

Sustainable Waste Management and Circular Economy Practices: A Community-Based Study of Awareness, Behaviour, and Infrastructure Among Local Businesses

Lakshya Garg, Aditya Agarwal, Adit Mishra, Advait Rastogi, Sarthak Tyagi

Christ (Deemed to be University), Delhi NCR, India

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Abstract

Whilst urban waste is considered as an environmental issue, it is also a behavioural, infrastructural, economic and institutional problem. This study aims to analyse the characteristics of sustainable waste-management practices of local commercial waste producers and to look at how everyday waste practices relate to the principles of the circular economy. The study was a community-engagement project with direct contact with small and medium sized business, comprising roadside food stalls, restaurants, grocery stores, medical stores, stationery stores and bakeries. The fieldwork involved structured answer to questions, observation, community interaction, awareness activities and reflection.

A relationship between awareness and action is explored with particular focus. The current project evidence shows that plastic and packaging waste are major waste flows and that source segregation is poorly implemented. Community assessment from earlier found that of 22 respondents that reported plastic waste generation, only one respondent reported that waste was always segregated, 15 respondents said recycling was important to take action individually, seven of the respondents were aware of sustainable waste-management practices, and 14 respondents were willing to change their waste-disposal practices. The findings indicate that there can be a situation where people are willing but not aware of the problem and the situation is not a good situation to be in. Sustainable behaviour is thus considered to be the result of an interaction between knowledge, convenience, infrastructure, habits, perceived effort, institutional support and opportunities for material recovery.

The paper suggests the interpretation of this gap under an Awareness–Action–Infrastructure framework. The study does not simply believe that information is enough – community interventions need to include not only information but also facilities which are easy to use, simple behavioural prompts, source-segregation systems, convenient collection, and coordination between businesses, citizens, municipal authorities, waste workers, recyclers and producers, as well as the provision of facilities for reusing waste. The paper also contextualizes local insights and research in an ever-changing policy landscape in India, such as the Swachh Bharat Mission- Urban 2.0, plastic waste management and Extended Producer Responsibility, and the activities of the Circular Economy Cell at NITI Aayog.

The community survey is still undergoing refinement and the paper contains clearly marked-editable fields for the final result counts, percentages, cross-tabulations and figures. The verified results already obtained from the community project are kept and whenever the final response spreadsheet needs the statistic, it is indicated for later insertion. This way, there aren't any statistics made up and the paper stays academically coherent as the final survey analysis is added in.

Keywords: sustainable waste management; circular economy; source segregation; plastic waste; recycling; reuse; community engagement; behavioural change; local businesses; India

1 Introduction

Waste is an inevitable consequence of the modern economy and society. Materials are used in a household, business or restaurant every day and end up in waste or packaging at the end of their use. The importance of waste to the environment however, is not solely the amount of waste produced but the actions taken beyond disposal. Commingling wastes can lead to contamination of recyclables, difficulty in processing the organic waste, and loss of valuable resources to disposal systems. A paradigm change is needed, from waste as an end product to waste as a stream of materials that can be reduced, reused, recovered or recycled within a sustainable waste management program.

This study is a result of a community-engagement project Sustainable Waste Management and Circular Economics. Local commercial establishments were recognized as an important setting for research as businesses are the confluence of consumption, material use, and the creation of waste. The original project intentionally engaged with various types of businesses, not a specific type of business. These included roadside food stalls, restaurants, grocery stores, medical stores, stationery stores and bakeries. This method understood that businesses have different waste profiles; for example, businesses that prepare food waste can produce a lot of organic waste; businesses that supply food can produce packaging and carton waste; stationery businesses can produce paper and cardboard waste; and bakeries can produce food and packaging waste.

During the initial field assessment, a central issue was identified: the volume of waste produced by business premises was not always linked with sustainable waste-management practices. The project recorded issues of segregation, re-use, recycling and waste reduction / resource recovery. It also highlighted the difference between the knowledge that a behaviour is desired and its actual use in practice. Community interactions suggest that whilst people may recognise the importance of sustainable practices, access to separate bins, time or the inconvenience, perceived extra effort and limited understanding on what happens to materials after they are collected can hinder on-going sustainable practices.

It is significant that this distinction is important in research as it simplifies the explanation of waste behaviour that can only be based on awareness. While increasing awareness can produce little change if individuals know about recycling and there is no convenient way for them to drop off their recyclables. Likewise, if a company desires to cut down on packaging, but their customers demand single package products, then there is a commercial aspect to it as well as an environmental aspect. A system approach is therefore necessary in the context of sustainable waste management, the individual and structural factors of which need to be considered interacting.

This analysis is enhanced from the circular economy's point of view. The resources flow in linear economy typically from extraction to production, to consumption and to disposal. The circular economy aims to maximise the value and lifespan of products and materials by minimising waste and loss of value at every stage of their life cycle, including at the end of their life, through reduction, reuse, repair, refurbishment, recovery and recycling. The aim is not just to improve the cleanliness of disposal, it is to use less virgin resources and preserve the value of resources in economic systems. Examples of potential organic residues for a local bakery include organic wastes that can be composted or otherwise recovered; while the cardboard and appropriate packaging can be recycled or reused. Shows how the concept of circularity can be implemented in commercial practice.

Therefore, the current study explores sustainable waste-management behaviour in the local commercial establishments using an exploratory method of community-based approach. It aims to gain

insight into the types of waste produced, segregation and recovery practices in place, awareness of sustainable practices, barriers to action, willingness to act and ways in which support is sought. It further looks at how these local observations can be used to inform community level circular economy interventions.

1.1 Problem statement

There are various waste materials produced by local business organizations, but its sustainable management isn't followed consistently. The issue of waste generation is in itself not a problem. There is a mix of disposal methods, poor segregation of sources, low reuse rates, an incomplete recycling system, dependence on plastic and packaging and convenience limitations and weak linkages between local businesses and formal activities. The research fills this practice–predict gap between waste management awareness and practice.

1.2 Significance of the study

The study is meaningful because material consumption occurs frequently at local businesses and businesses are small. Smaller amounts than larger industrial facilities are produced, but they can add up to be significant in neighbourhoods. Much more significantly, businesses impact on customer behaviour, packaging options, buying choices and material flow to local waste streams. Therefore, this could be a step towards cleaner communities and resources recovery and circularity.

There is a value and significance in the study from a service-learning standpoint as well. By engaging in the community, students can gain a deeper understanding of environmental issues beyond their second hand descriptions and see how policies and sustainability concepts relate to their daily lives. The lessons of the original project were that change cannot be initiated by the imposition of instructions, but must start with listening to community members. That insight is then expanded into a systematic exploration of barriers, opportunities and behavioural change, in the research paper.

1.3 Scope of the study

The study is based on small and SME local commercial establishments that can be accessed by the project team. Not all businesses are in India and not all businesses in the city itself are covered. It is meant to be exploratory: to gain an understanding of practice, themes that emerge and recommendations that can be piloted and/or adapted in other communities.

