

INTEGRATION OF FORMAL AND INFORMAL SECTOR IN WASTE MANAGEMENT SYSTEM IN SRILANKAN CITIES, SPECIAL REFERENCE TO HOMAGAMA

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Abstract: 'Solid waste management has been identified as a massive problem in especially developing countries, and there is no specific solution found for that. It is also a topic that gradually comes with a growing population, rapid urbanization, and fast development. There are two parties involved in waste management activities in the developing world, the formal sector and the informal sector. Both sectors play a specific role in the solid waste management process, but there is no official contact between these two sectors, which has an impact on the weekly waste management process. The purpose of this study is to investigate the formal and informal sectors' contributions to the waste management system, the importance of informal sector involvement in solid waste management, and to identify opportunities for integrating both sectors into the waste management process. Here, mass balance analysis is used to identify the waste flow within the boundary, and an integrated visualisation tool is used to identify possibilities for integrating formal and informal sectors in this Municipal solid waste management process. The result suggests the potential for integrating these two sectors in the municipal solid waste management system. It will provide mutual benefits for both sectors, public, health, and environment. Based on the findings, integration of both sectors will be a better solution for the solid waste management system in Sri Lankan cities.

Keywords: *Waste management, formal sector, informal sector, mass balance analysis, the integration visualisation tool*

1. Introduction

Urban SWM is recognized as one of the most pressing environmental concerns confronting developing-country cities. There are two parties involved in waste management activities in the developing world, the formal sector and the informal sector. Individuals or businesses engaged in private sector recycling and waste management activities that are not sponsored, financed, recognized, supported, organized, or acknowledged by formal solid waste authorities, or that operate in violation of or competition with formal authorities, are referred to as the "informal solid waste sector." (Linzner & Lange 2013). The formal sector can identify as the main responsible party in the solid waste management system. In the developing world, waste recovery is largely dependent on informal sector and informal activities provide significant benefits to society by cleaning up the city and transforming unwanted waste into valuable resources.

Municipal solid waste (MSW) is a growing problem in developing countries due to its heterogeneous composition, non-biodegradability of plastic waste, a lack of recycling facilities, the high cost of waste collection, transportation, and management, and the environmental problems caused by waste dumping. (Jayathilaka, Chandraseena & Premachandra 2018). In Sri Lanka, open dumping is still the most common method of MSW disposal. Sri Lanka generates 7000MT of solid waste per day and the highest waste generation announced in Western province. Every individual generates 1-0.4kg of waste every day. Every year, Sri Lanka imports 160,000 metric tons of plastic raw materials and another 100,000 metric tons of completed and intermediate goods, the most of which end up in the environment as post-consumer plastics and polythene trash, causing serious environmental and health issues (Dnushika, Waidyasekara & Dewagoda 2020). Concern the formal and informal sector, an informal sector highly engages in the recycling process and adds value for waste. In the formal sector, mainly focus on waste collection and dump in an open yard. In the current setting of Sri Lanka, waste management is an issue that must be addressed. In the present context, mostly open dumping is chosen as a solution for solid waste management due to financial and technical reasons.

Most developing countries continue to have problems with garbage collection and disposal; therefore, 3–15% of a city's operational budget for waste management. (Masood & Barlow, 2013). The local authorities in Sri Lanka spent 20% - 25% of their annual budget for solid waste management within their administrative boundary. There is no

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official contact between these two sectors, which has an impact on the weekly waste management process. The informal sector plays a significant part in this process, but it is not taken into account in the development of the urban SWM system. (Putra, Damanhuri, & Sembiring, 2017). In Sri Lanka, local administrations have failed to provide effective trash management services. Due to a lack of efficient vehicles and qualified personnel, local governments now collect just a portion of the trash stream. (Thirumarpan & Dilsath, 2016).

