating sustainable development principles into the entire construction cycle, from raw material extraction to planning, design, construction, deconstruction, and waste management, while focusing on minimising environmental and social impacts (Athapaththu & Karunasena, 2018). Waste plastic is being recognised as a useful resource in a variety of industries, including construction materials, fuel conversion, and the creation of home items, textiles, and apparel. Among these possibilities, using plastic waste to generate construction materials has received a lot of interest. This is mostly due to its capacity to solve both environmental issues and material shortages, providing a sustainable alternative that upholds circular economy principles while improving the performance and longevity of construction goods (Lamba et al., 2022).

2.3 WASTE MANAGEMENT IN SRI LANKA

Municipal Solid Waste Management (MSWM) is a major global challenge, especially for the quality and sustainability of urban ecosystems. It has far-reaching consequences for environmental health, public well-being, and socioeconomic development (Subasinghe, 2024). Municipal solid waste is often classified into numerous unique components based on its origin and type, as demonstrated in Figure 1, which depicts the major solid waste categories.

Due to the rapid urbanisation and population, limited infrastructure has resulted in significant waste management challenges (Dharmasiri, 2019). The key issues include inadequate waste segregation, insufficient collection and disposal mechanisms and lack of awareness regarding the impacts of this waste (Saja et al., 2021). In Sri Lanka, most of the waste is managed by disposing it into open areas and landfills and burning it (Kumara & Pallegedara, 2020). There have been efforts made by government programs and international collaborations to improve waste management within Sri Lanka. However, the implementations of these have been impacted by resource constraints and a lack of political support.

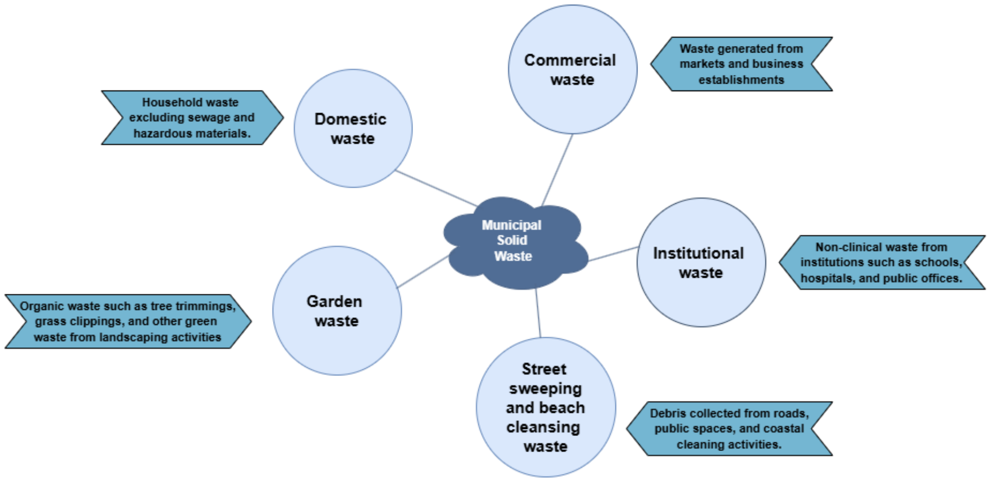

Figure 1: Major municipal solid waste

2.4 PLASTIC WASTE IN SRI LANKA

Wealthy nations often have modern and efficient waste management systems in place to ensure proper waste collection, recycling, and disposal. In sharp contrast, many low- and middle-income nations face inadequate waste management infrastructure, resulting in widespread inappropriate trash disposal. In some of these countries, 80 to 90 percent of plastic garbage is not properly handled, greatly contributing to environmental contamination and posing serious hazards to rivers, seas, and marine ecosystems. Plastic waste in the seas harms the environment, economy, and aesthetics (Jambeck et al., 2018).