2 Background of the study

Sustainable waste management is about more than collecting and disposing of waste. It encompasses prevention, reduction, segregation, collection, transport, processing, recovery and environmentally-friendly disposal. This is especially relevant due to contamination of the materials that will be used for recycling and for organic material. Mixed wet/dry materials are harder to recover and potentially valuable materials may not have a monetary value. Thus, in the initial evaluation of the project source segregation was considered as an important intervention point.

This can be done in the context of the Indian policy framework. Garbage-free cities and source segregation, collection, transportation and processing of waste are covered under the targets of Swachh Bharat Mission (Urban 2.0). Citizen involvement and behaviour change is also a major priority with the programme. Concurrently, policy for plastic waste management has been evolving,

moving EoL management responsibility from consumers, or municipalities, to producers, importers, and brand owners, through Extended Producer Responsibility (EPR).

The CPCB materials include the Plastic Waste Management Rules and subsequent amendments, which include EPR guidelines for plastic packaging. The regulatory approach acknowledges the link between plastic waste and production and packaging systems and consumers' disposal. This wider responsibility is applicable to the present research due to the fact that local businesses could very well get packaging from the upstream suppliers and might not have much control over the packaging material design.

The institutionalization of the circular economy policy is also in the process of development in India. In September 2022, NITI Aayog set up a Circular Economy Cell to coordinate action plans for circular economy. This is significant as it is putting the issue of resource recovery before the nation on the agenda as an economy-wide challenge and not just a cleanliness challenge. This policy direction is complemented by the local community perspective which will explore the former question and the latter: Is it easy to understand and implement the circular principles at the establishment level?

The study is thus a combination of three disciplines, namely environmental management, behavioural change and business practice and community participation. It questions not only about the knowledge of sustainable waste management by the respondents but also about the ability to practise it at the local level.

3 Sustainable waste management and the circular economy

3.1 From linear disposal to circularity

The linear economic model is represented as take–make–use–dispose. Raw materials are taken out, turned into products, eaten and thrown away. The model puts pressure on natural resources, and generates wastes at its tail end. Circular economy thinking is a challenge in this regard, and tries to extend the value and usefulness of products and materials for as long as possible.

Not all materials can be recycled, and circularity doesn't necessarily mean that all materials can be recycled forever. It implies prevention of waste generation and retention of materials is taken into account earlier and more deliberately. The first step is to avoid unnecessary material use and reduce material use, reusing, repairing, refurbishing, recovering and recycling are later steps, with disposal as a step after that. This new hierarchy turns questions of "What do we do with this?" from "How can we avoid this material becoming waste, and if it does, how can its value be recovered?"

3.2 Waste to waste and circularity

Local businesses are most relevant since they repeatedly consider buying, packaging, storing and disposing of products. A grocery shop can recycle cartons for storage, reduce the amount of packaging that is not necessary and separate recyclable items. Food waste is able to be separated from dry recyclables at a restaurant. An opportunity for reducing packaging and separation of cardboard at bakery can be studied. A paper/cardboard stream can be established at a stationery shop. Wherever and when possible and healthfully, a food vendor can cut down on the use of disposable products.

The examples show that there is no need for sophisticated technologies for implementing circular economy. There are a lot of interventions that are organisational, such as having two or more bins in

the right place, keeping cardboard dry, having a collection routine, using suitable containers for re-use where possible, buying in bulk where possible and communicating simple instructions to staff. The difficulty is to ensure that the sustainable choice is not so difficult that it can't be a regular part of business.

3.3 Energy and environmental awareness

The main contribution of this research is the Awareness – Action – Infrastructure framework. The awareness is the knowledge and recognition of the importance of the environment. Action is what happens in business, which includes segregating, reducing, reusing and recycling. Infrastructure is the external elements that enable the above actions to happen, such as separate containers, collection systems, information, incentives, enforcement and access to recovery channels.

The framework suggests the following: being aware is important but not enough. Even when there are no separate containers, recycling can be of value to a respondent and yet they may mix wastes. While a business may be willing to decrease plastic use, they may need packaging due to its cost or customers' expectations. Therefore, if there is a combination of awareness, motivation and opportunity to act sustainably, this is more likely.

4 Literature review

4.1 Organising waste prevention, collection and transfer stations

The study of waste disposal behaviour has become more and more a focus of waste management research, where disposal behaviour is now considered as a result of individual decision-making and institutional conditions. The failure to act sustainably is sometimes seen as the result of a lack of information and is therefore a failure of traditional awareness campaigns. But, even with high awareness, it is possible for environmental behaviour to still be inconsistent. Perceived convenience, social norms, habits, infrastructure, costs and time and confidence in the system are factors that affect behaviour. This implies that measures of awareness should not be the sole measure of the interventions; it is necessary to include whether people have the capacity and opportunity to make their intentions a reality.

This problem can be understood based on the theory of planned behaviour (TPB) which was proposed by Ajzen. The theory suggests that attitudes, subjective norms and perceived behavioural control are the factors that affect behavioural intentions. A negative attitude towards recycling coupled with a negative perceived social desirability of responsible disposal could lead to a negative perceived behavioural control for an individual in the context of waste management if the necessary bins and services to recycle are not available. This offers a theoretical understanding as to why positive attitudes are not always associated with consistent behaviour.

4.2 Source segregation

Source segregation is an important step as it is dependent on the quality of the material being collected for further downstream processing. Separating wet and dry waste at the source helps to minimize contamination and simplifies the subsequent sorting and processing. In business, the challenge is even greater because of the pressure of doing business. Staff may be concentrating on customer service, there may be limited space for storage, and waste receptacles may be positioned for ease of access rather than effectiveness in their ability to collect for waste.

This current study further explores the segregation debate by introducing the concept as a practice of the organisation, instead of as an environmental option of the individual. Segregation can be institutionalized within the business, responsibilities delegated, labels added to containers, collection times can be synced etc. This changes the meaning of the 'remember to segregate' message to one of developing a process where segregation is the default.

4.3 Plastic and packaging waste

Plastic packaging poses a rather complex waste management problem due to its light weight, frequency of use and the fact that it is frequently composed of a variety of materials. It is extremely useful for its protective properties to keep items safe, stop damage and make it easy to distribute – which is why it is unlikely to be enough to ban plastic. Practical solutions can be as simple as eliminating unnecessary packaging, as well as implementing reusable systems when possible and implementing the right packaging or solutions, and as far as returnable plastics are concerned, segregate waste if it is plastic.

Plastic packaging has come to the forefront of Indian policy in recent years, via the EPR programme. The EPR is relevant from a circular-economy point of view as it takes into account the producers/brand owners that drive the material into the market. But at the local level, the post-consumer management of materials remains up to businesses and consumers. It is important to coordinate the value chain in order to achieve effective plastic circularity.

4.4 Reuse and the limits of a recycling-only approach

While recycling is valuable, prevention and reuse are at the top of the hierarchy in the case of a circular economy approach. In most instances, recycling involves collecting, sorting and processing waste, and some properties or value of the waste may be lost. When appropriate, re-use can help retain the value of the original product. Reuse for businesses can mean cartons, storage containers or bags/returnable packaging, depending on business hygiene, safety and operational requirements.

