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ORIGINAL ARTICLE

Challenges and opportunities for the recycling industry in developing countries: the case of Sri Lanka

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Abstract
The paper identifies why the recycling industry is deficient in Sri Lanka from the viewpoint of the integrated sustainable waste management model (ISWMM). ISWMM identifies from a broad perspective the complex and multi-dimensional challenges and solutions in the recycling industries in developing countries. The focus of this study is on all types of recyclable waste generated by all the actors in a developing economy well beyond the commonly focused municipal solid waste. Data were collected from interviews, document analysis and site visits. The challenges for the recycling industry stem from various upstream and downstream actors in the recycling value chain (broadly stakeholders), waste system stages and enabling environment. Sri Lanka, far from being a circular economy, faces many social, environmental, and economic problems. They need remedial action based on these challenges through awareness creation, capacity building, investment in infrastructure and technology, law enforcement and policy implementation, international collaboration, private–public partnership, fiscal policy support, and industry formalization. Thus, the solutions call for a multi-faceted and all stakeholder-inclusive approach.

Keywords Developing countries · Informal sector · Integrated sustainable waste management (ISWM) · Recycling · Sri Lanka

Introduction

Proper waste management has become a key issue in achieving most of the sustainable development goals (SDGs) such as making cities safe, resilient and sustainable (SDG 11) and ensuring sustainable consumption and production patterns (SDG 12) [1]. These aspects are particularly evident in many developing Asian countries in the face of rapid economic growth, unplanned urbanization, and urban population growth [2, 3]. The problem of waste management lies inside developing nations who are yet to inculcate any government or private party influence in finding a solution for waste management. In managing waste, recycling is one of the most desirable options as it enables the recovery of precious materials. Countries like China, India, Indonesia, Sri Lanka, Pakistan and Bangladesh recycle only a fraction of waste originating from a limited number of sites such as schools, urban households, and commercial entities [4]. As a developing Asian country, Sri Lanka is facing serious difficulties with regard to waste management including recycling [3, 5, 6]. The evidence is that the recycling industry in Sri Lanka is underdeveloped like in many Asian countries (see [7, 8]). Local authorities especially have failed to cope with the increasing problem of solid waste management [5, 9]. Recently, in April 2017, a tragic landslide at the Meethotamulla garbage dump outside Colombo took the lives of at least 26 people while burying 45 houses [10]. The benefits of recycling for a developing country like Sri Lanka are many and fall into economic, environmental, and social areas, which are all interlinked. On the other hand, recycling creates a healthy market for basic resources for industries, particularly in the developing countries of Asia [2]. However, there is a dearth of studies that specifically focus on the recycling industry in Sri Lanka and other developing countries from a broader and multi-dimensional perspective. This study aims to fill this gap by identifying the problems and opportunities for the recycling industry in Sri Lanka.

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This paper is structured as follows. "Integrated sustainable waste management model (ISWMM) for recycling" presents the literature review and theoretical model followed by which materials and methods are presented. Analysis and results are presented in the subsequent section. "Strategies for overcoming the challenges" provides recommendations. The last section gives the conclusions.

Integrated sustainable waste management model (ISWMM) for recycling

The Integrated Sustainable Waste Management Model (ISWMM) is used in the study to map the different stakeholders and broader environment to identify challenges and solutions for recycling waste. It facilitates the study of complex and multi-dimensional waste management systems in an integrated and a systematic way [4, 11]. This model has been used particularly in developing countries to analyse waste management systems [11–13]. ISWMM was developed by WASTE, Advisers on Urban Environment and Development, in the Netherlands and other organizations working in developing countries in the mid-1990s [13] to overcome the shortcomings of traditional waste management. It emphasizes the following three dimensions [12] of a waste management system, or in this case, more specifically, a recycling system (see Fig. 1) [4, 11]:

a. Stakeholders involved in the waste management process
b. Waste system elements/stages
c. Lenses/aspects in the environment (enabling environment)

In this model, key stakeholders are the individuals and organizations that have a stake in waste management [11, 13]. In the context of recycling, these stakeholders are the households, commercial businesses, intermediaries, government, local government authorities, media and NGOs. Local government institutions are recognized as the key player in developing infrastructure and promoting recycling practices among the people [14]. However, in developing countries, outside local government there are many other stakeholders including informal sector waste pickers, itinerant waste buyers, intermediate dealers, wholesalers, recycling enterprises and end-user industries of recycled materials [11]. The informal sector is vital for the recycling industry as it offers part-time small business opportunities such as waste collection and transport to recycling premises [15–18].