1.1. ROLE OF THE INFORMAL SECTOR IN THE WASTE MANAGEMENT SYSTEM

The informal sector plays a key role in trash management in developing countries. Individuals or businesses engaged in private sector recycling and waste management activities that are not sponsored, financed, recognized, supported, organized, or acknowledged by formal solid waste authorities, or that operate in violation of or competition with formal authorities, are defined as the "informal solid waste sector." (Linzner & Lange, 2013). The below chart shows the flow of the informal recycling system.

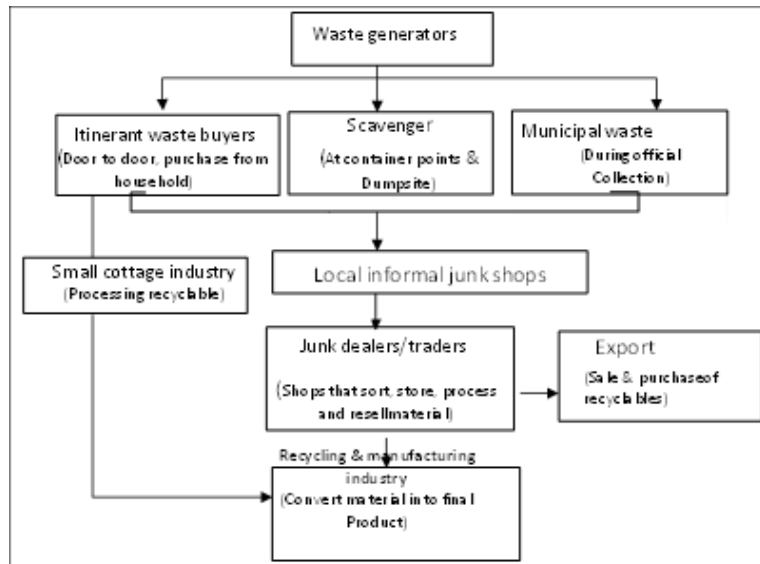


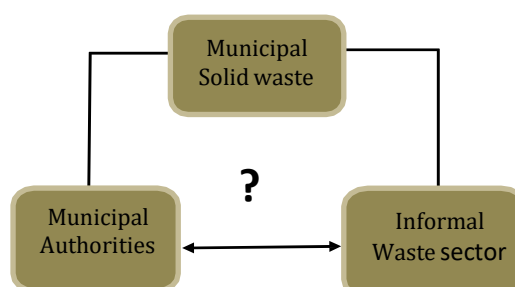
Figure 1: Flow of recyclables in a generalized manner through an informal recycling system

The informal sector efforts help reduce the quantity of waste disposed to the dumpsite and landfill. Also, play a significant role in achieving higher recyclable rates and reducing unemployment. Recycling is considered an essential part of urban planning. The informal sector plays a considerable role in improving the environment public health condition (Masood and Barlow 2013). The participation of the informal sector in this process is significant, but it is not taken into account in the planning of urban waste management systems in cities. However, the informal sector provides environmental and economic benefits through this waste management method. The informal sector aims, objectives, requirements, and methods are highly dependent on the quantity of recyclable material that is collected, recovered, and generated profit investment.

1.2. ROLE OF THE FORMAL SECTOR IN THE WASTE MANAGEMENT SYSTEM

Municipal local government plays the role of the formal sector. This is the main responsible party set up and operation in the solid waste management system. Traditionally, urban authorities across the world have interpreted their duty to include the supply of services such as sanitation, trash management, and disposal within their political and geographic authority. This formalizes their duty for solid waste management. (Klundert & Lardinois 1995). Also, the formal sector is responsible for implementing laws and regulations for waste management. The formal sector can be divided into municipal government and the formal private sector. Informal sector waste recycling, reuse is at a low level. Most developing countries continue to struggle with garbage collection and disposal and spend more money for that. Municipal authorities' objectives are to keep the city clean, improve waste collection rates, improve waste disposal practices, and reduce environmental impact.