The message should not simply be 'put it in the recycling bin' as this is the implication for community campaigns. It should question participants on why it is they don't want to avoid, reduce or reuse an item before they are thinking about recycling. It was incorporated in the community project's awareness activities in this broader framework.

4.5 Circular economy and small businesses

Constraints experienced by small businesses may be different to those experienced by larger businesses. They may not have much storage, fewer staff, have less leverage in supplier negotiations and have less time to operate multiple processes. Their smaller size may also have advantages in that aspects of interventions may be more able to be delivered simply due to the concentration of decision-making. Shop owners can be able to alter buying, container positioning or staff habits without intricate organisational approval.

Thus, it is suggested that context sensitive interventions are needed in the literature. One model for waste management is not necessarily applicable for a bakery, medical store, grocery store and food stall. The present study follows this principle and is based on the analysis of waste profiles of various establishment types and their applicability.

4.6 Community participation and service learning

Community engagement can enhance the effectiveness of sustainability interventions as the residents and businesses will have information external parties don't. When the researcher interacts with the informant, problems will be uncovered that are not apparent in secondary information. In this current project, it was found that the same policy goal (waste management) could have varied constraints to varying establishments - field interaction.

Service-learning has an educational component. Pupils don't just gather information; they engage with communities, consider social and environmental issues and create hands-on solutions. This process can help to increase the understanding of the interplay of policy, behaviour and infrastructure. It also prompts researchers to not simply be aware of the communities as recipients of awareness messages.

4.7 Research gap

There is a disconnect between small commercial waste providers and policies that are committed to sustainable waste management. There are many discussions that focus on the volume of waste, infrastructure or awareness, independently. This study combines these aspects, by looking at generation of waste, and knowledge, actual behaviour, barriers, willingness to change and desired support in a community-engagement setting. It's unique aspect is the direct local interaction approach that allows the creation of an Awareness–Action–Infrastructure interpretation of circular-economy readiness.

5 Research objectives and research questions

5.1 Objectives

- To determine the types of significant waste streams from selected local commercial waste generators.
- To measure the level of knowledge of waste segregation, recycling, reuse and circular economy.
- To look at how aware people are and what they do about the waste that they are aware of.
- To recognize the practical, behavioural and infrastructural challenges for sustainable waste management.
- To determine the willingness of respondents to changing the current waste-disposal practices.
- To gain an insight into local perceptions of the support that the government provides and local waste-collection systems.
- To come up with practical solutions to enhance sustainable waste management and to engage in circular economy at community level.

5.2 Research questions

- Which wastes are produced most often by local businesses?
- Are waste segregated, reduced, re-used and recycled regularly at establishments?
- How can be seen the relationship between awareness and real sustainable behaviour?
- Which factors stop sustainable waste-management practices?
- Are there actions that respondents are willing to implement that would be considered improvements?
- Which types of help are helpful?

- What could be done with local waste and how to link local waste practices with principles of circular economy?

5.3 Propositions for future testing

P1: It is expected that people who are more aware about sustainable waste management will be more willing to engage in sustainable practices than those who are less aware. It is expected that the more aware people are about the sustainable waste management, the more they are willing in adopting the sustainable practice as compared to less aware persons.

P2: The presence of good infrastructure for segregation and collection is expected to relate to more regular source segregation.

P3: Inconvenience and extra effort are likely to be linked to less implementation of sustainable practices.

Propositions are not causal claims in this case, as the present study is a limited, community based sample.

6 Research methodology

6.1 Research design

This study is an exploratory study in a community based approach. This approach is a blended approach of quantitative questionnaire responses and qualitative observations and interaction with community. The selection of this design is because the problem of the research is not only pattern but also explanation that gives context. Responses can be described using frequencies and percentages, and reasons for the behaviour(s) may be explained through interviews, observations and reflections.

6.2 Study population and sampling

Study population includes commercial establishments in the community that are accessible to the project team. The project purposefully represented a diversity of types of establishments and not just one sector. The food stalls that were included were roadside, restaurants, grocery stores, medical stores, and stationery stores and bakeries. The sampling was purposive and accessibility sampling was used. The results, therefore, are indicative evidence from the sample community, and should not be considered as estimates of the larger city or country.

6.3 Data collection

Primary data were gathered by interacting with their respondents at their establishments. The questions in the questionnaire covered the type of establishment, the most common type of waste produced, waste segregation methods, knowledge of government initiatives, obstacles faced, and the willingness to implement sustainable practices and recommendations to reduce these wastes. Field observation, photographic documentation, and interaction records and post-engagement reflection were also utilized in the project.

6.4 Survey variables

6.4.1 Establishment category

The following are examples of waste generated in various types:

1. FSeg = the number of times the source was segmented.
2. Cleanliness of bins and use of separate bins
3. How important is recycling and what is people's recycling behaviour?
4. The waste reduction and re-use practices
5. Knowledge of sustainable waste-management practices.
6. An understanding of Government programmes
7. Perceived barriers
8. Easy to collect/dispose of waste
9. Willingness to change
10. The kind of assistance they wished for. The type of help they wanted.
11. Future priority actions

6.5 Data analysis plan

Descriptive statistics should be used to analyse the final survey spreadsheet. For categorical variables calculate frequencies and percentages. If applicable, cross tabulations can be provided between establishment type and waste type, segregation behaviour, awareness and willingness to change. Major patterns can be shown in bar chart or stacked chart. Exploratory association tests can be used if the final set of data is relatively large, but the size of the convenience sample should not be interpreted as being statistically significant.

The numbers of people who confirmed in each of the two questionnaires given were as follows: the final survey results present the numbers of people who confirmed in each of the two questionnaires given. The questionnaires are analysed separately as the questions differ and so do the groups of respondents.

6.6 Ethical considerations

The study was done for the purpose of education and community engagement. Subjects were contacted while they were at their establishments, and questioned about typical waste management practices. Individual responses should not be identified in the analysis and responses should not be presented in a manner that will negatively affect a business. Results should be analysed together and are for identifying opportunities at system-level not pointing out individual establishments.

6.7 Reliability and limitations of method

Subjective behaviours may be different from observed behaviours. Respondents can give socially desirable answers especially for the environment-friendly practices. Sample is also limited and locally available. These restrictions are dealt with in the field by observation and thematic interpretation but cannot be removed.

7 Data analysis and findings

The results of the community project are presented in this section and editable locations are included for the last version of the response dataset. There are 22 respondents reporting generation of plastic waste, 1 respondent that segregates waste at all times, 15 respondents who believe that the recycling is an important individual action, 7 respondents who know about sustainable waste-management practices, and 14 respondents who are willing to change their waste disposal. The numbers above give only an initial empirical footing for analysis.

7.1 Respondent profile

This study included sample individuals from various commercial categories. This diversity is significant as it is closely tied with the type of activities carried out by the establishment, which has a close relationship with the generation of waste. Organic residues and disposable materials used in food services generate in food businesses, packaging and cartons generate in grocery businesses, paper and cardboard generate in stationery businesses and last but not least medical stores have other waste streams such as packaging wastes that may need special handling.

Table 1. Respondents by establishment type.