The second dimension of the ISWMM model, elements/stages include core phases of waste management such as waste generation, separation of waste, treatment, recycling

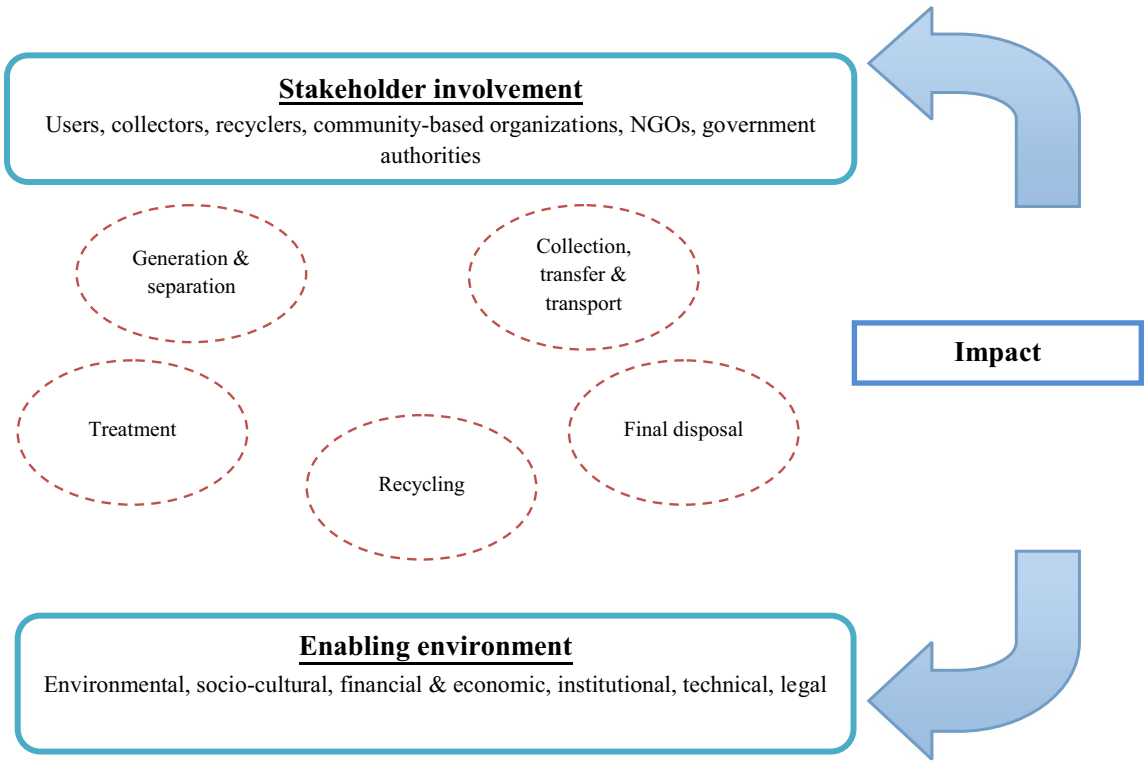

Fig. 1 Integrated sustainable waste management model. Source: Based on Guerrero et al. [4], van Klundert and Anschütz [11]

and final disposal. They represent stages of the movement, or flow, of waste materials [4, 11] from the point of origin to the final users of recyclable material. Earlier studies show that collection, transfer and transport practices are affected by improper collection systems, poor route planning, lack of information about collection schedules and other factors in the enabling environment [19–21].