Sri Lanka now has approximately 400 plastic processing enterprises, with a total investment of Rs. 15 billion in reprocessing across the nation (Samarasinghe et al., 2021). According to the Manoharan et al. (2023) report, In Sri Lanka, the plastic material flow is divided into many important stages. It starts with the plastic product manufacturing business, which employs virgin and recycled plastic pellets to make items, some of which are exported and the remainder consumed locally (Jambeck et al., 2015). These goods are subsequently distributed to intermediate users, who use them to manufacture end-use items, and eventually to end consumers, who consume both locally manufactured and imported plastic products. After usage, plastic garbage is collected and sent to recycling facilities, landfills, or exported. Some of this trash is used in cement factories as an alternative fuel, while others are recycled into plastic pellets (Hama & Hilal, 2017). Another technique is to convert plastic to oil using technologies such as pyrolysis. However, a large quantity of plastic garbage gets disposed of in landfills, and some ends up in the open environment, either dumped or burned, with some ultimately making its way into the ocean.

The construction sector creates a substantial amount of solid waste; therefore, there is a growing emphasis on proper construction and demolition waste management (Banihashemi et al., 2018). Construction and destruction waste types include ceramics, cement, conduit, blocks, floor finishes, lumber, tar and bituminous items, glass, hazardous components, plastic, asphalt, metals, soil, dredged soil, building and demolition debris, insulation and gypsum-based materials (Ghosh et al., 2016).

2.5 USE OF PLASTIC WASTE IN THE CONSTRUCTION INDUSTRY

Polyethene Terephthalate (PET), High-Density Polyethene (HDPE), Polyvinyl Chloride (PVC), Low-Density Polyethene (LDPE), Polypropylene (PP), and Polystyrene (PS) are the five most frequent plastic waste components found in municipal solid waste. Each of these plastic varieties has a different chemical structure, use, and amount of recyclability. They are commonly used in construction applications because of their durability and availability in huge quantities as waste (Ismail & AL-Hashmi, 2008). Studies show that adding plastic waste in small proportions (typically 10–20%) can improve certain properties like ductility, water resistance, and insulation, though excessive amounts may compromise strength and durability (Athithan & Natarajan, 2023; Lamba et al., 2022). Plastics are also valued for their lightweight, chemical resistance, and low cost, making them suitable for insulation, waterproofing, and other specialised building applications (Cui, 2025).

Plastics have been successfully used in a wide range of construction materials, including concrete, mortar, building plaster, blocks, pavement surfaces, base and subbase layers of pavements, and Hot Mix Asphalt. Integrating plastic waste into these applications not only enhances particular mechanical features (such as durability, flexibility, and wear resistance) but also provides a sustainable manner of plastic waste disposal (Rahat et al., 2022). Table 1 presents the construction applications, associated barriers, and potential benefits of utilising plastic waste in the construction sector.

3. RESEARCH METHODOLOGY

This study, using a quantitative questionnaire survey, investigated the problems associated with the prospective inclusion of plastic trash as a construction material in the Sri Lankan construction sector. This commonly used technique of study provides important insights into people's attitudes, opinions, and preferences. It is especially useful for measuring the incidence of specific behaviours or occurrences and spotting developing patterns or trends (Borrego et al., 2009). This research study enrolled 42 participants and used 5-point Likert scales to assess the applications, associated barriers, and potential benefits of utilising plastic waste in the Sri Lanka Construction Sector. To evaluate the data, the Relative Importance Index (RII) approach was used, which computes the relative significance of each element based on weighted replies. The RII readings were then classified into four significance categories (High, High-Medium, Medium, and Low) based on prescribed ranges. Data was interpreted using RII, and the results were visually portrayed with charts and diagrams. The following equation (Equation 1) is used to determine the RII:

$$RII = \frac{\sum w}{A\ x\ N} \qquad Equation\ (1)$$

Where:

- $\sum$w = Sum of the weights assigned to each factor by the respondents
- A = Highest possible weight (e.g., 4 or 5 depending on the scale used)
- N = Total number of respondents