Establishment Type	Frequency	Percentage
Roadside food stall	See verified results in the final survey results	See verified results in the final survey results
Restaurant	See verified results in the final survey results	See verified results in the final survey results
Grocery store	See verified results in the final survey results	See verified results in the final survey results
Medical store	See verified results in the final survey results	See verified results in the final survey results
Stationery store	See verified results in the final survey results	See verified results in the final survey results
Bakery	See verified results in the final survey results	See verified results in the final survey results
Other	See verified results in the final survey results	See verified results in the final survey results
Total	See verified results in the final survey results	100%

In the final survey results, the verified results from the two questionnaires that were sent out are displayed. The questionnaires are analysed separately because their questions and the groups of people answering the questionnaires are different.

7.2 Waste generation patterns

The most prevalent waste type that was found in the initial community assessment was plastic, with 22 people from the community indicating that plastic waste is generated in their community. Important streams identified were also packaging and food waste. The high occurrence of plastic is in line with the commercial use of easily obtainable and cheap packaging. The finding needs to be read in the context of the purpose of each establishment, and should not be seen as a single behavioural issue.

Table 2. Types of waste generated.

Waste Type	Frequency	Percentage
Plastic	See verified results in the final survey results	See verified results in the final survey results

Waste Type	Frequency	Percentage
Food/organic	See verified results in the final survey results	See verified results in the final survey results
Packaging	See verified results in the final survey results	See verified results in the final survey results
Paper/cardboard	See verified results in the final survey results	See verified results in the final survey results
Glass	See verified results in the final survey results	See verified results in the final survey results
Metal	See verified results in the final survey results	See verified results in the final survey results
Other	See verified results in the final survey results	See verified results in the final survey results

In the final survey results, the verified results from the two questionnaires that were sent out are displayed. Each set of questionnaires is analysed independently as they ask different questions and have different groups of respondents.

7.3 Source segregation

One of the most critical behavioural problems that arose in the role of the source of segregation. The current project report indicates that one of the respondents always separates waste, whereas most of the respondents report that they do so sometimes or rarely. This is important as it will be the first stage in practice where segregation can be used to direct waste into various recovery streams.

Table 3. Frequency of source segregation.

Segregation Frequency	Frequency	Percentage
Always	See verified results in the final survey results	See verified results in the final survey results
Often	See verified results in the final survey results	See verified results in the final survey results
Sometimes	See verified results in the final survey results	See verified results in the final survey results
Rarely	See verified results in the final survey results	See verified results in the final survey results
Never	See verified results in the final survey results	See verified results in the final survey results

The pattern should be taken in conjunction with infrastructure. However, if there are no convenient use of separate bins then requesting businesses to separate adds an extra task for them. Therefore, low segregation does not necessarily mean that there is low concern for the environment.

7.4 Recycling and reuse

The number of respondents that said recycling was an important individual action in the existing project was 15. This means that the recycling behaviour is recognized as a desirable behaviour. The study does not, however, differentiate perceived importance from consistent implementation. The results from the final survey analysis should be compared to the number of respondents who believe that recycling is important and the number of respondents who actually report that they recycle on a regular basis.

Table 4. Recycling and reuse indicators.

Indicator	Frequency	Percentage
Consider recycling important	See verified results in the final survey results	See verified results in the final survey results
Recycle regularly	See verified results in the final survey results	See verified results in the final survey results
Reuse materials	See verified results in the final survey results	See verified results in the final survey results
Reduce unnecessary packaging	See verified results in the final survey results	See verified results in the final survey results

This comparison can provide insight into an awareness–action gap. This is because the results indicated that the percentage of respondents who thought that recycling was important was significantly higher than the percentage who recycled regularly, suggesting that there was a need to look at the role of intention in recycling.

7.5 Awareness of sustainable waste management

Out of the existing project, only seven were reported as knowing about sustainable waste-management. This provides an indication that there is a knowledge gap as well as an implementation gap. The two gaps should not be considered as the same gap, however. Some may be aware but not respond due to infrastructure problems, or others may need to be made more aware of the situation before they can change their behaviour.

In the final survey results, the verified results from the two questionnaires that were sent out are displayed. The questionnaires are analysed separately since their questions and groups of respondents vary.

7.6 Willingness to change

There were 4 people who indicated that they would be likely to change their waste disposal habits and 14 who indicated that they would not be likely to change. This is significant since the willingness is something that could provide an opportunity for intervention. Therefore, a community programme should not be solely about changing behaviour but also identify ways of making what is already being done easier to implement in the community.

In the final survey results, the verified results from the two questionnaires that were sent out are displayed. The questions and the groups of respondents vary and thus the questionnaires are analysed separately.

7.7 Barriers

The community interactions found that the following barriers reoccurred: separate bins were lacking; there was not enough time; it was hard or inconvenient to collect items separately; understanding of material lifecycles was limited; there was a perceived additional effort and lack of visible enforcement. These barriers illustrate context shaping sustainable behaviour.

Table 5. Barriers to sustainable waste management.

Barrier	Frequency	Percentage
Lack of separate bins	See verified results in the final survey results	See verified results in the final survey results
Lack of time	See verified results in the final survey results	See verified results in the final survey results
Lack of information	See verified results in the final survey results	See verified results in the final survey results
Additional effort	See verified results in the final survey results	See verified results in the final survey results
Collection inconvenience	See verified results in the final survey results	See verified results in the final survey results
Lack of enforcement/ monitoring	See verified results in the final survey results	See verified results in the final survey results
Other	See verified results in the final survey results	See verified results in the final survey results

7.8 Overall finding

The pattern that is emerging is that some respondents don't have enough knowledge, some have the knowledge but they don't do it all the time, and many have knowledge but a practical obstacle exists that makes it hard to act sustainably. Most useful intervention is therefore likely to be a combination of awareness and infrastructure design and routine.

7.9 Final survey results

The final analysis of the submitted survey data is presented in this section.

The two CSV files provided with the research paper contain 25 entries each, for a total of 50 responses to the two separate questionnaires. The first questionnaire asks questions on business/shop waste practices ($n = 25$) and the second asks questions about community awareness and experiences of local waste management among residents, shopkeepers, street vendors and other respondents ($n = 25$). These are not 50 answers to the same questionnaire. Results are thus reported separately, and themes compared where questions overlap. Percentages are expressed as such with the denominator in the questionnaire in question. Percentages may sum to more than 100% due to rounding of multiple items.

7.9.1 Business and shop survey

The business sample included: Food Stall: 6 (24.0%); Kirana Store: 6 (24.0%); Fruit/Vegetable Vendor: 5 (20.0%); General Store: 5 (20.0%); Pharmacy: 2 (8.0%); Clothing Shop: 1 (4.0%). This spread provides illustrative examples of different types of small businesses but not a probability sample and thus cannot be used to represent all businesses in the area. Food stalls, organic residue collectors, packaging collectors, and fruit/vegetable vendors may collect organic residues and packaging; kirana and general stores may collect cartons, packaging (plastic and paper), and paper; pharmacies and clothing shops have varying material profiles. If one intervention is applied to all businesses, it will not be an effective one.

The multiple response waste question had responses for plastic (88.0%), food waste (56.0%), packaging material (76.0%) and paper/cardboard (48.0%). These counts refer to people who referred to the category, and not to the weight or composition of the waste. They do make plastic, food waste, packaging and paper/cardboard sensible local priorities, though.