1.3. IMPORTANCE OF INTEGRATION OF FORMAL AND INFORMAL SECTOR



Formal and informal sectors both play essential roles in the MSW management system. However, the link between the formal and informal waste sectors is unclear.

In a waste management system, the informal and formal sectors play roles that may be complimentary, but there is also the possibility of conflict. The informal sector fills the gap between in municipalities' solid waste management programs. The informal waste sector contributes a significant role in improvements of the city environment, public health, and hygiene condition. However, their role is not yet considered in urban waste management planning. Informal sector huge quantity of waste recycle and gain profit. It provides a positive environmental, social, and economic impact.

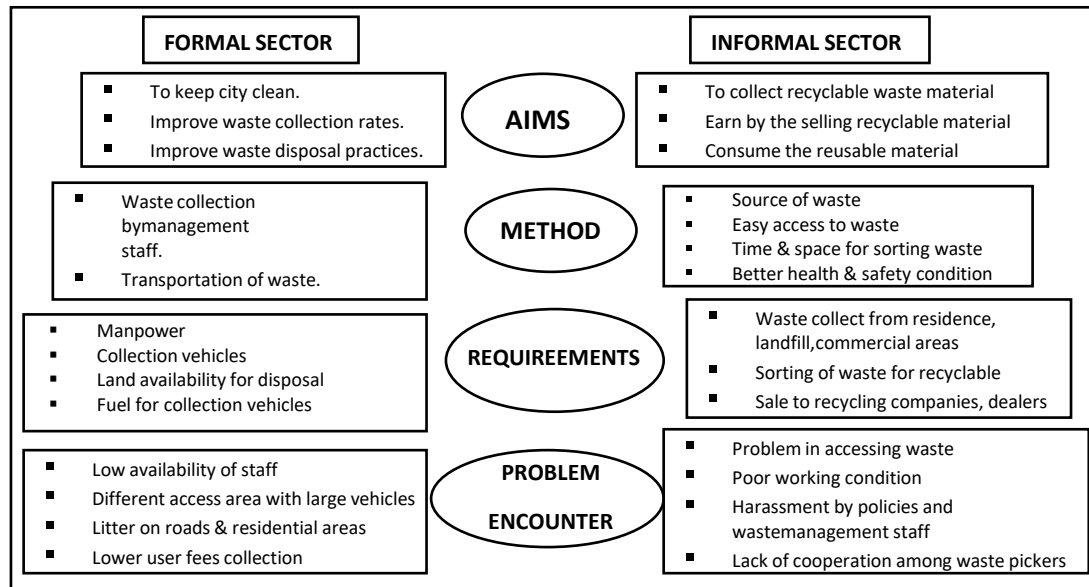


Figure 2: Aims, method, requirement & problem encounter by formal sector and informal sector in the waste management process

When considering the formal and informal sectors their aims, methods, requirements, the problem encountered differently in each. Municipal authorities are concerned about city cleanliness, improving waste collection and disposal practices, reduce environmental impact. The informal sector aims are collecting recyclable materials, selling recyclable materials, gain profit.

