THE ROLE OF CENTRAL ENVIRONMENTAL AUTHORITY IN MANAGING SOLID WASTE IN SRI LANKA

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ABSTRACT

Large-scale solid waste generation, together with improper waste management systems (WMSs), has been a critical issue in the world today. Thus, properly managed WMSs are essential to ensuring the good health and environmental quality of the nation. This study explored the contribution of the Central Environmental Authority (CEA), empowered through the National Environmental Act (NEA), in managing solid waste in Sri Lanka, mainly based on secondary data gathered from the CEA annual reports, corporate plans and websites, and NEA. Informal discussions and interviews were conducted with CEA officials for more details and clarifications. The data gathered was qualitatively analyzed using techniques: thematic analysis and content analysis. The study reveals that CEA, coordinating with provincial and district offices, contributes substantially to managing waste/ solid waste/ hazardous waste in Sri Lanka. Through legislation, CEA influences industrialists and takes actions to minimize the volume of waste and its polluting density from the initial stage before commencing high-medium-polluting industrial activities and large-scale projects. Similarly, by delegating power to local authorities (LAs), CEA assists in managing waste/solid waste from low-polluting industries and households. CEA is also involved in initiating and amending regulations, and implementing them to streamline waste management practices. Thus, CEA's role shows the importance of taking protective measures in advance to minimize the extent of waste and its pollution density. CEA has initiated large-scale waste management projects as well. The findings help relevant authorities take policy decisions, strategies, and actions to reform WMSs. In turn, these findings provide valuable insights for waste generators, collectors, and recyclers to be more attentive to their responsibilities, legal compliance, and potential for maintaining suitable WMSs. This study mainly focused on three divisions of CEA which are mostly related to waste management. Thus, it did not explore the role of other divisions of CEA and the difficulties/ challenges faced by related parties i.e., CEA, LAs, waste generators, collectors, and recyclers, in implementing waste management strategies and actions; all such unexplored areas are thus, exposed to future researchers.

Keywords: Central Environmental Authority, Environmental Legislation, Environmental Pollution, National Environmental Act, Solid Waste Management

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1. INTRODUCTION

Large-scale solid waste generation has been a serious issue in the world today. However, in the Sri Lankan context, the absence of a sound national policy for solid waste management (SWM) has triggered tremendous negative environmental consequences (Fernando, 2019). Solid waste consists of solid materials discarded from industrial, commercial mining (withdrawal), or agricultural operations and materials discarded from community activities, also known as garbage, refuse, or rubbish (Allaby and Park, 2013).

Thus, SWM is an essential component of urban environmental management that affects daily life and environmental quality (Anand, 2010). Plenty of garbage lining the streets, overflowing dumps, and mountains of solid waste are indicators of one of the most visible and serious environmental issues facing society. Apart from the eyesores these create, more serious implications are the health hazards created by improper disposal of waste. All forms of human activities result in the generation of waste, which can harm the environment, but careful management and minimization of waste can limit the damage to the environment while conserving scarce resources (De Mel and Sirimanne, 2009). In this sense, waste generation is considered as an unavoidable byproduct of human action, and its management influences people's health and the natural environment (Jagun et al., 2023). The accumulation of unmanaged waste on a global scale is increasing, and its composition is becoming more complex (Vergara and Tchobanoglous, 2012). Meanwhile, Wu et al. (2022) identify waste as a very precious resource that is kept in the wrong places.

Moreover, Jagun et al. (2023) reveal that, similar to previous global studies, current waste management has a significant impact on the socio-economic development of developing countries. They conclude that effective waste management is directly related to socio-economic development, including social components, population density, level of education, the standard of living, and per capita income. It denotes a set of benefits that would assist individuals in developing nations in distinguishing the socio-economic significance of more effective waste management (Jagun et al., 2023). Ikhlayel (2018) also emphasizes the importance of waste management in enhancing developments that has become increasingly apparent in recent years (Ikhlayel, 2018). Thus, the importance of waste management in developing countries has grown rapidly in recent years. In this respect, Badola and Chauhan (2022) illustrate the "7R" principles (refuse, reduce, reuse, repair, repurpose, recycle, and recover) that can contribute to effective waste management.

In the Sri Lankan context, the National Environmental Act (NEA) No. 47 of 1980, as amended by Acts No. 56 of 1988 and No. 53 of 2000, is recognized as the most important piece of environmental law applicable to all companies and industries in the country. The NEA is thus enacted as an umbrella law to address a variety of environmental matters, while other laws deal with specific aspects of the environment. Therefore, NEA is deliberated as the basic national charter for the protection, conservation, and management of the environment. The Act is administered by the Central Environmental Authority (CEA), established in 1981 under the provisions of the NEA. The CEA was given wide regulatory powers

through the NEA for the protection, management, and enhancement of the environment; for its regulation, maintenance, and control of quality; and for the prevention, abatement, and control of pollution (NEA, 1980). The Ministry of Environment (MOE), established in 2001, is the main policy-making body for the environmental sector in Sri Lanka. MOE has the overall responsibility for the affairs of the CEA, with the objective of integrating environmental considerations into the development process of the country. Under this Ministry, CEA has been formulated as a regulatory body for environmental management in the country (www.cea.lk).

According to the National Environmental (NE) Protection and Quality Regulations No. 1 of 2008, the NEA is the most important piece of legislation and has extensive provisions on pollution control, regulation of development, and preparation of management plans for the protection of the environment. Among the environmental problems in urban areas, improper management of solid waste is one of the biggest and key environmental problems in Sri Lanka. The lack of systematic systems for waste collection, waste transport, intermediate treatment systems, and suitable waste disposal has been contributing to aggravate the solid waste problems in Sri Lanka (Dassanayake, 2011). As a result, the total waste generated in Sri Lanka is 10,768 Metric Tons (MT)/day; however, waste collection is 3458 MT/day, which confirms that one-third of the generated waste is collected (MOE, 2021). In this sense, in striving to take action to mitigate environmental pollution towards protecting the environment, a foremost concern should go to SWM in Sri Lanka. Given all the above concerns, this study thus explores the contribution of CEA made through the legislation enacted by NEA and, strategies and policies initiated by the relevant government authorities i.e. MOE, in managing solid waste in Sri Lanka.

2. LITERATURE REVIEW

This section analyses the findings of previous studies on waste management and related issues with particular attention to the Sri Lankan context and developing countries. Accordingly, Fernando (2019), observing the SWM of local governments in the Western Province, realizes that the absence of a sound national policy for SWM has instigated tremendous negative environmental consequences in Sri Lanka. Regardless of various SWM programs being implemented by Municipal Councils (MCs) and other local governments with the relevant authorities, most of them have not been successful at their implementation stage due to some administrative problems such as insufficient land for final dumping, composting, and recycling; a lack of necessary vehicles and instruments, modern technology and an integrated SWM program; a poor regulatory framework; and inappropriate political interference (Fernando, 2019).