Usual disposal routes were: Public dustbin: 8 (32.0%); Municipal waste collection: 7 (28.0%); Private waste collector: 6 (24.0%); Open area/roadside: 3 (12.0%); Burn the waste: 1 (4.0%). Open area/roadside disposal was the choice of three respondents and burning waste was reported by one. All of these answers are worthy of consideration as open dumping and burning may cause environmental and public health problems. The survey does not quantify the quantities disposed of this way or confirm each response. The responsible interpretation is that these practices were reported by a small number of respondents, and deserve further investigation.

Separation of biodegradable and non-biodegradable waste was reported as: Sometimes: 11 (44.0%); Rarely: 7 (28.0%); Never: 6 (24.0%); Always: 1 (4.0%). 11 responded "sometimes", 7 responded "rarely" and 6 responded "never", with only one responding 'always' (4.0%). Also, 15 (60.0%) reported not using separate dustbins, five said they did use separate dustbins, and five planned to do so. The results highlight an operational problem, segregation is not a routine for most of this business sample, and the lack of separate bins can make the desired action more difficult.

Awareness of sustainable waste management was: No: 13 (52.0%); Yes: 7 (28.0%); Not sure: 5 (20.0%). Fourteen of the respondents indicated that they are willing to change their disposal habits, eight respondents were not sure, and three respondents were not willing to change their disposal habits. This means that there was an opportunity to support in practice but not necessarily a success in the adoption of new habits. The dubious group is important: Demonstrations, clear instructions, appropriate containers and consistent collection can be more effective than general messages.

Open ended business responses mentioned lack of proper dustbins, irregular garbage collection, mixing wet and dry waste, open dumping, overflowing dustbins, littering, limited recycling facilities, burning, plastic waste and lack of awareness. The following comments provide details regarding the closed-ended findings and show that respondents perceive the issue as being a result of their personal conduct, and availability of facilities and quality of local services. A solution that solely addressed individual responsibility would not encompass the breadth of issues outlined.

7.10 Community Awareness Survey (CAS) introduction

The second questionnaire has mixed community responses of 25. These respondents comprised shopkeepers, street vendors, residents, food-stalls owners and others from localities such as Indirapuram, Shipra Suncity, Vaishali and others that were noted. The sample can be helpful for exploratory evaluation, but is too small and selected in a way that does not allow for statistical generalisation to all the residents or businesses in those localities.

Self-rated awareness of proper waste disposal was: High: 9 (36.0%); Moderate: 7 (28.0%); Low: 5 (20.0%); Very High: 3 (12.0%); Very Low: 1 (4.0%). When asked about the knowledge of wet/dry segregation, 13 responded "Yes", nine "Somewhat" and three "No". On knowledge of harmful effects of improper disposal, 12 answered "Yes", four "Somewhat" and nine "No". Awareness of government or local initiatives was: Yes: 14 (56.0%); No: 6 (24.0%); Not Sure: 5 (20.0%). The results indicate an awareness but varying across topics. Waste harm is a different category of knowledge from understanding wet/dry segregation and knowledge of a local initiative.

Usual disposal methods were: Throw it in an open area: 10 (40.0%); Throw it in a community dustbin: 7 (28.0%); Give it to the municipal waste collector: 6 (24.0%); Burn it: 1 (4.0%); Other: 1 (4.0%). Ten respondents reported throwing waste in an open area, seven using a community dustbin and six giving waste to a municipal collector; one reported burning waste and one selected another option. The 10 open area responses are important indicators for follow-up. The questionnaire does not indicate whether this is indicative of all waste or occasional disposal or a specific situation. Observation and discussion with the collection providers will be useful in explaining the causes and extent.

Wet/dry segregation frequency was: Often: 8 (32.0%); Always: 7 (28.0%); Sometimes: 6 (24.0%); Rarely: 3 (12.0%); Never: 1 (4.0%). Seven people responded “Always”, eight people responded “Often”, six people responded “Sometimes”, three people responded “Rarely” and one person responded “Never”. So, for 15 out of 25 respondents (60.0%) wet waste was always or often separated from dry waste. This is good news, but leaves 10 of the respondents without consistent segregation. It should not be directly compared with the business survey, due to different questions and groups of respondents.

The most frequently reported waste categories were: Food waste: 6 (24.0%); Plastic: 6 (24.0%); Packaging waste: 6 (24.0%); Paper/Cardboard: 4 (16.0%); Glass/Metal: 2 (8.0%); Other: 1 (4.0%). Reuse/recycling frequency was: Always: 7 (28.0%); Sometimes: 7 (28.0%); Often: 6 (24.0%); Rarely: 4 (16.0%); Never: 1 (4.0%). Plastic handling was: Put it with general waste: 9 (36.0%); Give it to a waste collector: 7 (28.0%); Throw it outside: 5 (20.0%); Reuse it: 4 (16.0%). Nine respondents reported putting plastic in with general trash, seven gave it to a waste collector, five threw it outside and four reused it. This means plastic is not always channeled towards recovery. Future questionnaires should clarify whether or not a collector is known as a separator/recovery collector.

The most significant problems of waste management locally were lack of dustbins (7, 28.0%), poor waste segregation (7, 28.0%), lack of awareness (5, 20.0%), open dumping (4, 16.0%), irregular waste collection (1, 4.0%) and excessive plastic waste (1, 4.0%). Poor dustbin provision/poor segregation was the top two results, with lack of awareness and open dumping coming next. The satisfaction with the collection was mixed: seven respondents very satisfied, seven very satisfied, seven neutral and four dissatisfied. Some of the respondents may be receiving satisfactory service and others may suffer difficulties with location/timing, overflowing containers or segregation.

Reported barriers to segregation were: Irregular collection: 8 (32.0%); Lack of awareness: 7 (28.0%); Lack of time: 5 (20.0%); Lack of motivation: 3 (12.0%); Lack of trust in the system: 1 (4.0%); Lack of separate dustbins: 1 (4.0%). The improvements desired were as follows: Regular waste collection: 7 (28.0%); Waste segregation facilities: 5 (20.0%); Awareness campaigns: 5 (20.0%); More dustbins: 3 (12.0%); Fines for littering: 3 (12.0%); Recycling facilities: 2 (8.0%). The most common barrier chosen was irregular collection and the most common improvement was regular collection, followed by segregation facilities and awareness campaigns. Respondents are not only asking for information, but also for service reliability and facilities are practical needs.

Participation in local cleanliness or awareness activities was: Probably: 8 (32.0%); Probably Not: 8 (32.0%); Definitely: 5 (20.0%); Maybe: 4 (16.0%). 8 respondents answered “Probably Not”, 8 answered “Maybe” and 5 answered “Definitely”. It is not assumed that a group will participate, but through local activities, a group may be accessible. Sixteen people said it is important for educational institutions to be helpful in raising awareness, five people replied “Maybe” and four people responded with “No”. The preferred activities were: Cleanliness drive: 7 (28.0%); Waste segregation

demonstration: 5 (20.0%); Awareness workshop: 4 (16.0%); Door-to-door awareness: 4 (16.0%); Recycling campaign: 3 (12.0%) and Social media campaign 2 (8.0%). The most popular were cleanliness drives and segregation demonstrations, which complemented all the support for practical and participatory outreach.