2. Methodology

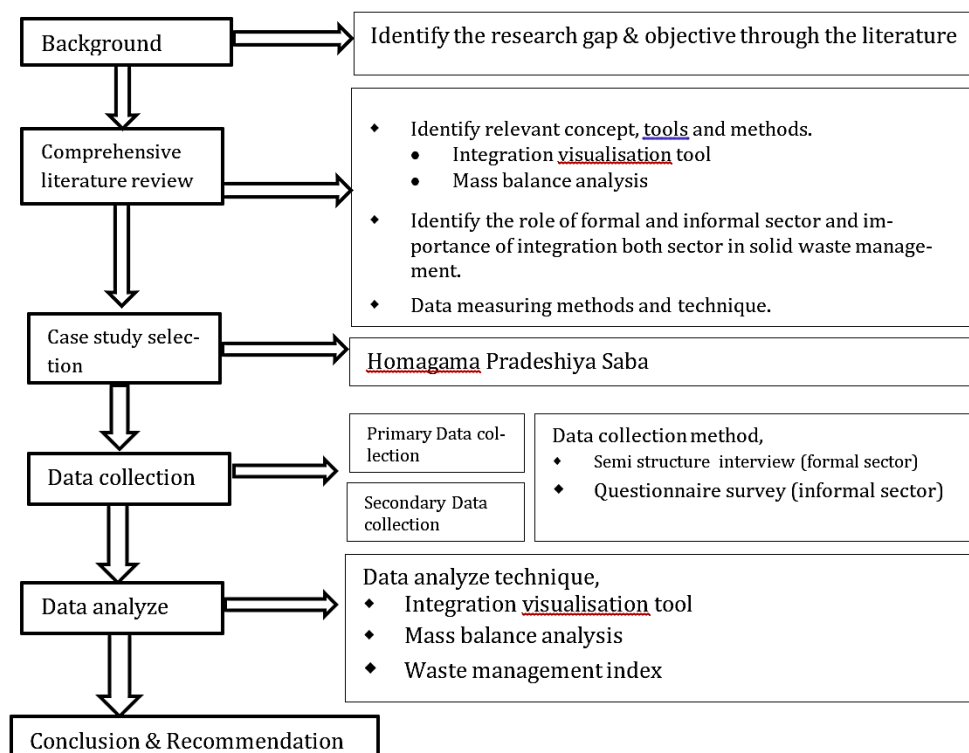


Figure3, Methodology of the Research (Source: Compiled by Author)

Homagama pradeshiya Saba area is selected as the case study area. Solid waste management has become a significant problem in cities due to the increasing population and rapid urbanization. In Homagama, existing waste generation amount to 112-ton per/day, and the local authority collected 48 tons. Their waste separation, composting, and recycling rates are low. More informal sector waste- collecting centers engage in the waste recycling process when concerned about the informal sector. Integration these both sectors will give a solution for better solid waste management. The purpose of this research is to determine the roles of both sectors in the waste management system, the significance of informal sector involvement, and the possibilities for integrating these two sectors. According to that, Homagama was selected as a case study.

3. Research Findings

3.1. WASTE MANAGEMENT MECHANISM AT THE BOUNDARY

Homagama Pradeshiya Saba is the main authority responsible for waste management within this area. Also, the waste management authority and central environment authority connect with local authorities in the waste management process. According to the population, the total waste generation amount is 112 tons/per day. In the present context, from total waste generation, the amount of 47 tons is collected by the local authority. Local authority waste collects only 54 GN divisions, and the service provides seven days. The standard per capita daily generation is about 0.40 kg in the PS area. There is a place called “Sampath Piyasa” located near the Homagama PS, and there is a responsible group of people for separate non-degradable waste for recycling purposes. According to the local authority, 23847kg of non-degradable waste is collected monthly. The (figure 4,5,6) shows the solid waste generation, non-degradable waste composition with each waste type and existing waste disposal methods within the boundary.

The local authority collected waste 20MT transport to Karadiyana composed plant, 14MT transport by expressway to Kerawalapitiya waste to energy plant and rest of that burnable waste give to holsium cement factory. Also, the separated waste polythene, plastic, gives recycling companies recycling purposes. The rest of 12MT was dumped in Homagama dumpsite, near the town center. There is an environmental problem associated with the Homagama dumpsite in the present context. The below chart shows the non-degradable waste composition with each waste type and existing waste disposal methods within the boundary.