The third dimension of the model, the enabling environment represents factors which both trigger and hinder recycling initiatives in an economy. It includes environmental, institutional, financial–economic, political and legal, social–cultural and technological environments [11]. The integrated approach in this model also means looking at all six aspects of waste management in the evaluation and decision-making processes [12]. There should be policy level and institutional support to make the recycling industry attractive especially for small sector recyclers [16, 17]. Waste collection is a profitable practice but recycling is not because of the high capital investment it requires unlike in waste collection. Therefore, financial–economic and technological factors can hinder waste recycling in developing countries [14]. Paul [22] observed that attitude, a part of the broader social–cultural environment, can affect the level of and the capacity for recycling. This could have a negative impact particularly in the developing countries. The literature suggests that technical factors affecting the system are lack of technical skills among personnel within municipalities and government authorities [21], deficient infrastructure [19], poor roads and vehicles [20], insufficient technologies and reliable data [23].

Materials and methods

The data for this study were collected from interviews, documents and site visits from May 2015 to September 2016. The semi-structured interviews were conducted with recyclers, households, government institutions, municipal councils, waste pickers and intermediate waste buyers. 15 semi-structured interviews were conducted both face-to-face and over the phone with 9 formal recyclers (see Table 1). Permission of the interviewees was obtained for later transcription of the records. Each interview took 30 to 45 min on average. The questions were mostly open-ended so as to get clear and detailed answers. Further, 22 households in several local government areas, 12 waste pickers and 7 intermediate waste buyers, 4 officials of 2 municipal councils and 2 government institutions were also interviewed. Most of these interviews were not recorded either due to practical limitations or interviewees' unwillingness. However, the researchers took down notes during or after the interviews.

The researchers also visited factories, recycling plants and collection centres to obtain a better understanding of the recycling processes. These on-site observations also served as a very important source of information for analysis and synthesis of interview data. Some of these processes were videoed and photographed with permission. Various other documents such as raw data available at Central Environmental Authority (CEA), information given by former senior officials of local authorities, newspaper articles and web sources were also analysed as a means of triangulating the data. The collected data were analysed based on the three dimensions of ISWMM.

Results

Status quo of the recycling industry in Sri Lanka

As with any other developing nation, the Sri Lankan recycling industry is also comprised of a complex web of many stakeholders [4, 11, 13] (see Fig. 2). The actors of the Sri Lankan recycling industry include households, commercial organizations and other entities (waste generators), municipal councils, informal and formal waste collectors, waste buyers (downstream intermediaries) and primary and value-adding recyclers (main hub), upstream intermediaries, and consumers and businesses that use the recycled products

Table 1 List of formal recyclers interviewed

Recycler	Recycling material	Location	Main contact person/s for interviews
Company A	Plastic/polythene	Mulleriyawa	Owner, marketing director
Company B	Plastic	Wellampitiya	Factory manager
Company C	Plastic	Homagama	Factory manager, finance manager
Company D	Plastic	Wattala	Owner
Company E	Paper	Wellampitiya	Marketing director, factory manager, assistant marketing manager
Company F	Polythene/plastic	Wattala	Owner
Company G	Total waste management	Katunayake	Head of finance, general manager
Company H	Glass	Horana	Factory manager, production manager
Company I	CFL Bulbs	Homagama	Factory manager