7.11 Comparative interpretation of the two surveys

The two surveys have similar material challenges. Food waste, plastic and packaging waste are also significant business items and were among the top three business concerns reported on the community survey. This convergence helps to prioritise these materials in a local pilot. Does not display the most "Heavy" or "Environmentally Harmful" material as the surveys are in categories not measured amounts.

There is some inconsistencies in segregation in both questionnaires. None of the respondents always used separate dustbins for biodegradable and non-biodegradable waste and 15 respondents did not use separate dustbins in the business survey. In the community survey 15 people always or often separate their waste into a separate wet waste bin, with 10 people sometimes, rarely or never doing so. These are not a controlled comparison, they simply indicate that segregation is important as a topic throughout the broader project.

The results of the awareness are complicated. The business respondents had not heard of sustainable waste management (13) or were unsure (5); the community survey had a spread of self-reports of awareness. There was no contradiction among these results due to different measures of the questions. Someone might have heard an environmental message without being able to identify segregation of materials, while another might know how to sort wet/dry waste, but not the term "sustainable waste management". The separation between awareness and practice should be made in the future assessment.

Reliability of infrastructure and collection is a cross cutting issue. Business respondents highlighted the issues of missing bins or bins that are not collected regularly and for community respondents, poor segregation and irregular collection were the key issues. The regular collection was the most common improvement selected as well. The convergence helps facilitate alignment of awareness with service delivery. While this message is crucial, it can feel like a waste of effort if people don't have the resources to separate into containers and have an effective collection system.

The surveys suggest a willingness to take action, but don't necessarily mean they are "ready". The four groups that responded to changing reported willingness to change (14) but were not sure (8). Of those who responded to the community survey, 13 indicated they would definitely take part in community activities, while 12 indicated they would probably not or maybe take part in community activities. Interventions should be inexpensive, obvious and accessible; small specific actions might be easier to achieve than sweeping requests to change all practices all at once.

7.12 Verified key indicators

Table 6. Verified key indicators.

Indicator	Count	Percentage
Business survey responses	25	100.0%
Business respondents reporting plastic waste	22	88.0%

Indicator	Count	Percentage
Business respondents always segregating	1	4.0%
Business respondents not using separate bins	15	60.0%
Business respondents aware of sustainable waste management	7	28.0%
Business respondents willing to change	14	56.0%
Community survey responses	25	100.0%
Community respondents reporting open-area disposal	10	40.0%
Community respondents always/often segregating	15	60.0%
Community respondents identifying lack of dustbins	7	28.0%
Community respondents identifying poor segregation	7	28.0%
Community respondents selecting regular collection as improvement	7	28.0%
Community respondents saying educational institutions can help	16	64.0%

8 Discussion

8.1 The Awareness–Action gap

The key takeaway from the study is that awareness alone is not enough and needs to be followed by behaviour. The results that have been published are already a good illustration. Only one respondent was recorded as always segregating waste while recycling was viewed as important by 15 respondents. Meanwhile 14 respondents indicated that they would like to alter their disposal practices. The mix implies that there is no apathy. On the contrary, there is a mix of recognition and willingness in the environment, as well.

This is consistent with a behaviour-related explanation that posits that perceived control and environmental opportunity are important. One person may say that segregation is a good thing but may not actually be practicing it because they may not be able to find separate containers or collection may be mixed or a longer time is required for segregation to occur. It is thus important to "awareness" campaigns to be part of a larger behavioural intervention.

8.2 Infrastructure as a behavioural enabler

Infrastructure is a key factor, especially. You can switch to a two-bin or multi-bin waste separation system which can help to minimize the amount of work to separate waste at source. Labels can help to eliminate confusion. Routine pick-up can have a positive impact on the level of confidence in the separation process. Adopting an approach of partnerships with recyclers can provide a destination for recovered materials. These interventions bring sustainability to life and make it a routine for the students.

This aligns with the community project's results of many communities having no provision for separate bins. It's not like all businesses need to have costly equipment. The first phase of segregation can be achieved simply by using a container, signage and coordination of the collections in many cases. The intervention that is appropriate should be commensurate with the size and type of waste of the establishment.

8.3 Plastic waste: Beyond a “stop plastic” message

The largest waste type among the ones that were most reported in the original survey was plastic. But a simple answer would be to say that businesses should desist from plastic use. This sort of message is unlikely to be achievable due to the functional and commercial roles of packaging. Separation of avoidable from unavoidable use is an improved method. Businesses can minimize unnecessary packaging, adopt reusable/pallets systems, when necessary, purchase in bulk and make sure that plastic that needs to be packaged is kept clean and separated for recovery purposes.

This is also in line with the decision-making principles of Extended Producer Responsibility. When packaging design and decisions on packaging supply chains are made upstream, local businesses must not be blamed as the main source of packaging waste. The whole chain of producers, importers, brand owners, businesses, consumers, local bodies, waste workers and recyclers have to take their fair share of responsibility with regards to circularity.

8.4 Recycling is important but not enough

The results also highlight the importance of not only the sustainability message about recycling. Downstream of consumption and disposal is the recycling. Avoidance of material, and its reuse may mean that it is not even required for recycling. Therefore the community workshop recommended to the participants the consideration of reduction, reuse and recovery along with recycling.

Reuse also can be of economic benefit to commercial establishments. Cartons can be used to store products; containers can be reused if they are suitable; packaging waste can be minimized and product purchasing can be revamped. The results of these actions can be to reduce the costs of the materials used in addition to any environmental effects, depending on the business.

8.5 Business context matters

Different businesses have different waste-management needs due to the variety of businesses. An organic/substrate separation system may be required by a food vendor. It can be necessary for a grocery store to have a separate cardboard stream. Maintaining a dry and clean paper at a Stationery shop can be beneficial. There are two ways that the bakery can solve organic waste and packaging issues. Regulated waste may be a subject of special regulations for medical stores. Ideally recommendations should be specific not general.

8.6 The role of the government and local institutions

Government programmes offer crucial institutionalisation and implementation is at the local level. The plastic waste rules, EPR, and the Swachh Bharat Mission – Urban 2.0 highlight the need for responsibilities along the plastic value chain and source segregation and processing of plastic waste. There is a need to link up awareness of the policy with its availability in practice as suggested by the local evidence. Any policy mechanism that isn't known to or accessible by a business cannot help or benefit that business.

It is important to coordinate, therefore. Strengthening segregated collection; supporting separated materials in the businesses; creating viable recovery pathways for recyclers; supporting packaging recovery; and raising awareness among community groups can all help improve segregated collection. The circular economy is made more feasible when these roles are linked up and not looked at individually.

8.7 Community engagement as a research method

The project's emphasis also highlights the importance of community involvement in the project. In face-to-face exchanges, concrete limitations were identified which can not be seen during a desk review of the policy. This experience revealed environmental issues are environmental, economic, behavioural and infrastructural. It is a valuable methodological point to note that listening to the people that create change is a valuable way sustainability research can help.