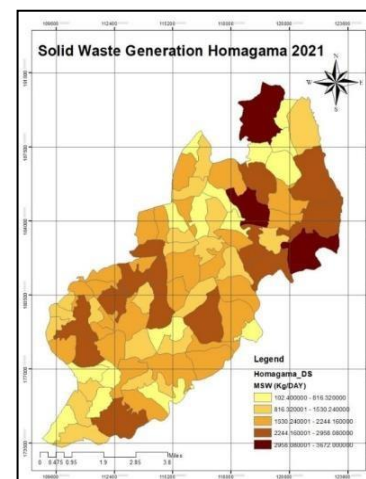


Figure 4: Solid waste generation
(Source: by author)

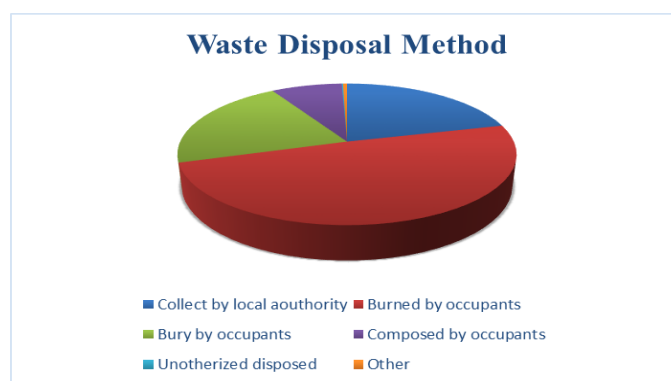


Figure 5; Waste disposal methods in Homagama
(Source: by author)

The questionnaire survey was conducted to get information about the informal waste management systems, and 15 informal waste pickers responded. All respondents have been engaged in waste collecting activities for more than five years. There were 73% of them registered in Homagama Pradeshiya Saba as a responsible authority, and 26% of them were not registered in any responsible authority. Most of them are collected 300- 400 kg of waste per day. All respondents think informal waste management is at a good level, and 60% liked to integrate with the formal sector, and 40% did not like to integrate with the formal sector.

3.2. WASTE MANAGEMENT INDEX

In waste management index concern about the effective, most environment-friendly methods for wastemanagement. According to that, recycling, incineration, compost consider positive techniques and the landfill, open dumping, and unaccounted waste are negative techniques. In Homagama local authority area, composed, recycling, and waste to energy contribution get as managed waste. The below calculation shows the waste management index in Homagama.

$$\begin{aligned}
 \text{Waste management index (\%)} &= \text{Managed waste (x)} / \text{Total collected waste(c)} * 100 \\
 &= 923.19 / 2040 * 100 \\
 &= \underline{45.2\%}
 \end{aligned}
 \tag{1}$$

According to that calculation can be identified, the Homagama waste management index is higher than the lowest score, and it indicates a moderate level.

3.3. IDENTIFY THE WASTE FLOW WITHIN THE BOUNDARY

Mass balance is the method used to calculate the material flow in and out of the system. The quantity of waste input and output from waste management in the local authority boundary can be measured through this method. Using mass balance analysis, a proportion of material that may be utilized as input for subsequent processes is computed, allowing future material recovery to be estimated. Mass balance analysis (MBA) identifies waste flow within the boundary. The analysis shows the waste flow of this area and input- output relation as monthly. Below formula used to calculate recovery rates within the boundary.

$$\begin{aligned}
 \text{Recovery rate} &= m_2, m_3, m_4, m_6 / m_1 \\
 &= \underline{m_2, m_3, m_4, m_6} * 100 / m_1 \\
 &= \underline{23.4 + 54 + 320 + 0} * 100 \\
 &\quad 1380.7 \\
 &= \underline{28.7\%}
 \end{aligned}
 \tag{2}$$

According to that Homagama, the monthly recovery rate is 28.7%, at a low.