Table 1: Summary of construction applications, associated barriers, and potential benefits of utilising plastic waste in the construction sector

Material	**Construction Application**							**Barrier**						**Benefit**			**Source**
	Concrete	**Pavements**	**Plaster**	**Block**	**Mortar**	**Asphalt**	**Hot mix asphalt**	**Functionality**	**Collection**	**Recycling**	**Separation**	**Processing**	**Performance**	**Improve performance**	**Environment quality**	**Reduce cost**	
PET	√		√	√		√		●	●	●	●	●		x	x	x	(Abu Abdo & Khater, 2018; Batayneh et al., 2007; Hama & Hilal, 2017; Ismail & AL-Hashmi, 2008; Khalid et al., 2018; Salim et al., 2019)
HDPE		√				√	√	●				●		x	x	x	(Angelone et al., 2016; Arabani & Pedram, 2016; Gibreil & Feng, 2017)
LDPE				√		√	√	●				●		x	x	x	(Angelone et al., 2016; Kumi-Larbi et al., 2018; Suaryana et al., 2018)
PP						√	√	●				●		x	x	x	(Angelone et al., 2016; Wang et al., 2022)
PVC	√				√			●		●		●		x	x	x	(Aciu et al., 2018; Puri et al., 2013)
PS	√	√	√					●				●	●	x	x	x	(Hama & Hilal, 2017; Ismail & AL-Hashmi, 2008; Salim et al., 2019)

4. RESEARCH FINDINGS AND ANALYSIS

This study's data was mostly acquired via a structured questionnaire survey, which included closed-ended questions meant to generate measurable replies. These questions used a five-point Likert scale, which allowed participants to express varied levels of agreement or significance in a consistent style. The collected replies were systematically examined using the RII approach, which allowed for the prioritising and comparison of crucial elements based on the respondents' collective judgments. This analytical method allowed for a clear interpretation of the data, facilitating relevant discoveries and conversations within the study environment.

The questionnaire was distributed to 42 professionals, including civil engineers, lecturers, quantity surveyors, construction managers, project managers, structural engineers, quality assurance managers, architects, and materials engineers, to gain diverse perspectives on the applications, challenges, and potential benefits of using plastic waste in Sri Lanka's construction industry. Among the chosen respondents, 92% were aware of the usage of plastic waste in building applications, and 55% had directly engaged in a project that included plastic waste in construction.

4.1 SUITABILITY OF DIFFERENT TYPES OF PLASTIC WASTE FOR SUSTAINABLE CONSTRUCTION PRACTICES

According to the responses of 42 participants, the majority of construction experts believe various forms of plastic waste are viable for construction uses. Figure 2 presents the details of the respondents.

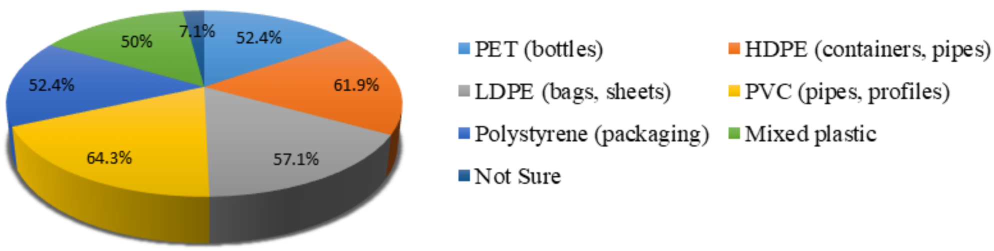

Figure 2: The suitability of different types of plastic waste for sustainable construction practices

PVC (pipes and profiles) was the most popular material, chosen by 64.3% of respondents, followed by HDPE (containers and pipes) at 61.9% and LDPE (bags and sheets) at 57.1%. PET (bottles) and polystyrene (packing) were both recognised by 52.4% of respondents, whereas 50% felt mixed plastic could be used successfully in building. Only a small portion, 7.1%, indicated they were unsure about which types of plastic waste are suitable. These findings demonstrate a high level of awareness and acceptance among experts about the possibilities of various plastic waste in building procedures.