Supporting these opinions, Gupta et al. (2023) argue that the challenges in waste management seem to be a global issue, and thus, the waste management sector requires significant improvements to handle the growing amount of waste generated. The main challenges are the inadequate infrastructure, resulting in open dumping and waste burning, and these practices contribute to pollution and health hazards. In relation to developing countries, the management of municipal solid waste is a significant issue due to rapid urbanization and population growth. Gupta et al., (2023)

advocate that in developing SWM programs, it is important to identify the causes/ sources of solid waste, such as inhabited waste, institutional waste, manufacturing waste, building and destruction waste, commercial waste, municipal waste, and agriculture waste.

Moreover, by reviewing existing literature, policies, information, and records on waste management in developing nations, Jagun et al. (2023) highlight four main drives for waste management problems in developing countries: growing populations, expanding economies, industrialization, and urbanization. Likewise, Bui et al. (2020) recognize economic growth, rapid urbanization, and industrialization as the main causal factors for accumulating a lot of waste, which has made it hard for people to get rid of it. In this sense, Breukelman et al. (2019) stress that increasing amounts of waste are being generated at an alarming rate and thus, if they are not managed properly, it may negatively affect the environment and human health, especially in developing countries. Therefore, they suggest that citizens worldwide must have access to waste management services that are both professional and cost-effective.

In this respect, Jagun et al. (2023) further recognize finances, population density, per capita income, education level, policies, and technology as essential socio-economic factors having a significant impact on waste management, which encompasses waste generation, collection, composition, and disposal/ treatment. Nonetheless, the study denotes that waste management has a number of economic benefits, including financial stability, job creation, and community cohesion. Yuan et al. (2023) also recognize that the capital investment of enterprises and stakeholders' willingness and attitudes are the critical factors that influence illegal dumping behavior; nevertheless, compared with business-level factors, macro-level factors such as 'social norms and culture' and 'government incentive policies' tend to be less influential. The authors suggest 'enhancing the industry-wise administration system and practitioners' dedication' as an option to avoid this issue.

Kumari and Raghubanshi (2023), identifying waste generation as one of the major environmental management challenges in the world today, reveal that rapid population growth, together with urbanization and economic development processes, leads to an increase in waste production in various forms. The waste management problem is becoming more critical in developing countries, where waste generation outpaces population growth and economic development. The challenges of waste collection and disposal are massive, but effective waste management practices (recycle, reuse, reduce, landfills, incineration, etc.) are critical for any nation's development. The authors thus, disclose that despite rapid population growth, an integrated waste management system with well-coordinated policies, strong financial support, and infrastructure can reduce waste-related problems (Kumari and Raghubanshi, 2023).

Overviewing global solid waste management practice, Jagun et al., (2023) reveal that approximately 70% of countries have set up institutions for initiating waste policy, development, and monitoring oversight, and solid waste management is regulated by about two-thirds of countries, though enforcement varies widely. In this respect,

governments run at least half of the services from collecting waste to treating and disposing of it, apart from the private sector. Nevertheless, private sector financing and operations partnerships do not always work out because they need the right incentives and enforcement mechanisms (Jagun et al., 2023).

Based on a comparative analysis of solid waste management in developed, developing, and less developed countries, Mmereki et al. (2016) indicate that SWM is becoming an increasing concern across the globe due to changing lifestyles, production processes, and rapid urbanization. However, developed countries manage this issue with well-functioning policy frameworks, reliability of SW administration and technically skilled human resources, and efficient waste management technologies. Unlike developed countries, traditional SWM practices still remain dominant in developing and lesser developed countries, so they are facing challenges of SWM such as lack of assessment of developmental programmes, continuity, economic resources and public–private partnerships. Supporting this view, Jagun et al. (2023) also emphasize that developing countries' waste management methods are not as efficient as they could be. As a result, existing waste management practices of most developing countries do not fully conform to developed countries' best practices for meeting socio-economic goals.

Mmereki et al. (2016) further advocate that the key to a successful SWM system includes: identifying simple, appropriate and affordable strategies such as source separation systems, controlled disposal facilities; involvement of all the stakeholders in designing and implementing 'home-made' solutions; reforming existing recycling systems; and integrating the informal sector into the formal sector. It should further include zero corruption, increased assessment of developmental programmes and increased public participation. Waste minimization through source reduction could also be implemented effectively for sustainable SWM and sustainable development of society (Mmereki et al., 2016).

Ranasinghe et al. (2020), evaluating the electronic waste management system in Sri Lanka, identify major challenges as: insufficient formal mechanisms for e-waste collection; inadequate awareness of health hazards and environmental impacts; inadequately trained manpower for e-waste handling; insufficient regulations to address the entire lifecycle management of e-products; and a lack of data and control over the informal sector involved in e-waste collection and recycling. Thus, they suggest timely mechanisms to strengthen and streamline the system: formulating and implementing proper policies and regulations on e-waste management; introducing economic instruments that influence consumer behavior, such as extended producer responsibility; and raising taxes for the importation of secondhand products.

Exploring existing complexities of municipal SWM processes, practices, and emerging challenges in the south-eastern coast of Sri Lanka, Saja et al., (2021) reveal that although the municipal SWM systems in the urban areas consist of all necessary elements, their effectiveness and efficiency are not satisfactory for several reasons, such as poor or non-segregation of waste, a lack of resources, the absence of regulations to mitigate waste generation and control polluters, the absence of a regular collection plan and schedule, and a lack of technical know-how and

initiatives. Warunasinghe and Yapa (2015), investigating household SWM in a peri-urban area (Kottawa) in Colombo, reveal that they are knowledgeable on environmental and health issues with improper SWM, and thus very few are practicing improper waste disposal methods such as open dumping and dumping waste in flowing water. However, they are not practicing waste recycling, reusing, and reduction sufficiently. The authors also disclose the necessity of further commitment from the government for a proper SWM system in the area.

In considering the developing countries and specifically the Sri Lankan context, the literature evidences that almost all studies focused on exploring SWM systems and practices to identify key drives/ reasons for waste management problems arising worldwide, and accompanying environmental issues. Their foremost attention has been made to investigating the implementation and monitoring mechanisms applied in these societies once generating waste from industrial and household activities, rapid urbanization and other sources. The authors conclude that unsatisfactory, improper SWM systems are operating in these contexts, so that society is facing serious environmental and health issues. However, the least attempts (i.e., De Mel and Sirimanne, 2009) were made to explore the preventive and controlling measures taken by government authorities (i.e. CEA) from the initial stage before generating waste and, also allied legislation enacted and policies/ strategies initiated in the context under investigation. This study thus attempts to fill this gap by exploring the role of CEA, as the governing body for environmental management in the country, in managing solid waste in Sri Lanka.