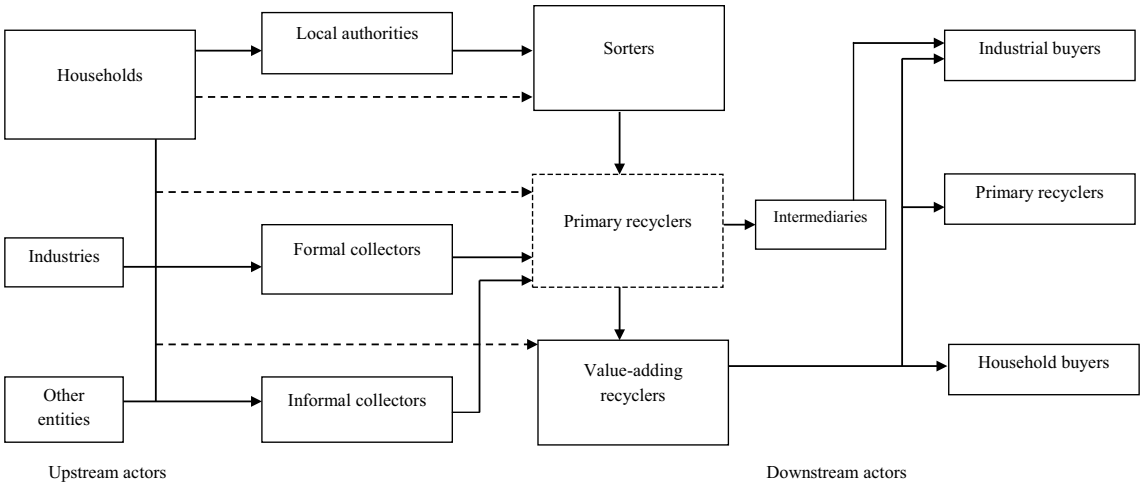

Fig. 2 Recycling value chain in Sri Lanka

(end consumers). Households, industries and other institutions such as schools and hospitals are the main providers of input for the recycling industry in Sri Lanka. Then there is a range of channels through which the recyclable waste is collected, which includes local authorities, formal collectors and informal collectors like many other developing countries [16–18]. While the household waste is collected by all three types of collectors, industrial waste is mainly collected by the formal collectors. This is because the companies, motivated by the need to meet stakeholder pressures as a means of legitimizing the process, are keen to dispose of their waste responsibly through formal channels.

Currently, in Sri Lanka, only a few and least harmful categories of waste such as paper and polythene, plastic and glass are recycled. There are a few recyclers who now focus on e-waste [24]. Plastic is the least developed segment in the Sri Lankan recycling industry. Only a few small players operate in this segment in preliminary collection and basic processing for exporting without a final product.

As at now, there are 210 registered waste collectors in the country [25] as shown in Table 2. Though registered as recyclers, the majority of them are merely waste collectors who supply waste materials to the large recycling entities for further processing. Only a very few entities are involved in only recycling (primary recyclers) and even a fewer number of organizations offer at least a minor value-added output (value-adding recyclers).

Challenges for the recycling industry

In this section, the challenges for recycling industry are analysed based on the three dimensions of ISWMM, i.e., stakeholders involved in the recycling industry, recycling system elements/stages and lenses/aspects of the recycling environment.

Table 2 Registered plastic polythene collectors and recyclers in Sri Lanka. Source: CEA [24]

Geographical distribution	No. of entities	Nature of business		Status	
		Collector	Recycler	Active	Inactive
Central	15	12	3	11	4
Eastern	2	1	1	1	1
North Central	5	5	–	2	3
Northern	2	2	–	1	1
North western	7	5	2	6	1
Sabaragamuwa	2	2	-	1	1
Southern	13	10	3	10	3
Uva	3	3	–	3	–
Western	161	81	80	147	14
Total	210	121	89	182	28

Challenges involved with stakeholders

As the main waste generators, Sri Lankan households hardly sort out waste at the point of origin (see Fig. 3 that provides an example on how collectors encourage sorting). This is mainly because many households are unaware of the need, availability of recyclers (waste collectors) or lack of regulations. Further, the need for sorting out waste has not been emphasized adequately by the relevant parties such as governments or local authorities. Although this is the general situation, it is now changing in some municipalities which demand that the waste be separated. Contrary to this, commercial entities generally sort out waste at the point of origin as part of a corporate social responsibility (CSR) activity (see Fig. 3).

Waste is collected and delivered to recyclers through formal and informal waste collectors. In addition to the registered recyclers, there are many unregistered small-timers who engage in waste collection activities on a part-time and full-time basis. Being dominated by the informal sector similar to that of many other developing countries [16–18], waste collectors only provide a basic service of collecting and delivering the waste to recyclers. Most of them either collect one or a few types of waste items such as glass, steel or paper. This poses a challenge for the households and commercial industries since they have no way of disposing of the rest of the waste items. Further, the waste collectors do not add value such as cleaning or sorting during the process of transportation as in many other developing countries. Hence, the lack of value addition provided by the downstream actors is one of the key challenges faced by the recycling entities.