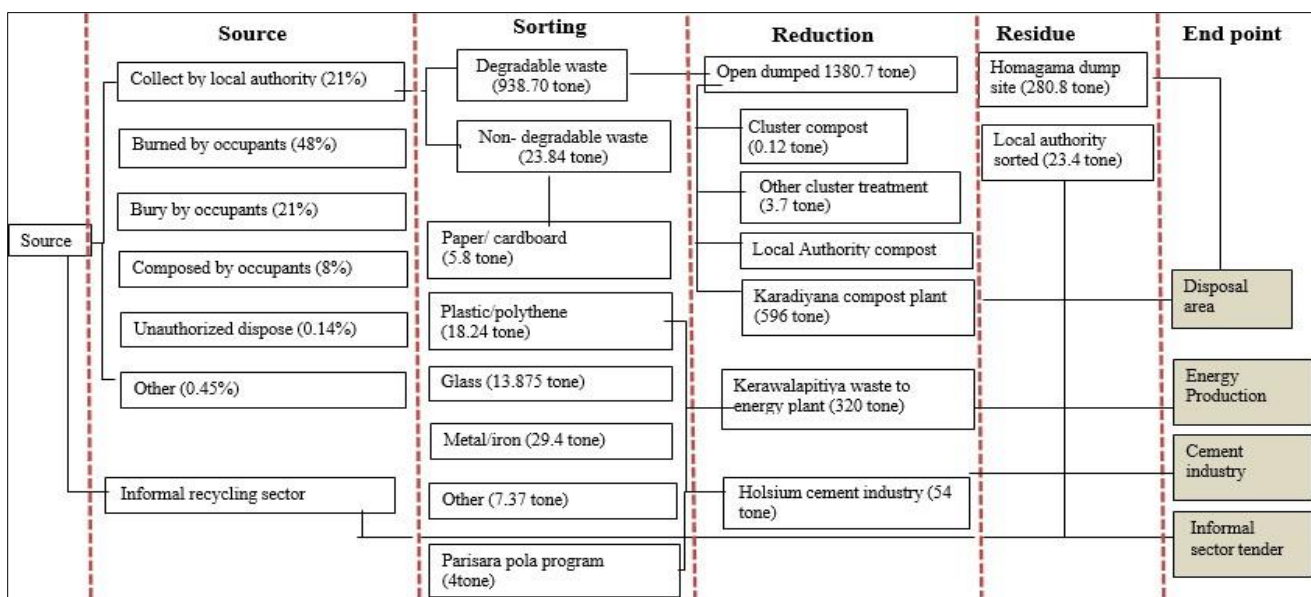


Figure 6: waste flow from the source (generator) to endpoint (landfill) in Homagama (source: by author)

3.4. APPLICATION OF INTEGRATION VISUALISATION TOOL

The proposed system was assessed by using an integrated visualisation tool. The integration visualisation tool consists of four intervention named A, B, C, and O. each category has an 'intervention point' and consists of 'specific action.' Each category assigned a score between zero and one. According to that, specific actions are considered key action (K) its score as one. If specific action is considered as medium degree (C), it is scored as 0.5. If specific action is ignored or information not found (I) it is, score as zero. Finally, get an overall score for each interface. The total score ranges between one and zero. This tool is supported to analyzing potential actions that are often necessary to facilitate the integration of the IRS into a city's SWM system. The resulting radar image is useful for a quick overview of the current or anticipated system. This tool consists of four categories,

- Solid waste management sector interface
- Material and value chain interface
- Social aspects and interface with society
- Enabling action, organization, and empowerment interface

The intervention point of the key four categories of intervention and calculations of each intervention are shown in tables 1- 4

3.4.1. Intersection of the solid waste management interface

Table 1: Calculation of solid intersection of the solid waste management sector interface (source: by author)