Thus, the theoretical perspective of this study stemmed from 'agency theory'. The agency theory is defined as the contract agreement between the principal and the agent primarily for information exchange and management autonomy for two basic consequences of outcomes: incentives and authorizations (Røiseland et al., 2015; Benegrew, 2020). The agency theory is assumed to bring about efficiency and accountability in the public-sector by adopting a contract and Pay for-Performance (PFP) scheme. The agency theory has been applied to the public sector, especially concerning its accountability (Mengiste, 2022). As cited by Mengiste (2022), the theory of Public Service Motivation (PSM) is based on motivation and driving "To do good for others as well as for the society" (Benegrew, 2021) instead of maximizing self-interest through incentive mechanisms. Thus, the PSM is about yearning to serve society and the public interest, not yearning for incentives. Accordingly, theoretical support for this study is provided from agency theory, by denoting CEA as the government agent. In that sense, CEA's role is administered through legislation (i.e. NEA), strategies and policies enacted/ initiated by the MOE under the direction of the government of Sri Lanka.

3. Research Methodology

This study applies a qualitative approach to investigating, as a case study, the role of CEA. It entails the detailed and intensive analysis of all the attempts made by CEA towards managing solid waste in Sri Lanka. It mainly applied the following qualitative methods for gathering data and information: analysis of documents and texts, web-content analysis, and in-depth individual informal interviews and

discussions with CEA officials. Accordingly, the study first explored secondary data and information by reviewing mainly the CEA and MOE websites, the NEA of 1980 and its amendments, with particular attention to relevant regulations, the CEA Annual Reports (2015–2021), CEA Corporate Plan (2021-2025) and other relevant reports. In this respect, it specifically explored the role of three main divisions of CEA: Environmental Management and Assessment Division, Environmental Protection Division and Waste Management division, which are mostly related to waste management. Then, depending on the data and information reviewed through the above sources, informal discussions and interviews were conducted with CEA officials i.e. the Acting Director of CEA in the Southern Province and officials of the CEA Head Office in Colombo, for more details and clarifications.

Thematic analysis and content analysis were used to produce an expressive analysis for this study, which are considered as the most frequently used methods in qualitative data analysis. Both methods are perceived to have a similar process in the coding of data, even though some differences are demonstrated between them. For example, content analysis has a wider selection of coding approaches and thematic analysis supports deeper immersion (Humble and Mozelius, 2022).

4. ANALYSIS AND DISCUSSIONS

This section elaborates on the legislation, policies, enforcements, strategies, and actions taken, institutional arrangements made by CEA as per the provisions of NEA, and other responsibilities assigned to CEA by the MOE towards managing waste/ solid waste in Sri Lanka. Among many divisions of CEA, this study mainly explores the functions of three main divisions that demonstrate greater contribution in managing waste in the Sri Lankan context, as described below.

4.1 The Role of the Environmental Management and Assessment Division in Managing Waste

Relating to this division, this study mainly investigates the role of the Environmental Impact Assessment (EIA) Unit, with particular attention to EIA and Initial Environmental Examination (IEE) procedures in managing waste.

EIA/ IEE Procedures

Part IV C of NE (Amendment) Act No. 56 of 1988 mandated that all "prescribed" development projects are required to be subjected to EIA, and CEA was assigned the regulatory functions of EIA. Apart from the CEA web site, the list of prescribed projects requiring an IEE/ EIA is published in the Gazette in a timely manner, i.e., Gazette No. 772/22 of June 24, 1993; 859/14 of February 23, 1995; 1104/22 of November 5, 1999; and 1108/1 of November 29, 1999. In law, an IEE is required for a project, and then, depending on what arises out of the IEE, the project proponent is asked to do an EIA. Thus, if the environmental impacts of a project are not very significant, it is enough to do an IEE (a relatively short and simple study), but it is required to do an EIA if the potential impacts of a project appear to be more significant (a more detailed and comprehensive study).

Accordingly, the EIA Unit continues its major regulatory function of administering the EIA/IEE process for all prescribed projects, aiming at mitigating the adverse environmental impacts of these projects and facilitating the prevention and mitigation of waste from the initial stage itself. This includes convening scoping meetings and technical evaluation committee (TEC) meetings, drafting Terms of Reference for EIA/IEE reports, evaluating EIA/IEE reports, and facilitating the public participation process and subsequent decisions and monitoring of approved projects. In 2021, for example, 64 projects were processed, and 15 projects were granted EIA approvals by CEA. They also granted approvals for extensions of six already permitted projects that were not yet completed. The EIA Unit has also intervened to resolve conflicts; for example, in 2021, the EIA Unit attended the 22 complaints and, on request, provided responses to the public on EIA/IEE projects (CEA Annual Report, 2021).

Thus, EIA is clearly recognized in Sri Lanka as an effective tool for integrating environmental considerations into development planning. EIA helps identify the likely effects of a particular project on the environment at an early stage, find ways to reduce unacceptable impacts, and shape the project to be suitable for the local environment. It enables officials to incorporate mitigating measures identified in this assessment into the planning process before commencing the project, thereby reducing harm caused to the environment to the maximum possible level. It thus helps the project proponent achieve its aims more successfully in an environmentally friendly manner. The EIA can, therefore, be considered a major planning tool and one of the key techniques to achieve sustainable development (SD) (NEA, 1980). Thus, it is clear that the EIA process greatly influences society to prevent and mitigate waste generated from such projects and related activities.

4.2 The Role of Environmental Protection Division in Managing Waste.

The division functions with three units: Environmental Pollution Control (EPC) unit, Air Quality unit, and Water Quality unit. The goal of the EPC unit is to maintain and improve industrial pollution control instruments and tools, introduce new tools for pollution control, and increase the income of the CEA through the proper implementation of existing tools. Thus, this section explains the following activities and procedures instigated by the EPC unit towards preventing and managing waste.

4.2.1 Improving Air, Water, and Soil Quality

As specified in the CEA Corporate Plan (2021-2025), Goal 02 stands for protecting, maintaining, and improving the water, air, and soil quality of the environment. Six main strategies implemented to this end are: i) strengthening the provisions given under the legislative framework; ii) effective implementation of the EPL procedure; iii) effective monitoring of procedures; iv) strengthening testing and monitoring of ambient air, water, soil, waste, and materials; v) strengthening laboratory services and technical support; vi) encourage stakeholders to improve environmental quality and respond to emergencies. To streamline such functions, the NE (Protection and Quality) Regulations, No. 1 of 2008 published in the Gazette Extraordinary No. 1534/18 of February 1, 2008, was amended as 2264/17 regulations of January 27, 2022. Accordingly, a person who carries on a prescribed activity in terms of Section 23A of NEA shall only discharge, deposit, or emit waste into the environment in such

a manner that it shall not cause or be likely to cause pollution, under the authority of a license issued by CEA and subject to specified terms and conditions set out therein, and in accordance with such standards and criteria specified in Schedule 1 hereto, in respect of specified industries'.