8.8 Circular economy readiness

Not all businesses may be able to be measured on their recycling, and that's only step one in becoming circular-economy ready. It should contain awareness, willingness to reduce waste, capacity for segregation and link to recovery systems, capacity for reuse and opportunities for reuse. If this broader definition is adopted, the study community is partially ready: It is aware of the importance of recycling and many are ready to make the change, however, segregation and the system support are still not sufficient. Thus, the community seems to be in a transitional phase and not yet in a circular model.

8.9 Implications for the Awareness–Action–Infrastructure framework

The finished data sets provide the proposed framework with more empirical support. Awareness is related to knowledge about the problem and understanding of appropriate practices. Action involves practices like separation, reusing and disposal of materials. Infrastructure – bins, collection schedules, space, signage, access to recovery channels. The results of the survey can be seen for each dimension, although the questionnaires do not measure each dimension in the same way.

Part of the need for awareness is that the respondents must be aware of what should go where and why mixing wastes can decrease the recovery rate. However, information is not going to be enough to solve the problem. The concerns by business respondents about missing bins and the focus on irregular collection in the community survey suggest that there are practical concerns. If there are no separate containers or people do not feel that separated waste will stay separated, they may not see the advantage of taking the additional step.

Actions need to be thought of in the context. Small shops might not have sufficient floor space, staff might be busy serving customers and waste might be building up during busy periods. It may be impossible to have more than one large bin in a household. The right action should be easily achieved and proportionate to the setting when performing an intervention. Clear instructions on how and when to put things in the trash may be more helpful than detailed instructions.

Infrastructure requires coordination. When businesses part with but no collector picks up their cardboard, it could be a part of regular trash. Collection of wet and dry waste material together could make the participants lose faith. Overflow can be a problem if containers are available, but not emptied regularly, which may enable the intervention to fail. Local government, private collectors, industrial and corporate waste generators, waste workers and recyclers should thus be a part of planning.

The sequence suggested in the framework is to inform, equip, collect/recover reinforce behaviour with feedback and follow-up. The sequence needs to be tailored in relation to the material stream and the type of business and measure should be used to determine if there is an information, behavioural or infrastructural barrier.

9 Government initiatives and policy context

There are a few mechanisms of the waste-management policy regime in India that are relevant to the findings. Under the Urban sanitation and solid waste management, Swachh Bharat Mission- Urban 2.0 has been designed which includes source segregation, collection, processing and management of solid waste. The behavioural aspect of it is significant for this research as community participation is essential in implementing policies at the point of waste generation.

In addition, plastics-waste management has been evolving via regulatory measures and EPR. As per the document prepared by CPCB, there are arrangements for EPR being made involving the producers, importers, brand owners and waste processors. The framework acknowledges the importance of the responsibility not just of the end user, but also of all those who have interacted with the flow of plastic waste. For the community that is the focus of this study, it suggests the need for taking sustainable waste management as a value-chain responsibility shared by the community.

The Circular Economy Cell under the Government of India, NITI Aayog, is a mechanism for coordination at policy level for circular economy action plans, set up in September 2022. Cleaning, as practiced in regular cleaning campaigns, is a part of the circular economy approach, as it takes into account resource efficiency, material recovery or reuse of materials. This resonates with the focus of the study that stresses the concept of waste as resource and not just waste to be eliminated.

Meanwhile, policies are not necessarily being implemented locally. Three gaps (information gap, convenience gap, behavioural gap and coordination gap) are identified in the study. The gaps identified indicate a need for mechanisms at the local level to make policy translate into everyday procedures in small businesses.

10 Community intervention and circular-economy implications

The awareness workshop, which was a part of the project, was called “From Waste to Resource: Understanding the Circular Economy”. It was constructed to make the survey results into action that would result in learning. The workshop was not a lecture, but an interactive experience that asked participants to think about how waste is disposed of after it's picked up, what should be done with waste, and have them think about one reasonable step they could take.

Some of the suggested activities were the separation of wet waste, reduction of over-packaging and recycling of cardboard and keeping recyclable materials separate. The logic of the intervention was thus Awareness–Action–Infrastructure: tackling the awareness, showing what action looks like, and identifying conditions for sustaining action.

The workshop is not meant to show up the impact the program will have in the long term but rather as a first step in behavioural intervention. A single workshop will not lead to long-lasting change of behaviour. A follow-up survey should be administered after a few weeks or months to see if the participant(s) took the action(s) that they had planned and to ascertain what barriers they encountered.

10.1 Draft Tidy Towns plan

A neighbourhood pilot should boil the survey results down to a practical list of activities to remove waste in the neighbourhood, not the promise of a total neighbourhood waste elimination. Start with a mapping activity to determine what properties are interested, where containers are already in place,

when they are collected, common materials and potential recycling partners. Mapping should be used to aid planning and should not reveal individual responses to the survey.

Phase 1: Baseline (Weeks 1-2) and coordination: verify participating sites and meet with collection providers. Note if labelled bins are used, if containers overfill and the approximate collection date and is separated material separated. Apply the same checklist when checking at the follow up. Never make judgements about the level of waste based on the categories of response; the actual quantities must be weighed or another specified method used to measure the waste.

Phase 2—Practical guidance and facilities (Weeks 3-4): develop a one page guide containing examples for all establishments Food stalls can be on food waste and packaging that is disposable; grocery shops on cardboard and plastic packaging; stationery shops on clean paper; and bakeries on food and packaging. Pharmacies are obligated to comply with relevant regulations on the disposal of regulated waste and are not allowed to place this in a normal waste stream. Where possible, offer clearly labelled containers and label should correspond with the local collection program.

Phase 3 – Collection coordination (Weeks 3-6): on the coordination of collections – agreed on days, who does what and a point of contact for those who miss their collections. Inquire with providers what materials they will accept, and how materials should be presented. If material becomes mixed downstream, investigate the problem before having participants increase their efforts. When the actual service is the same as the instructions given during awareness activities, this is more likely to build trust.

Phase 4 – Community reinforcement (Wk5-8): conduct a practical segregation demonstration, cleanliness activity or brief awareness workshop. Do not use only abstract messages, or only include real examples. Use reminders around containers and make it easy for each participating business to take a take-it-as-it-is-it responsibility for checking bins. Participation must be voluntary, convenient and respect business hours.

Repeat core questions/do observations with permission (Phase 5, Weeks 9–10). Determine if bins are labeled at the location, if there are changes in the frequency of segregation, if there are missed collections and if the participant(s) knows where separated materials are taken. Post campaign follow-up after 1-3 months would help determine the persistence of practices following the campaign. Be cautious when reporting an improvement when there is no comparison group.

This issue ought to be a team effort. The student/community team may lead the way in gathering information and evaluation; business owners may help facilitate day-to-day operations; collectors may provide information on accepted materials, services, and schedules; municipal representatives may provide information on offered services; and recyclers may provide information about viable recovery streams. Schools can help with the awareness and volunteers, but are not a replacement for infrastructure and reliable collection.