A	Overall interface score	Intervention points	Average score per intervention point	Total marking for specific action	Level of consideration of each intervention	Specific action
Intersection of the solid waste management interface	0.555	Access to waste	0.833	1	K	Determine the legal right to collect wastages, purchase the sorted products, and keep the proceeds for wastecollectors.
				1	K	Make waste collectors' access to waste collection point easier.
				0.5	C	Access to garbage at transfer points, landfills, and other trash sites should be controlled for waste collectors.
		Function in the formal SWM system	0.333	0.5	C	Integration with MSW collection system.
				0.5	C	Integration with MSW transportation system.
				0	I	Provide official role within the MSW management system.
		Encourage inclusiveness.	0.75	0.5	C	All parties must be involved in MSWM planning.
				1	K	The inclusion of the informal sector should be institutionalized.
		Promoting public health	0.666	0.5	C	The collected waste is disposed of properly.
		Improving MSWM/ informal sector	0.25	0	I	Facilitating the transition of secondary transportation and final disposal from the informal sector to municipalities.
				0.5	C	Improving informal recycling sector in MSW system.
				0.5	C	Legislation/national policies to promote recycling
				0.5	C	Putting regulations in place concerning the informal sector.

3.4.2. Interface between the material and value chains

Table 2: Calculation of material and value chain interface (source: by author)

B	Overall interface score	Intervention points	Average score per intervention point	Total marking for specific action	Level of consideration of each intervention	Specific action
The interface between the material and value chains	0.437	Improving raw material quality and reducing cross-contamination	0.5	0.5	C	Separation of sources.
				0.5	C	Contracts with waste collectors and generators are in place.
		Increasing the number of items for sale	0.166	0.5	C	Increasing the types of materials that can be recycled
				0	I	Provide equipment and facilities for informal waste collectors.
				0	I	Use large vehicles, carts, containers for IRS.
		Reprocessing	0.333	0.5	C	Sorting gathered things into various groups.
				0	I	Decrease transportation cost and increase density
				0.5	C	Creating final product
		Improving links along the value chain	0.75	1	K	Improving the relationship between the IRS and the recycling industry.
				0.5	C	Contracts with particular middlemen/recyclers

3.4.3. Aspects of social interaction and interaction with society

Table3: Calculation of social aspects and interface with society (source: by author)

C	Overall score for interface	Intervention points	Average score per intervention point	Total marking for specific action	Level of consideration of each intervention	Specific action
Aspects of social interaction and interaction with society	0.374	Increasing legal acceptance	0.333	0	I	Birth certificates & other legal documents are issued.
				0.5	C	Right & responsibilities
				0.5	C	Recognizing garbage collection as a profession
		promoting recognition and acceptance	0.5	0.5	C	Identity card issuance
				0.5	C	Uniforms are provided
		Participation of the general public in initiatives	0.666	0.5	C	Through public awareness campaigns
				0.5	C	By encouraging source separation
				1	K	By the involvement of planning intervention
		Facilitating child education	0.25	0.5	C	Make efforts to eradicate child labor.
				0	I	Providing schooling for the children of waste collectors
		Promoting gender equity/ inclusivity	0	0	I	Involvement of women in planning
				0	I	Offering targeted interventions to women
				0	I	Women can obtain loans.
		Ensuring health and safety		0.5	C	Health-care access
			0.5	0.5	C	Ensuring hazardous waste is sorted separately
				0.5	C	Safety equipment's

3.4.4 Enabling action, organization, and empowerment interface

Table 4: Calculation of enabling action, organization, and empowerment interface (source: by author)

0	Overall score for interface	Intervention points	Average score per intervention point	Total marking for specific action	Level of consideration of each intervention	Specific action
Interaction Between enabling action, organization, and empowerment interface	0.361	Organization of waste collectors	0.5	0.5	C	Encourage and organization groups.
		NGO involvement	1	1	k	Non-governmental organizations are aiding the IRS in organizing themselves.
		Network promotion on a national scale	0.25	0	I	Establishing a countrywide network of waste collectors.
				0.5	C	Organizing national forums and gatherings.
		Financial sustainability	0	0	I	Access to financing for the informal sector.
				0	I	Reduce the reliance on market fluctuations in material pricing.
		Capacity development and building	0.166	0.5	C	Courses in training & literacy.
				0	I	Recognizing buyer requirements.
				0	I	Participation in the intervention steering committee.
		Data gathering and documentation	0.5	0.5	C	Keeping track of the labor, tonnage collected costs and profits.