List IV of this new regulation signifies 'Tolerance limits for the discharge of wastewater or effluent on land for agriculture purposes'. LIST V indicates 'Tolerance limits for the discharge of leachates in respect of either solid waste or hazardous waste landfill into either inland surface water, coastal water, or both'. Under the notes on these lists, it also describes conditions to be followed to maintain and improve the quality of the environment. In this sense, CEA is authorized to take all required measures to minimize the impacts or damages to the environment (air, water, soil, etc.) by going through licensing procedures and legal actions.

4.2.2 Environmental Recommendation (ER) Procedures

Assessing the site's suitability and issuing an ER are the most important procedures adopted by the CEA for non-prescribed activities under the EIA regulations. Relating to all potential industrial sites and the establishment of new industrial activities, apposite parties are advised to obtain ER from the CEA. E.g., CEA has issued 1046, 730, and 822 ERs by providing guidance to control their emissions and discharges in 2019, 2020, and 2021, respectively. In this evaluation, CEA considers the capacity of the area to receive additional pollution loads and waste disposal requirements. This ER provides benefits for both parties: the CEA gets benefits by controlling the possible pollution at the initial stage, and the industrialists get the same if they adhere to the conditions stipulated in the ER. It also facilitates industrialists to avoid difficulties in complying with the standards stipulated by the CEA. Because industrialists normally locate their industries in an arbitrary manner without incorporating precautionary measures. All relevant parties are thus compelled, through such ER procedures, to take preventive measures in advance to mitigate waste to be discharged from such industrial activities.

4.2.3 EPL Procedures

The EPL is a regulatory/ legal tool executed by the CEA under the provisions of the NEA to control industrial discharges and emissions. As per Section 23A of the NEA and NE Protection and Quality Regulations No. 1 of 2008, the Minister determines the *'prescribed activities'* requiring an EPL before commencing or continuing operations and publishes the list in the Gazette in a timely manner, i.e., Gazette Notification No. 2264/18, January 27, 2022, discloses prescribed activities requiring EPLs under four lists A, B, C, and D, with types of industries and activities included in each depending on their pollution potential: high polluting industries - A (33), B (71); medium polluting - C (56); and low polluting - D (39). CEA is authorized for EPLs in lists A, B, and C and delegated power to LAs (Municipal Councils, Urban Councils, and the Pradeshiya Sabha) for EPLs in list D. The validity period of EPL (from the effective date) is one year for lists A and B, two years for list C, and three years for list D.

The main objective of the EPL is to develop an approach for pollution control by preventing and/or minimizing the discharge, deposition, or emission of toxic pollutants or waste from prescribed activities/ industries into the environment. In this respect, CEA has issued 1751, 1242, and 1464 new EPLs covering all provinces and districts in the country and renewed 8473, 7295, and 9041 of ongoing EPLs in 2019, 2020, and 2021, respectively. For the renewal of EPLs, monitoring is carried out by relevant authorities (CEA or LAs) by inspecting the industries at regular intervals and reviewing reports. If a violation of conditions is observed, the applicant or industrialist will be informed to take the required pollution control measures in order to be considered for renewal. After ensuring conformity in all these, renewal of the EPL is considered. In turn, if the industrialist continues to violate the conditions, legal actions are initiated in terms of cancellation or suspension of the EPL, rejection of the application for an EPL, hearing appeals by the secretary of the Ministry, issuing legal notices, and filing cases.

Further, under Section 17 of the Board of Investment (BOI) Act, the CEA contributes to controlling the pollution of industrial activities by providing guidance through concurrence procedures for 884, 688, and 1118 BOI industries and issuing EPLs to 02, 03, and 05 BOI Zones in 2019, 2020, and 2021, respectively, ensuring compliance with environmental standards. CEA has initiated legal action for Seethawaka and Horana BOI Zones for noncompliance of standards (CEA Annual Reports, 2019, 2020, 2021).

In Gazette Notification No. 1533/16 dated January 25, 2008, the implementation of the EPL scheme for low-polluting industries has been delegated to LAs; however, the compliance percentage is less than 50% in the country. Therefore, the cumulative effect on the environment is considerable, as the number of industries in this category is very high. CEA recognized lack of technical knowledge among implementing officers in LAs as the main reason for this and thus conducted 10 training programs to improve the knowledge of LA personnel, covering 4 provinces (Central, Eastern, Northern, and Uva), in 2019 and reviewed the EPL procedure manual in 2020 to give guidance to LAs on issuing EPLs. Towards the same drive, CEA conducted four online training programmes with the Sri Lanka Institute for Local Governance for all the LAs in the country in 2021 (CEA Annual Reports, 2019, 2020, 2021).

4.2.4 Other Actions of the EPC Unit towards Managing Waste

- *Presidential Environmental Awards (PEA) Programme:*

CEA has implemented this programme to recognize and reward the industries that have achieved compliance beyond the existing environmental standards and norms, thereby encouraging them to reduce the pollution load by instigating competition among similar categories of industries. E.g., CEA organized 4 workshops to prepare industries for PEAs, including textiles, rubber-based products, hotels, and food and beverages, and to share experience and knowledge of winners in the past year. CEA received 167 applications under Industries and Business Sector, and 34 enterprises were awarded (CEA Annual Report, 2019). This strategy contributes to mitigating

waste generated by industries while improving the environmental quality of the country.

- *Preparation of the EPL Guidebook:*

  CEA developed guidelines to streamline the EPL Scheme island-wide in 2019.

- *Pollution Source Inventory:*

  It has developed and been implementing in the year 2018 onwards.

- *Low-cost Technology for small and medium-sector industries:*

CEA introduced it in 2019 to overcome financial and technological constraints relating to pollution control. CEA also prepared two technical guidebooks on pollution control for bakeries and limekilns with the technical support of the Industrial Technology Institute.

- *The cabinet memorandum on the Kelani River basin*:

It specifies the limitations on locating high-medium-polluting industries to protect the Kelani River from industrial discharges, and thus, CEA was able to control discharges and emissions mainly to the Kelani River and other receiving environments.

- *Maintaining, regulating, and monitoring the river water quality:*

In collaboration with the Compliance Monitoring Unit of CEA, Colombo and Gampaha district offices conducted a rapid industrial monitoring programme covering 141 industries. Thus, CEA was able to upgrade the existing pollution control methods and calculate the pollution load discharged into the Kelani River. In 2020, water quality monitoring and analysis were carried out in Kalu, Nilvala, Maha Oya, and Badulu Oya. The results could be used as a basis to trace industrial pollution and impose strict control measures. These attempts support maintaining and protecting inland waters from pollution while managing waste.

- *Streamline Gully Bowser Services:*

CEA has initiated a registration procedure to streamline Gully Bowser service providers. It plays a major role in pollution control as it transports industrial effluent to safe disposal sites. E.g., 27 Gully Bowser service providers were registered for 2020/2021, and a training programme was conducted to streamline the service.

