OPTIMIZATION OF MATERIAL RECOVERY IN MUNICIPAL SOLID WASTE (MSW) OF SRI LANKA IN CIRCULAR ECONOMIC FRAMEWORK.

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Degree of Doctor of Philosophy

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Declaration

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The above candidate has carried out research for the PhD thesis/ Dissertation under my supervision.

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Date : 12/08/2024

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Abstract

The acceleration of economic growth, urbanization, and population expansion has led to heightened planetary issues, surpassing key planetary boundaries. Large volumes of uncontrolled resource consumption, particularly material-intensive resources, lead to resource depletion. Consequently, this surge in consumption has resulted in uncontrolled and substantial release of waste into the environment. Currently, the waste and resource management system lack a comprehensive approach that involves the entire spectrum, starting from product design, raw material extraction, production, consumption, and recycling, to waste management in nations.

The application of circular economic practices can help address current issues by comprehensively understanding municipal solid waste material channels and its composition. A concise knowledge of material composition plays a crucial role in identifying problems and gaps. Understanding waste material flow and composition is critical in developing effective waste management strategies. Moreover, a deeper understanding of material recovery strategies is essential to reveal the hidden circular value within waste materials.

The absence of a standardized composition analysis method for municipal solid waste results in the application of different methodologies based on volume. This research aims to identify material flow within municipal solid waste, from household generation to final disposal, specifically within a defined geographical location in Sri Lanka. Its objective is to ascertain the potential circularity of waste, facilitating its reintegration into material cycles.

A new methodology was developed for volume-based analysis of municipal solid waste using a one cubic meter waste composition analysis. This assessment aids in identifying the circularity potential of materials within a one-cubic meter waste volume. An initial method development investigation was conducted at the Karadiyana municipal solid waste site in Sri Lanka.

Furthermore, this research expanded its scope to develop a waste circularity model within a techno-economic framework. This model aims to enhance waste circularity through various pathways, enabling their recovery and reintegration into the material supply chain. The model optimization was carried out using the genetic algorithm optimization method with the assistance of MATLAB® Simulink, focusing on waste generated at the Karadiyana municipal solid waste site for Plastic waste material categories.

The study results highlighted the potential of plastic material recovery in terms of both material recovery and circular value addition within a Techno-Economic framework. Moreover, this model has the potential to be replicated for other MSW materials across different geographical boundaries. Such a model can assist in decision-making processes for developing sustainable business models through material recovery technologies. Additionally, it aids in formulating waste management strategies for policymakers during city and country planning stages and infrastructure development phases. Overall, it contributes to combating resource depletion, thereby supporting the sustainability of critical planetary boundaries.

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List of Abbreviation

ABS	Acrylonitrile Butadiene Styrene
ASTM	American Society for Testing and Materials
CBSL	Central Bank of Sri Lanka
CE	Circular Economy
CEA	Central Environmental Authority
CIWMB	California Integrated Waste Management Board
CS	Census and Statistics
CVA	Circular Value Addition
GA	Genetic Algorithms
GDP	Gross Domestic Production
GN Division	Grama Niladhari Division
GNSS	Global Navigation Satellite Systems
GPR	Ground penetration radar
HDPE	High Density Poly Ethelene
HH	Households
HIPS	High Impact Polystyrene
IS	Industrial Symbiosis
ISO	International Organization for Standardization
JICA	Japan International Cooperation Agency
KSWMS	Karadiyana Solid Waste Management Site
LDPE	Low density polyethylene
MC	Municipal council

MFA	Material Flow Analysis
MOE	Ministry of Environment
MRF	Material recovery factor
MSW	Municipal Solid Waste
NPWM	National Policy on Waste Management
OM	Optimization methods
PET	Polyethylene Terephthalate
PP	Polypropylene Plastic
PRO	Producer Responsibility Organization
PS	Pradeshiya Sabha
PVC	Polyvinyl Chloride
SEA	Sustainable Energy Authority
SWA	Solid Waste Analysis
SWM	Solid Waste Management
SPSS	Statistical Package for the Social Sciences
UC	Urban Council
W2E	Waste to Energy
WCP	Waste Circularity Potential
WBG	World Bank Group
WMA	Waste Management Authority
WP	Western Province

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