Recycling entities form the hub of the recycling industry in Sri Lanka. Due to unsorted waste at the point of generation, recyclers are compelled to spend additional time to sort out the waste even into major categories such as paper, polythene, plastic and glass. Consequently, sometimes these recyclers end up having irrelevant inputs (e.g., plastic recycler having a considerable amount of glass waste). Moreover, the technology used for their recycling processes is at a primary level and thus value addition for the recycled materials is far less than market expectations. Hence, they have found it difficult to capture the market over products made out of virgin materials. On the other hand, the government as a key stakeholder provides minimum support for the development of this industry. Like in many other countries [11, 13, 14], in Sri Lanka too, the absence of environmental policies and laws and regulations with regard to recycling is a major obstacle.

Challenges involved with stages/elements of the recycling system

Waste generation and separation In general, the majority of Sri Lankan households do not separate waste at the generation stage. On the other hand, commercial entities exhibit relatively developed waste segregation practices. Other entities such as schools, hospitals and other public institutions practise mixed levels of waste separation. However, any waste separation at these entities is largely driven by internal motivations rather than any policy-level drive. When waste is separated, it is often sorted into several basic categories: food, paper, polythene/plastic and glass. Irrespective of these different practices, mixed waste is the major problem at the initial stage for the recycling industry (see Fig. 4).

Collection, transfer and delivery of recyclable materials Collection and delivery of waste materials in Sri Lanka are done in different ways from municipal councils to formal and informal collectors. The well-established collectors and municipal councils use their own vehicles for transportation. However, most of these vehicles do not have the facilities and capacity to store the different types of waste (see Fig. 4). Additionally, the poor infrastructure poses a challenge for waste collection at rural levels. On the other hand,

Fig. 3 Formal waste collector, who offers a free sapling of fruit when plastic and polythene is handed over as a means of motivating households/schools to sort out waste (left photograph) and hotel uses a separate sorting system for waste collection (right photograph)

Fig. 4 Mixed waste before collection (left photograph) and a delivery vehicle without facilities for separate storage of waste (right photograph)

most of the waste collectors, especially the municipal council workers who are usually appointed on political patronage rather than any qualification or merit, are not provided with any training for collection or sorting as identified by [21]. Even if the waste is sorted at the point of collection, it can be later mixed due to these reasons. The majority of recyclers, therefore, buy the input materials from collectors with impurities and water.

Treatment and recycling process Once the waste items arrive at the recycler's facility, a preliminary screening is done such as manual cleaning of plastic bottles by removing of any filled water and hard pasted labels. In the secondary screening, the items are graded according to quality. This again highlights the lack of value-added services provided by the intermediary players in the recycling value chain. After the screening process, the waste materials go through various processes depending on the nature of the materials. For instance, polythene is broken into small pieces during the grinding process before the palletizing process. Then the pellets are used to process various products such as small sockets for electrical needs, flower pots for gardening purposes and polythene bags (see Fig. 5). However, it is clear that the Sri Lankan recyclers perform minimum processing of recyclable materials or produce non-advanced products for end markets. Hence, this limited value addition lowers the return on investment of the recyclers [14]. Similarly, the recyclers, on the other hand, face the problem of not having sufficient quantities of material for recycling. This situation reflects a considerable imbalance between supply