In this sense, CEA believes that complying with legislation, standards, and norms in industrial activities may reduce their waste load to the environment by more than 90% from their waste generation (CEA Annual Report, 2019). Thus, it realizes that such measures greatly influence the prevention and management of waste generated from industrial and household activities.

4.3 The Role of the Waste Management Division in Managing Waste

The division deals with the regulatory aspects of hazardous waste, chemical management, and SWM under the provisions of NEA and the other related regulations. It also provides necessary awareness and educational assistance for the

general public on waste management (www.cea.lk). The following sub-sections explain the contribution CEA has made through this division in managing waste.

4.3.1 Scheduled Waste Management License (SWML)

Hazardous waste is identified as 'scheduled waste', e.g. waste from pharmaceutical units, hospitals, including operation theaters, medical laboratories, and research centers; mineral oil and oil-contaminated waste. As per the NEA, all persons involved in handling scheduled waste specified in the regulation (generate, collect, transport, store, recover, recycle, or dispose) must obtain a SWML from the CEA and comply with standards and other criteria specified. To streamline the procedures, in 2009, the CEA published '*Guidelines for the Management of Scheduled Waste in Sri Lanka'* (CEA, 2009). CEA conducted and reviewed ongoing recycling programs on the safe disposal of empty pesticide containers, empty pesticide barrels, bottles, and other chemical containers. In this sense, CEA has issued 273, 201, and 329 SWMLs in 2019, 2020, and 2021, respectively. To make available a database for an effective hazardous waste management process, CEA published 'hazardous waste inventory for the industrial sector' (CEA Annual Report, 2019).

4.3.2 Chemical Management:

As a part of implementing chemical management, CEA issued 60, 40, and 55 environmental recommendations for chemical storages and issued 419, 365, and 413 clearances for certain chemical importations in 2019, 2020, and 2021, respectively.

4.3.3 Electronic Waste Management:

It was revealed that a significant amount of e-waste is collected and dismantled through the informal sector, causing very big potential to create health and environmental impacts. To mitigate such impacts, the Hazardous Waste and Chemical Management (HWCM) Unit of CEA conducted e-waste management programs to regulate the e-waste generated at the household level in Sri Lanka jointly with the regional offices of Puttalam, Batticaloa, and Monaragalala in 2019, with the Department of Postal in 2020, and with western province provincial and district offices in 2021. The collected e-waste was handed over to the licensed e-waste collectors (CEA Annual Reports, 2019, 2020, 2021). It evidences the involvement of CEA in managing e-waste throughout the country.

4.3.4 Solid Waste Management (SWM)

The SWM unit was established in 2018 with the objective of creating a clean and healthy environment through the mainstreaming of effective and efficient implementation of municipal SWM systems in the country. Focusing on the main responsibilities of the SWM unit, this section elaborates on the role of CEA in managing solid waste under three sections: Policy and Technical Interventions; Regulations and Law Enforcement; and Implementation of Special Projects, as described below (www.cea.lk).

I) Policy and Technical Interventions

National, provincial, and district-level initiatives for policies, strategies, guidelines, and plans regarding SWM are made under this section. For example, major activities undertaken during 2019–2021 are indicated below (CEA Annual Reports, 2019, 2020, 2021).

3R (Reduce, Reuse, Recycle) concept on SWM:

CEA promotes and implements this concept mainly through LAs. Towards this end, the island-wide recyclable waste collectors and recyclers database was updated and uploaded to the CEA website. As per the field verification for environmentally friendly waste collection, 177 of the 272 recyclable waste collectors were registered up to November 2019. From 2020 onwards, recyclable waste collection was recorded under three types: registered collectors, BOI industries, and ship waste collectors, and then all such waste was directed for recycling. The SWM unit grants permission by issuing a *"No Objection Letter"* to dispatch plastic and polythene waste generated in BOI industries in Sri Lanka. Also, environmental recommendations for ship waste collectors of non-hazardous or non-contaminated recyclable waste (i.e., plastic, metal, and paper) were implemented and issued for 5 and 17 ship waste collectors in 2020 and 2021, respectively, out of which 11 were renewed for 2022.

Plastic Waste Managing Entrepreneur Training Manual: In collaboration with the Ceylon Chamber of Commerce and the expert in SWM, a 3R training manual for plastic waste management was prepared, and training programs were planned for CEA officials in 2022.

The Glass Waste Collection and Recycling Industry

This was inspected in 2020 and decided to make an agreement between LAs, collectors, and recyclers under the guidance of the SWM Unit of the CEA. Discussions were held at the Excise Department with the participation of liquor manufacturers, and a proper collection mechanism was proposed.

Yoghurt Cup Recycling:

After discussing with yoghurt manufacturers and recyclers to address recycling issues, it was recognized that the recyclability of the yogurt cups has improved by modifying the aluminum foil.

Plastic Free Parks:

Technical inputs were given to the Department of Wildlife through the MOE for the 'Plastic Free Parks' programme in order to reduce plastic usage in all national parks. Also, a detailed plan was developed for the Zoological Garden in Dehiwala.

Plastic/Polythene Garland Replacement with Paper Garlands:

Plastic garland was identified as a widely used 'single use plastic item' in sacred places, i.e., Katharagama Devola. Therefore, with the support of the National Craft Council, more than 100 plastic garland manufacturers in the area were trained to produce paper and natural flower garlands in order to replace the plastic. Further, extensive door-to-door awareness was given in collaboration with the district office

of CEA. With the positive responses, this item was included in the 'banned list of single-use plastics' in 2021.

Solid Waste Treatment and Final Disposal:
CEA technically facilitates SWM projects within LAs for-waste treatments such as composting, recycling, energy recovery, etc. and final disposal.

II) Regulations and Law Enforcement

CEA contributes by providing recommendations to the Ministry for enacting obligatory regulations and then implementing them as per the provisions enforced by the NEA or relevant authority to achieve intended purposes as follows:

Single Use Plastic Regulation 2211/51:
This was published on January 21, 2021, to prohibit the production and use of listed items, aiming to reduce unnecessary usage of plastic by controlling single-use plastic. In this regard, key actions taken by CEA are: i) in 2020, obtained Cabinet approval to ban some single-use plastic items after the grace period; conducted 2264 and 3512 island-wide raids; and detected 156 and 522 violations on commercial use and exhibition for sale of polythene lunch sheets in 2020 and 2021, respectively. (the highest number of violations were in western, eastern, and southern provinces); ii) to minimize the social impacts, all manufacturers of environmentally friendly alternative products were invited to register and promote the alternatives for single-use plastic items; iii) In collaboration with several government bodies, promotional activities on signal use plastic banning were published via leading television channels; iv) more than 100 CEA officers were trained on SWM and assessment of cleanup programmes online; and v) the CEA laboratory obtained the necessary equipment to strengthen its capacity in analyzing micro-plastics (CEA Annual Reports, 2020, 2021).