4.2 CONSTRUCTION APPLICATIONS OF INCORPORATING PLASTIC WASTE

Table 2 gives the RII and accompanying rankings for various construction applications that use plastic waste.

Table 2: Construction applications of plastic waste

Construction Applications	RII	Rank
Plastic-infused bricks/ blocks	0.705	3
Asphalt roads with plastic	0.681	6
Plastic fibre-reinforced concrete	0.719	2
Wall panels and formwork	0.695	4
Insulation materials	0.690	5
Furniture and fittings	0.757	1
Roofing tiles	0.671	7

According to the findings, furniture and fittings scored the highest with an RII of 0.757, suggesting that it is the most appropriate application. This is followed by plastic fibre-reinforced concrete (RII = 0.719) and plastic-infused bricks/blocks (RII = 0.705), which rank second and third, respectively. Wall panels, formwork, and insulation materials had intermediate rankings, with RIIs of 0.695 and 0.690. Meanwhile, asphalt roads with plastic and roofing tiles were deemed the least acceptable uses, with RIIs of 0.681 and 0.671, placing sixth and seventh, respectively. These rankings indicate the professional preference for using plastic waste mostly in non-structural or secondary building components.

4.3 KEY BARRIERS TO USING PLASTIC WASTE IN CONSTRUCTION

Table 3 highlights the main barriers to employing plastic trash in building based on their relative importance (RII).

Table 3: Key barriers to using plastic waste in construction

Key Barriers	RII	Rank
Lack of standards and regulations	0.686	11
Concerns about structural strength	0.695	7
Long-term durability issues	0.724	1
Lack of awareness or expertise	0.719	2
High processing costs	0.705	4
Environmental concerns about microplastics	0.710	3
Difficulty in sourcing and sorting plastic waste	0.681	12
Resistance from clients or stakeholders	0.690	8
Lack of technical knowledge	0.690	8
Cost and availability of technology	0.705	4
Absence of regulatory support	0.690	8
Negative perception of plastic materials	0.705	4

The most important hurdle is long-term durability (RII 0.724, Rank 1), followed by a lack of information or experience (RII 0.719, Rank 2) and environmental concerns regarding microplastics. High processing costs and a bad image of plastic materials share fourth place (RII 0.705). Other notable barriers include concerns about structural strength, resistance from clients or stakeholders, a lack of technical knowledge, the cost and availability of technology, a lack of regulatory support, and, finally, a lack of standards and regulations, as well as difficulty sourcing and sorting plastic waste, which are ranked as the least significant barriers.

4.4 POTENTIAL BENEFITS OF USING PLASTIC WASTE IN CONSTRUCTION

Table 4 presents potential benefits of using plastic waste in construction, graded by the Relative Importance Index (RII).

Table 4: Potential benefits of using plastic waste in construction

Potential Benefits	RII	Rank
Utilising plastic waste can reduce construction costs.	0.652	12
It helps in effective waste management and reduces landfill usage	0.700	4
It contributes to environmental sustainability	0.724	1
It improves the thermal or acoustic performance of buildings	0.690	7
Plastic-based materials are lightweight and suitable for construction.	0.667	10
It fosters innovation in construction techniques and materials	0.705	3
It creates employment opportunities in the recycling sector	0.714	2
Lightweight, durable, and eco-friendly alternative to traditional	0.690	7
Increased flexibility and crack resistance	0.657	11
Recyclable	0.676	9
Corrosion-resistant	0.700	4
Reduces landfill waste, maintenance-friendly	0.700	4