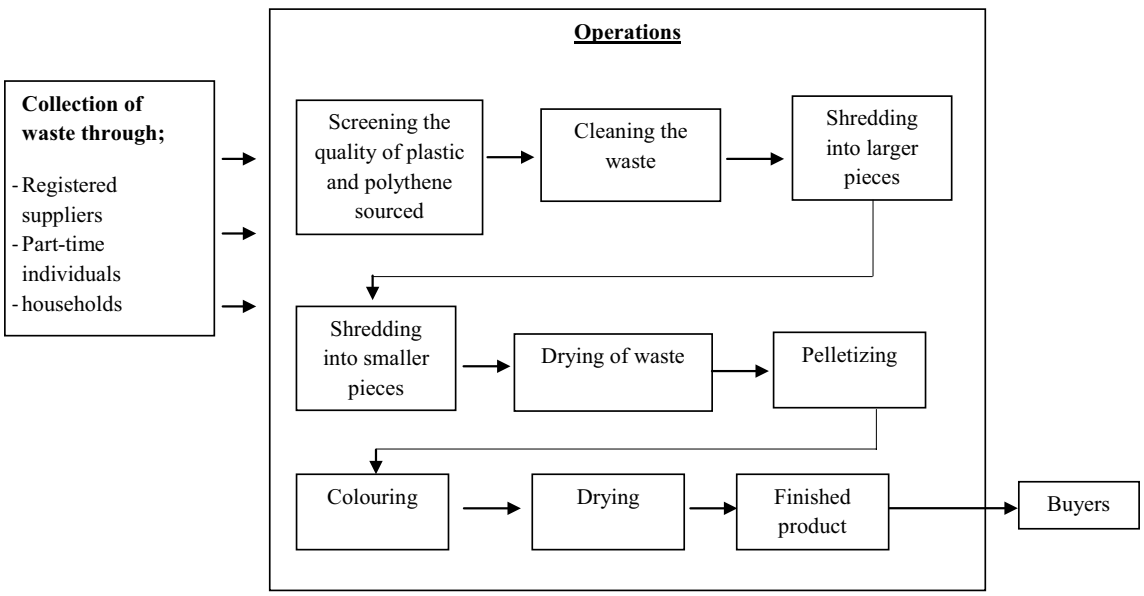

Fig. 5 Recycling process of a plastic/polythene recycler

Fig. 6 Open storage of waste materials until processing (left photograph) and plastic (PET) bottle recycling facility, where a recycler uses labour intensive methods (right photograph)

and demand as there is a huge amount of waste going into landfills without being properly treated when recyclers do not have enough materials for processing.

Challenges involved with enabling actors/lenses

Political, legal and institutional environment The absence of a national policy framework or even broadly for waste management is a major challenge for developing the recycling industry in Sri Lanka. The absence of legislation and more importantly effective implementation of any existing government and municipal level environmental policies/laws is another barrier. Lack of specialists to advise the government and insufficient data are other related issues. Further, government support by way of tax concessions, valued-added tax (VAT) exemptions, or capital allowances for investment in the industry has not been provided for the recyclers to make the industry financially viable. As identified in other countries [19–21, 23], lack of infrastructure such as provision of colour-coded bins for waste collection, dedicated industrial zones and waste management facilities for recycling plants has also led to many large players reducing their scale and operating capacity.

Social–cultural environment Lack of consumers is another major challenge for the recycling industry. The entire process of reaching the household, industries and other entities, creating awareness, sourcing and processing waste is done by many recyclers. In addition to increasing the cost of operations and posing additional administrative challenges (supply-side challenge), recyclers are unable to get a proper market value for their recycled end-product (demand-side challenge), as Sri Lankan consumers (and business entities even) always place less value for the products made out of recycled materials unlike consumers in developed countries, as suggested by Paul [22].

Ecological environment With a tropical climate, the Western Province of Sri Lanka receives an annual average rainfall above 2000 mm [26]. Since this is the geographical area in which the highest waste generation takes place and almost all the recycling facilities are located, recyclers face major challenges due to this climatic condition. In Sri Lanka, household waste is usually stored on the roadside until delivery vehicles arrive, the majority of which are not covered. Further, due to inadequate in-house storage capacity, recyclers usually store waste material in open areas until processing (see Fig. 6). All these conditions coupled with high humidity and dust due to the climatic conditions pose a major challenge for the recyclers.

Financial–economic and technological environment Due to lack of access to and use of advanced technology many recyclers use outdated processing techniques or manual labour to process the materials [23]. Due to this, recycling entities are not capable of producing value-added products that meet market requirements (see Fig. 6). On the other hand, in developed countries, the practice is for consumers or households to pay a price and dispose or give waste to waste collectors. In contrast, Sri Lankan recyclers have to pay the households to get recyclable materials. Since this is an additional cost, the financial position of the recyclers is worsened. Further, there are no concessionary loan facilities or financial support for them from banks or financial institutions. This limits their access to capital which, in turn, limits their investments in technology and research and development activities [14].