Regulations on Polythene and Plastic Management 2017- 2034/33-38

In 2017, a polythene lunch sheet banning regulation was published, and biodegradable lunch sheets were introduced as an alternative. Eight biodegradable lunch sheet manufacturers registered with the CEA were renewed and updated in the database on the CEA website (CEA Annual Report, 2021). The government banned using 20-micron polythene lunch sheets in Sri Lanka from September 1, 2017 and strictly re-imposed the ban with effect from January 2023, considering the massive environmental pollution in the country (news.lk). For effective implementation of said regulation, on request, Sri Lanka Standards Institute (SLSI) prepared a compostable lunch sheet standard in 2021, and the CEA invited countrywide all manufacturers and importers of biodegradable and compostable products to be registered with the CEA since they all have to comply with the standards specified by SLSI (CEA Annual Report, 2021).

Further, CEA granted necessary approval for the country's first biodegradable and compostable food wrapping sheets and bags manufacturer, 'Plastic Packaging Pvt. Ltd. (PPP),' and introduced such products to super centers. Over 10 million such products manufactured by PPP are currently used by Sri Lankan major supercenters

under the brand name `Naturplu'. The PPP informed the public that the biodegradable and compostable standard food wrapping sheets and bags are 100% environmentally friendly and suggested consumers throw them in the home compost bin after using them (news.lk).

Plastic Coding Regulation No. 2211/50

This was published on January 21, 2021, with seven groups of cords 01–07 to promote plastic recycling by overcoming challenges faced by collectors and recyclers in identifying types of plastic correctly. As per the Plastic Material Identification Standards specified in the Gazette, any manufactured plastic item shall be marked clearly.

Regulation No. 2034/36 on September 1, 2017:

CEA issued directives to all municipalities (24) to streamline the implementation of this Regulation *"No person shall burn or cause to, allow or permit the open burning of refused or other combustible matters, inclusive of plastics,"* and monitoring is in progress. To streamline the biodegradable product manufacturing and raw material importation processes, applications were called for registration renewal (CEA Annual Report, 2020).

Other actions taken/ to be taken by CEA for SWM:

As per the CEA Corporate Plan 2021-2025, the following actions denote SWM in Sri Lanka:

- *National Waste Management Plan*

To solve the solid waste problems in the next five years, starting in 2021, the following activities were implemented by CEA: i) developing a 'National Waste Management Plan'; ii) implementing a National Plastic Waste Management Corporate Plan: iii) set up and maintain a comprehensive database on recyclable waste, collection, and recycling; iv) monitoring of the waste management activities of LAs, including SWM facilities (compost plants, bio-gas plants, incinerators, landfills, etc.); v) conducting training awareness and promotion programmes on SWM for stakeholders and the public; vi) providing technical guidance for supportive infrastructure facility transfers stations and equipment for LAs as required; vii) conducting research and development on SWM; and viii) Managing Sanitary Landfill-Dompe; ix) establishing compost plants, bio-gas plants, incinerators, and waste collection centers in all LAs, including recycling processes. Further, it is envisaged to implement regulations and guidelines on hazardous waste management.

- *New penalty provisions and novel concepts*

CEA has taken steps to amend NEA by introducing 'Polluter Pays Principle' by publicizing 'Load Based Licensing Scheme' and the Extended Producer Responsibility (EPR) regulations for selected products.

All such initiatives and attempts made by CEA greatly facilitate managing solid waste (SW) in Sri Lanka and minimizing the impacts and damages to the environment. It

also facilitates the adoption of modern policy reforms in the NEA and the current development trends in the country.

III) SWM-related Special Projects/ Programmes/ Plans:

CEA is involved in initiation, operational maintenance, and improvement activities on the following projects/ plans at the national and regional levels towards managing SW and mitigating pollution in Sri Lanka.

'PILISARU' National SWM Project:

This is a large-scale national-level project implemented by CEA in 2008–2018 to facilitate, mainly, LAs. The theme of the project is "Year 2018: Waste-Free Sri Lanka," and the estimated financial provisions were 5.675 billion to be accumulated mainly from the General Treasury (Dassanayaka, 2011). Even though the entire responsibility for SWM lies on LAs under respective legal enactments, due to poor attention paid by LAs and their inadequate facilities, CEA has launched this project by generating ideas and mechanisms for operations and allocating required funds under the direction of MOE. CEA has taken initiatives by making LAs and other government institutions aware of the necessity of formalizing, particularly the municipal SWM processes in Sri Lanka. In this attempt, CEA called proposals from LAs, forces, hospitals, education institutions, etc., evaluated them, and then assisted these institutions based on identified necessities, i.e., obtaining funds, buildings, instruments, equipment, training for labor, etc. The overall guidance for the implementation of the Pilisaru program has been provided by a high-level National Committee on SWM (called the 'National Pilisaru Platform') co-chaired by the Secretaries of MOE, Local Government, and Provincial Councils.

The major activities performed by CEA under this project are as follows: i) provision of proper waste management facilities for LAs; ii) fixing of compost and biogas plants for hospitals and other government institutions, i.e., MCs, PSs, Ragama medical faculty, air force, army camp iii) provision of necessary instruments /equipment for LAs where compost sites are being operated i.e. tractors, tailors, shiver machines, excavator; iv) provision of compost bins at low cost for LAs to promote home composting; v) establishment of waste recycling banking system negotiating with the SANASA Development Bank, vi) conducting education and awareness programs through TV, Radio, Newspapers, posters, leaflets etc.; Inclusion of waste management subject for school curricular; and Discussions held with National institute of education (NIE) to include this to subjects from years 6 to 9; vii). strengthening recycling by establishing waste collecting centres and collection network for metal, plastic, glass, and paper wastes viii) technical support, institutional strengthening, and capacity building; ix) construction of low-cost sanitary landfills for disposing of residual waste (facilitating LAs to dispose of residual wastes on a cluster system); x) conducting awareness programs on waste segregation at the LA level (covering MCs and LAs to encourage household dwellers for waste separation); xi) project coordination, monitoring and evaluation, and taking legal action (all compost sites are being monitored monthly through divisional environmental officers

in CEA district offices and taking legal action against LAs that do not carry out proper SWM practices) (www.cea.lk; Dassanayaka, 2011).

In this project, the construction of 'Compost Plant Complexes' was considered one of the major tasks undertaken, covering several provinces such as Western, Southern, Central, North Central, Northern province (Dassanayaka, 2011). Issues identified through this project on SWM are being discussed with the relevant LAs as lessons learned from the project. Inadequate infrastructure is one of the main barriers to managing municipal waste. (Action Plan, 2021-2025).