Contributing to environmental sustainability is seen as the most important advantage (RII 0.724, Rank 1), followed by generating job opportunities in the recycling industry (RII 0.714, Rank 2) and encouraging innovation in building processes and materials (RII 0.705, Rank 3). Helping with effective waste management and decreasing landfill usage, as well as being corrosion-resistant, lowering landfill trash, and maintenance-friendly, all rank fourth (RII 0.700). Additional benefits include the use of lightweight, durable, and ecologically responsible alternatives to traditional materials, as well as improved thermal and acoustic performance in buildings (both with a RII of 0.690, ranking seventh). Other noted benefits include recyclability (RII 0.676, Rank 9), the suitability of lightweight plastic-based materials for construction (RII 0.667, Rank 10), improved flexibility and cracking resistance (RII 0.657, Rank 11), and, finally, the potential cost reduction in construction through the use of plastic waste, which was identified as the least significant benefit in this ranking (RII 0.652, Rank 12).

5. DISCUSSIONS

Sri Lanka's increased emphasis on environmental sustainability and green construction provides an ideal opportunity to incorporate plastic waste as a sustainable material in construction. The findings of this study reveal that the professionals in Sri Lanka recognise the capabilities of using plastic waste for non-structural applications within construction. This aligns with the research conducted by Abdo and Khater (2018), which demonstrated that plastic materials can be utilised in various applications. One of the key findings of this study is the preference for using plastic waste in the secondary construction components rather than structural elements. This aligns with several studies conducted in India and Kenya, where plastic-infused bricks and plastic-reinforced concrete have been used in low-cost housing and infrastructure projects, yielding positive results (Lamba et al., 2022). In construction projects, incorporating plastic in asphalt has led to improved road durability and water resistance (Angelone et al., 2016), while Kenya has utilised recycled plastic bricks to address housing shortages, demonstrating that technical feasibility can lead to socioeconomic benefits. The top-ranked barrier in this study was concern over long-term durability, which is consistent with global literature highlighting uncertainty about the mechanical and structural integrity of plastic-based construction materials (Rahat et al., 2022; Aciu et al., 2018). Similarly, the lack of awareness and technical expertise identified in the Sri Lankan context reflects challenges faced in other developing nations, where insufficient training and regulatory frameworks hinder the adoption of innovative materials (Gibreil & Feng, 2017).

Despite barriers, promoting environmental sustainability, creating employment and supporting waste management lays a solid platform for using recycled plastic in building. These were in line with the studies conducted by researchers emphasising the circular economy in the construction industry (Samarasinghe et al., 2021; Millette et al., 2019). This method not only eliminates plastic waste, but it also encourages economic growth, so it integrates environmental aims with socioeconomic development for a more sustainable future.

Furthermore, studies have provided evidence of successful integration. Australia has developed modular construction units using recycled plastics that meet both thermal and strength requirements (Wang et al., 2022). Trinidad and Tobago have explored plastic reuse through systems-level material flow analysis to support circular construction practices (Millette et al., 2019). These studies demonstrate the potential for Sri Lanka to adopt similar models, especially with collaboration between government and academia.

6. CONCLUSION AND RECOMMENDATIONS

In conclusion, the use of plastic waste as a construction material offers a practical and sustainable solution to Sri Lanka's growing environmental and material challenges. This study highlights that the Sri Lankan construction industry is aware of the potential to incorporate plastic waste into non-structural elements such as blocks, furniture, and insulation, which can help reduce landfill usage, lower costs, and promote innovation. However, key barriers such as concerns about long-term durability, lack of standards, limited awareness, and environmental risks like microplastic pollution still hinder widespread adoption. To effectively implement plastic-based construction, Sri Lanka must develop clear technical standards and regulatory frameworks to ensure safety and consistency in material performance. Furthermore, international collaboration and integration into national policy frameworks will further support the adoption of plastic-based construction, enabling Sri Lanka to lead in sustainable and green building practices in the region. Future research should focus on long-term performance testing of plastic-based materials in various climatic zones, and the development of eco-friendly plastic composites.

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