According to the result, the solid waste management interface (A) is higher in the existing scenario. According to that, can identify the existing situation of these interfaces and can decide what are the areas that need to be improved in future scenarios. These four interfaces' overall scores are not at the optimum level & when considered, all aspects can go to the optimum level. These values depend on the context.

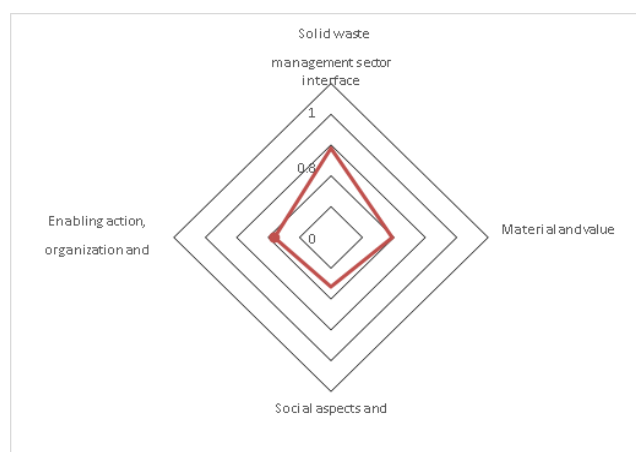


Figure 7: The result of the integration visualisation tool

The above radar diagram shows the result of the evaluation metric and integration visualisation tool. The specific action, intervention points, and their marking are shown in table 4.6.1 – 4.6.4. According to the radar diagram, in present context mainly focus on the solid waste management sector interface. It will positively affect the initial step of integration formal and informal sector and, in the future, can be focused on areas of organization and empowerment, material and value chain, and social aspects interface. Access to waste, NGO participation, promoting public health and environment, organization of waste pickers are key intervention points in the present context. According to the result, the four interventions are not balanced. Improving and balancing these four categories of intervention will affect a step toward the proper solid waste management system. When concerned with the limitation for integrating these sectors, the attitude of both sectors, sometimes relationship will be not friendly and supportive one. Informal sector plays an important role in the SWM system, and it is positively affected by increasing recycling rates. Informal sector integrates with formal sector provide mutual benefits. Because of that integration, both sectors are important, and this will be developed as a framework it will be a better solution for solid waste management.

4. Conclusion And Recommendation

This study describes the role of the formal and informal sector in the MSW management system the importance of integration of public and private sector waste management systems in Sri Lankan cities, with special reference to Homagama. The study was done by literature review, secondary data based on census data and data that provide waste management authority, and primary data collected by the author. This research aims to explore the formal and informal sector contribution of the waste management system and the importance of informal sector involvement for SWM and identify possibilities for integration informal sector with the formal sector with the waste management process. This study can use planners, policymakers, waste-related authorities, local authorities, surveyors to identify the role of the formal and informal sectors and identify possibilities for integrating these two sectors for a better solid waste management system. This study suggests integrating these two sector effects lowers municipal waste disposal costs and increases recycling rates.

The mass balance analysis was completed using a secondary database, and the validity and dependability of the results may require revision. According to the respondent's perspective, the possibilities for the integration of formal and informal sectors identify in this integration visualisation tool. Also, decide them as key action, considered as medium or ignored based on their perspective. The values depend on the context. The result of the integration visualisation tool is valid only for the Homagama Pradeshiya Saba area. It is impossible to generalize all ideas about solid waste management in Sri Lanka. All the values given depend on the context of Homagama. The study identifies the possibilities for integration for the formal and informal sectors in the MSW management process. Further, the study can explore more intervention points, develop a framework for integrating these two-sector, and can identify gaps between the two sectors.

5. Acknowledgement

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