National Action Plan on Plastic Waste Management 2021–2030:

CEA has given technical input and is actively involved in preparing this plan, which was published in 2021 by the MOE. The main objective of this plan is to assist in achieving the National Waste Management Policy's vision of '*Enabling Healthy Life and a Cleaner Environment for All'.* To this end, the key activity of this plan is to facilitate the collection of segregated plastic waste and the recycling of plastic waste as a profitable business to produce quality raw materials for the plastic industry. MOE has played a leading role in preparing and initiating this plan, and CEA represents the project team for developing the plan. CEA, together with MOE and the Marine Environment Protection Authority, has authority and responsibility for implementing its key activities. CEA's role includes: regulator of all plastic waste management-related work; facilitator; coordinator; and enforcer of related laws for implementation of the plan (MOE, 2021).

Gampaha District Integrated SWM Project:

CEA initiated this project in 2018 to provide a total solution for the solid waste generated in the Gampaha District, covering 9.49 hectares of land at Pethiyakanda, Gampaha. The total estimated cost of the project was Rs. 989 million. It facilitates for nine LAs to manage their municipal and industrial waste through five main components: i) Composting Yard (to provide a solution for the degradable organic waste); ii) Waste Plastic Pyrolysis Plant (to manage waste plastic and polythene in the capacity of 100 kg/hr). The plant produces pyrolysis oil as a byproduct, which can be used as fuel; iii) a recyclable waste collection center (five containers were installed in different places in Meerigama Municipal Council and Pradesia Saba, Kelaniya Pradesiya Saba); iv) a sanitary landfill (to manage inorganic non-recyclable waste in an environmentally friendly manner); and v) training and awareness (conducted a three-day workshop on SW for development officers in Gampaha district) (CEA Annual Reports, 2018, 2019).

Dompe Sanitary Landfill (Green Park Integrated Waste Management Center):

This is the first Sri Lankan landfill site managed by the CEA since 2015. This center consists of a sanitary landfill site (dumping capacity of around 90 tons per day), a composting site, and a training center. CEA granted USD 1.5 million for the project out of a total estimated investment of USD 6 million, and the rest (USD 4.5 million) was granted by the Korean government (CEA Annual Report, 2018). CEA facilitates the disposal of final non-recyclable waste in Dompe PS and final non-hazardous

waste in some selected industries located in Dompe PS at a rate of Rs. 5,000 per ton charged for the tipping fee. CEA has also assisted with some amount of Colombo municipal waste dumping since 2017 at Rs. 2000/ton.

Moreover, CEA facilitates 'Site Compost Yard' to produce composts using degradable wastes, convert degradable organic parts of the waste into valuable soil conditioners, and sell them to farmers. In 2018, CEA started facilitating some selected LAs from Gampha district to dump their non-degradable, non-recyclable, and nonhazardous wastes (strictly separated waste from institutions) for land fill. Further, in 2018, glass wool dumping from some institutions took place and accepted about 25 tons to the land fill site. Other than the industries that belong to the Dompe PS area, on request, CEA has made agreements to dump specific waste categories from industries.

Other activities implemented by CEA under this project include: site landscaping and organic vegetable production; and providing training and education facilities in the Green Park to obtain practical knowledge on waste disposal, composting, and recycling for many groups, such as university students, school students, and people engaging in duties related to waste management (in 2018 many groups from universities, schools, and newly recruited PHI students visited the site and gained knowledge on waste management). Moreover, staff from Rathnapura PS, Polonnaruwa PS, and Jaffna MC participated in hands-on training on composting and waste disposal conducted by Green Park staff. (CEA Annual Report, 2018).

'SURAKIMU GANGA' National Environmental Programme:

CEA recognized that the long-term sustainability of the rivers has become questionable due to various threats to them and many sources of river pollution, so that it is difficult to obtain clean water for drinking and other purposes as well. CEA thus implemented the 'Surakimu Ganga' program to address the problems and issues identified during the survey conducted in 2020, inspecting 10,377 locations relating to 103 rivers in Sri Lanka that need attention. The survey reveals the following factors that could affect river water pollution: discharging domestic effluent, solid waste, hazardous waste, wastewater sludge, and industrial waste into rivers; soil erosion and riverbank erosion; unauthorized and informal construction; illegal river reservations; unauthorized and uncontrolled sand and gem mining. The specific objective of the project is to conserve water resources while ensuring water quality, which is a key component of environmental conservation.

This program is implemented through three main committees: i) the Inter-Ministerial National Steering Committee at the national level (the Secretary of the Committee is the Director General of CEA); ii) the 25 committees at the district level (chaired by the Director, Deputy Director, or Assistant Director of the District Office of CEA); and iii) the 310 committees at the regional level (established and responsible for coordinating all relevant institutions). The primary role of the Regional Committees is to formulate an action plan at the local level for nationally identified issues related to rivers and to present them through project proposals. For this purpose, CEA has prepared "Surakimu Ganga" Guidelines. After going through the Project Evaluation

Committee in 2021, 50 projects were approved, and funds have been released for implementation, covering all the provinces of Sri Lanka. In this sense, a large number of activities were implemented across all provinces to protect rivers and surroundings, all of which facilitate managing SW in respective areas while minimizing pollution.

Surakimu Ganga National Inauguration Ceremonies were held, first in 2021 at the historic Ruhunu Kataragama sacred area and then in the other eight provinces based on the rivers specific to each province, thereby giving the program awaited publicity. Initiatives made towards managing SW at Kataragama sacred area include: making arrangements for sand mining only through proper methods with the permission of the Divisional Secretary; installing garbage bins for waste collection; disposing and recycling of remained fruits by the Pradeshiya Sabha; launching promotional programs to encourage people to offer only natural or recyclable flowers and garlands instead of plastic flowers and garlands; and putting a waste trap across the river 'Manic'.

10 Environment Protection Areas (EPAs)

CEA has declared EPAs as per the provisions of sections 24 C and 24 D of the NEA of 1980 by an order published in a Gazette notification. The responsibilities of CEA on EPAs are: i) preparation of management plans and implementation; ii) Assessment of project reports; iii) preparation of guidelines; iv) approval of prescribed activities; v) Monitoring activities; and vi) awareness of stakeholders, institutes, and the public. Accordingly, CEA shall exercise, perform, and discharge any powers, duties, and functions related to planning and development within such protection areas in order to manage SW and pollution in such EPAs (www.cea.lk; CEA Annual Report, 2021).

National Post Consumer Plastic Waste Management Project:

CEA implemented effective waste management programs by utilizing General Treasury funds in 2015. It includes: i) construction of plastic waste recycling model plants district-wise; ii) construction of recyclable waste storage centers, particularly in places where many people gather at one time and there's no waste storage facility to store the waste until they are dispatched for recycling, e.g., 'Sri Padaya'; iii) strengthening of programmes of private sector recyclers; iv) training, development, and awareness programs (CEA Annual Report, 2015).