Strategies for overcoming the challenges

As the challenges faced by the recycling industry arise from many dimensions of ISWMM similar to other countries [4, 11–13], it is necessary to address them through specific

Table 3 Solution/initiative to overcome the challenges

Nature of the challenge	Possible solution/initiative
Posed by the stakeholders	
Households	
Lack of awareness	Conduct focused awareness at suburb levels, i.e., Grama Niladhaari, GN, division level) while initiating mass media communications on national scale
llectors/sorters	
Non-provision/lack of provision of value-added services	Initiate market development assistance through government institutions such as Export Development Board (EDB)/National Enterprise Development Authority (NEDA)
Collection of limited waste types	Employ common waste collectors who collect all types of waste (costs also shared) in all suburbs across the country
Unavailability of skilled labour	Design and implement vocational and career development programmes
	Build recognition and a reputation for recycling industry workers and recognize the value of the industry
Recyclers	
Lack of technically qualified staff	Staff training and development
Lack of value addition provided to end customers	Invest in advanced technology to produce customized products that meet market expectations
Insufficient quantities of waste material	Minimize the waste dumped on landfills by facilitating the separation of waste
Government	
Not having required specialists/experts to advise on national policy level	Seek consultancy from related Asian countries such as Singapore, Japan and Taiwan for capacity building
Insufficient technical and reliable data	Seek guidance and support from international donor institutions such as UNDP, World Bank and ADB to fund the necessary research
	Invest in waste-related R&D activities
Lack of proper regulatory framework for recycling and waste management	Study and develop model frameworks from related Asian and European countries
Posed by the stages in the recycling system	
Generation and separation	
Mixing of waste at the origin	Build awareness and develop incentive schemes for sourcing of sorted waste
Collection, transfer and delivery	
Poor infrastructure (access to rural areas and narrow lanes in urban areas) and logistics (not having specialized collector and delivery vehicles)	Team up with private sector entities operating in farming and export produce to transport selected waste to nearby towns
Lack of training for collectors	Capacity building and provision of specific training on waste material handling and management
Treatment and recycling process	
Unclean waste	Awareness building for collectors/sorters to take in only clean waste
Use of manual processes	Invest in advanced technology
Posed by the enabling environment	
Environmental	
Exposure of waste to humidity and dust due to climatic conditions	Use proper collection and delivery vehicles and standard storing facilities to store waste
Institutional	
Lack of infrastructure, dedicated industrial zones and waste management facilities	Amalgamate recyclers into countrywide waste collection zones to facilitate waste collection and management
Financial–economic	
Lack of funding	Approach financial institutions through a recyclers' association for better bargaining of terms
Lack of concessionary loan facilities or financial support	Make representations for national budget proposals on behalf of recyclers

Table 3 (continued)

Nature of the challenge	Possible solution/initiative
Political and legal	
Absence of a favourable tariff and tax system	Make representations for national budget proposals to obtain tax and other benefits for the industry
Lack of policy framework	
Ineffective implementation of existing law	Effective implementation of existing laws and policies
Social–cultural	
Lack of awareness of value of recycling	Conduct awareness sessions for community-based organisation (CBO) to spread knowledge on recycling and waste management
Low perception towards products made out of recycled materials	
Technological	
Lack of investment/advanced technology for producing value-added recycled products	Develop high-technology common industrial zones for recyclers to share the investments and capital equipment

measures as part of a comprehensive national-level strategy [6]. They can be broadly identified as awareness creation, capacity building, investments in infrastructure and technology, law enactment and policy implementation, international collaboration, encouraging private–public partnership (PPP), fiscal policy support (through tax and other concessions), and formalization of the industry. The specific solutions for the challenges identified by ISWMM are given in Table 3.

Conclusions

The paper identified the factors that lead to a deficient recycling industry in developing countries such as Sri Lanka from the perspective of ISWMM. These interconnected factors pose many challenges for the development and even survival of the recycling industry. This prevents many developing countries from being a circular economy while at the same time creating many social, environmental, and economic problems. By analysing these challenges, the paper identified possible strategies for developing the industry. Taking Sri Lanka as the case, this study makes two specific contributions. First, most of the studies on waste management have so far focused on municipal solid waste. But this study focuses on all types of waste generated by all the actors in the economy of a developing country. Next, this paper uses ISWMM to identify from a broad perspective the challenges and opportunities for the recycling industry in developing countries. This is particularly important as the current undesirable state of the recycling industry is a result of a complex web of problems. Thus, any solutions aiming to improve the recycling industry in developing countries require a multi-faceted and all stakeholder-inclusive approach to addressing these numerous challenges.

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