Project for the Construction of Solid Waste Disposal Facilities in Sri Lanka:

CEA has planned to construct several integrated waste management solutions in the form of scientifically proven sanitary landfills as final disposal facilities for municipal solid waste in 2016. CEA requested financial assistance from the Export-Import Bank of Korea under the Export Development Cooperation Fund loan facility to construct four sanitary landfills in selected cities in Sri Lanka. Project scope covers: i) designing and constructing sanitary landfills in each of four locations: a) Meegaswewa in Medirigiriya; b) Keerikulama in Anuradhapura; c) Keerimalai in Jaffna; d) Monroviawatta in Hikkaduwa; ii) establishing plans for leachate treatment; iii) establishing plans for landfill gas management; iv) estimating waste; v) evaluating

waste disposal methods and capacity/dimensions of facilities (CEA Annual Report, 2016).

Accordingly, the above analysis demonstrates the way and extent to which the CEA, coordinating with provincial and district offices, contributes to managing solid waste in Sri Lanka. It also gives insights into the scope of the legal framework enacted in the Sri Lankan context and the role of CEA in managing solid waste, in complying with such legislation, government strategies and policies. In this regard, NEA provides all required legal provisions and, accordingly, the most important regulations executed by CEA include EIA, IEE, ER, and EPL procedures. As detailed in the above analysis, the CEA has taken a series of actions/ strategies, particularly relating to the three divisions considered, conforming to the legal framework enforced by the MOE towards managing solid waste in the country.

Other important measures taken by the CEA include conducting training and awareness programs, and consultations; practicing new concepts, i.e., the 3R concept; and using motivational devices, i.e., Presidential Environmental Awards. The CEA has also implemented long-term plans as evidenced by the CEA Corporate Plan (2021-2025) and special projects. Further, the CEA provides recommendations to the MOE to initiate new regulations, amend existing regulations, and implement them to streamline waste management practices in the country. Moreover, the above analysis demonstrates the outcomes/ performance (as evidenced by CEA annual reports) achieved by the CEA relating to SWM in the country.

Accordingly, the CEA facilitates the relevant parties including LAs, industries and households by providing necessary services with proper guidance and motivations to establish and maintain effective SWMs in the country. CEA thus contributes to a great extent, to preventing and managing any type of waste discharged typically from industrial activities, human activities in common areas, and households in general. As per the agency theory, the above analysis signifies the way and the extent to which CEA has performed its role, on behalf of the government and society, towards managing solid waste in the country.

5. CONCLUSIONS

It is realized that health and environmental issues are largely caused by improper or haphazard waste management practices and that finding sustainable solutions for them is a challenging task. As a result, waste management has become a daily topic, particularly in the urban areas of Sri Lanka. This study thus explores the contribution of CEA as the governing body to regulate environmental legislation enacted by NEA, in managing solid waste in Sri Lanka.

This study concludes that CEA, coordinating with provincial and district offices, contributes to managing solid waste in Sri Lanka conforming to the legislation enacted through NEA, and government strategies and policies. In this regard, NEA provides all required legal provisions and accordingly, the most important regulations executed by the CEA include EIA, IEE, ER, and EPL procedures. In turn, considering the necessity and practical issues identified relating to existing legal frameworks, policies, and procedures, the CEA provides recommendations to the MOE to amend

existing regulations and/ or initiate new regulations and then implement them by the CEA to streamline waste management practices in the country.

This study concludes that CEA's role impressively contributes to minimizing and controlling the volume of waste and its polluting density, from the initial stage before commencing high- medium-polluting industrial activities and large-scale projects and also during the process of industrial activities. Similarly, by delegating power to LAs, CEA assists in managing waste/solid waste from low-polluting industries and households. Through these attempts, CEA directs authorized bodies to identify the likely effects of a particular project or industrial activity on the environment at an early stage, to find ways to reduce unacceptable impacts, and to apply preventive measures before commencing the project/ industrial activities, thereby reducing harm caused to the environment in the maximum possible manner. It also helps the project proponents and industrialists achieve their aims more successfully in an environmentally friendly manner. Thus, the CEA's role stresses that it is rather important to take protective measures in advance to minimize the extent of waste and its polluting density than to implement and monitor WMSs after generating waste.

Finally, this study concludes that all such attempts made by the CEA contribute extensively to mitigating environmental pollution while managing solid waste generated from industrial and household activities, thus improving the health and environmental quality of the nation. Consistent with the agency theory, this study signifies the way and the extent to which CEA has performed its role, on behalf of the government and society, in managing solid waste in the country.

Theoretical and Practical Implications

This study provides directions for future researchers to identify potential areas/ aspects relating to WMSs, procedures, and practices of different socio-economic settings. This provides avenues for them to investigate the way and the extent to which government authorities and other relevant parties are involved in establishing and implementing effective WMSs for the nation. It also helps future researchers evaluate the legal framework of waste management, its strengths and weaknesses, and make suggestions for amendments to existing legislation and enforcing new legislation towards establishing effective WMSs for a specific context or the nation.

The findings will help relevant authorities, i.e. MOE, CEA, and LAs make policy decisions, strategies, and actions to improve the existing systems and initiate new ones toward maintaining effective WMSs in Sri Lanka. It also directs government authorities to review existing legislation and policies and to identify the necessity of making amendments to them and/ or enacting/ initiating new legislation/ policies to strengthen WMSs and procedures and take action accordingly. In turn, these findings provide valuable insights for waste generators, collectors, and recyclers to be more attentive to their responsibilities, legal compliance, and potential for maintaining suitable WMSs. This study would help people and relevant authorities learn about the value of waste, the way of creating jobs attracting investors relating to waste management and earning money for the country, thereby improving the quality of the environment and lives. The application of effective WMSs and methods for a certain

region/country might attract tourists from diverse places worldwide that contribute to the economic growth of that region/ country, like Sri Lanka.

Limitations and Suggestions for Future Researchers

This study particularly investigates the role of the CEA, empowered through legislation enacted by NEA, in managing solid waste in Sri Lanka. This study confines mainly to secondary data and thus, where necessary, it uses primary data gathered through informal discussions and interviews with CEA officials for more details and clarifications. Data and information gathered by reviewing documents, reports etc. is particularly limited for the period from 2015 onwards.

This study did not explore the practical situations and issues faced by CEA in establishing, implementing and monitoring WASs for the nation. In turn, this study did not focus on the strategies and actions of waste generators, waste collectors and recyclers, even though their contribution is imperative in establishing effective WMSs in the country. Among many divisions of CEA, this study predominantly explored three divisions: Environmental Management and Assessment Division, Environmental Protection Division and Waste Management Division, which demonstrate greater contribution to waste management. Other divisions of CEA that were not investigated in this study may make a certain contribution to waste management. Moreover, this study did not focus decisively on difficulties/ challenges faced by related parties i.e., CEA, LAs, waste generators, collectors, and recyclers, in implementing waste management strategies and actions; all such unexplored areas notified above are exposed to future researchers. Also, it suggests undertaking future research on the same phenomena under investigation, relating to different socio-economic contexts demonstrating developing and developed countries.

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