The implication for the circular economy is that there's a need to establish material pathways, rather than behavioural intentions in the community. When the respondents part the cardboard but an effective means of recovery is not found, the intervention could lose credibility. On the other hand, businesses have an obvious incentive to keep up the recycling of clean cardboard if it's collected by a local recycler on a regular basis. Thus feedback effects between the behaviour of the system and the performance of the system are significant.

11 Recommendations

11.1 Implement a practical two-bin or multi-bin waste system

Local businesses should be urged to have clearly labelled bins for the significant waste streams associated with their business. The system should be very easy to use for employees during peak times. Labels and Examples can help decrease confusion.

11.2 Reduce before recycling

The first step for businesses is to find out the unnecessary packaging and material usage. Buying in bulk and eliminating double packaging and choosing reusable systems where possible, can help to minimise waste at source.

11.3 Promote reuse

Appropriate cartons, containers and packaging materials should be reused, provided hygienically and operationally suitable. Reuse programs should be customized to the specific type of business and should not be required of all businesses.

11.4 Improve segregated collection

There is need for reliable separated stream collection by municipal and community stakeholders. Segregation is dependent on the credibility of the respondents that separated material will be kept separate and delivered to the appropriate processing channels.

11.5 Engage in continuous Awareness, not one-time campaigns

Remind people of the awareness, using short reminders, posters, community meetings, school activities and business outreach. Occasional behaviour can build up to being a routine with continuous reinforcement.

11.6 Develop mechanisms for recognition and incentives

Local government or community groups may designate those businesses that consistently segregate, minimize packaging or are involved in recycling efforts. Recognition, as well as penalties, can also be used to create a positive social norm.

11.7 Develop business-specific guidance

Specific directions need to be given on a case-by-case basis to different venues. Food businesses can adopt the organic/dry separation, grocery shops can adopt the cartons/packaging, stationery shops can adopt the clean paper/cardboard, bakeries can adopt the food streams and the packaging streams, and medical stores can adopt the appropriate handling of regulated materials.

11.8 Strengthen value-chain coordination

A working connection between businesses, municipalities, producers, recyclers and waste workers should be established via practical recovery arrangements. There is a need to coordinate along the entire material pathway to ensure circularity.

11.9 Conduct follow-up measurement

Post intervention follow-up survey should be done. They should involve bin availability and perceived convenience, reuse, reduction, segregation frequency and recycling. This would enable transitioning of the project from awareness assessment to impact evaluation.

11.10 Monitoring and evaluation

Activities, outputs, outcomes and long-term impacts should all be distinguished when monitoring. Activities include workshops and demonstrations, and meetings with collectors. Outputs are the number of businesses reached, number of guides distributed, containers labelled, collection arrangements agreed. Short-term benefits of these are improved knowledge and increased segregation, reduced mixed materials and increased confidence of collection. The potential longer-term impacts for reduced disposal and/or increased recycling cannot be assumed from workshop attendance and/or stated intentions, and should be measured.

Table 7. Monitoring and evaluation indicators.

Dimension	Suggested indicator	Evidence source
Awareness	Share correctly identifying relevant waste categories	Baseline/follow-up questionnaire
Segregation	Share of sites reporting regular segregation; observed bin use	Survey and site checklist
Infrastructure	Sites with labelled containers; overflow incidents	Observation checklist
Collection reliability	Missed or delayed collections during pilot	Collection log
Material recovery	Quantity of clean recyclables recovered, if measurable	Collector/recycler record
Participation	Number of establishments and community members involved	Attendance record
Behaviour persistence	Whether practices continue after the activity	Follow-up after 1–3 months

Assessment should document unexpected challenges faced and successes obtained. There may be additional containers that need to be collected, these times may not match with the working days of the business, and the containers might be refused by the recyclers. These findings contribute to a better design of the intervention. A realistic programme takes account of how it is implemented rather than thinking that all the recommended actions are possible in all settings.

12 Limitations and future research

Some limitations of the study are mentioned below. One sample, particularly, is limited by the number of establishments and is based on the establishments that are accessible locally. The conclusions are therefore not statistically generalizable to all businesses, or communities. Second, there are some measures that are based on self-reported behaviours. Respondents may exaggerate their behaviour that is good for the environment. Third, a cross-sectional study was used for the main survey, which does not allow for any determination of whether awareness leads to long-term behaviour change or whether willingness leads to awareness.

Another constraint is that the project relies mainly on a descriptive analysis. The number of observations might not be adequate to enable more complex analyses. Relationships between awareness and infrastructure, perceived control and behaviour, could be tested with larger samples in the future. Interventions could also be evaluated in longitudinal studies to determine if they continue to be effective following the campaign.

Future studies could include a comparison of the different establishment categories, the economic cost and benefits of sustainable practices, mapping of local recycling channels and evaluation of the role of digital communication. Information on consumer needs could also be gathered as business packaging decisions might be affected by consumer preferences. Lastly, future research could examine the involvement of waste workers and informal recyclers, who are crucial to material recovery in the business level, but may not always be considered as part of the study.

12.1 Additional limitations and data quality

The total of 50 records in the two files is a total of 50 responses across two questionnaires, it is not 50 responses to the same questions in two different questionnaires. The business survey includes items related to the type of shop and business waste, the community survey includes items related to age, occupation, locality, disposal methods and preferences of the community. The denominators for each of the surveys are different: 25. It would be misleading to combine the two data sets into one overall percentage.

Names appear in the business file, but are not reproduced in the findings as they are not needed for the analysis. Contact data should be collected using anonymous codes for respondents and contact data should be held apart from the data that is collected. Timestamps are only available as an indication of when forms were submitted and don't necessarily confirm when each response was made but in each case.

There are multiple choices for some of the questions, especially the business question—waste types and individual actions. Option percentages are using the number of respondents as their denominator, and option percentages can be greater than 100%. These values reflect respondents' comments about materials and not the percentage of total waste (by weight or volume).

The datasets are self-report based. It is possible that the respondent will either misinterpret the question, come up with a definition of recycling that differs from the interviewer's, or report socially desirable behaviour. The survey does not involve direct weighing of wastes, systematic observation of all disposal events, logs from the collection service and/or verified records of recycling. Results are not necessarily environmental outcomes, but instead are patterns and preferences that may have been reported.

The different questionnaires have varying wording. One is asking about biodegradable/non-biodegradable waste and the other asks about wet/dry waste. The concepts are similar, but not the same. The awareness of sustainable waste management is not the same as merely saying that you're aware or unaware. Themes are compared and these measures are retained separately.

The sample is small and the respondents seem to be easily accessible. It does not represent all businesses and residents in the localities as a whole. The study is exploratory and appropriate for the purposes of identifying practical questions, designing a pilot, and making recommendations, not for causal inferences or estimates for a population.

13 Conclusion

The study discusses sustainable waste management behaviour and readiness for circular economy of local business entities using a community-based service-learning approach. The study started by a simple observation that businesses produce waste each day, but the impacts on the environment are significant based on what is done with the materials following their use. Field interaction showed waste management was not just an environmental problem. Also the issue of convenience of the business, infrastructure, knowledge, habit, cost, coordination and institutional support

This evidence of an awareness–action gap was found in the results. Plastic was determined to be the most dominant type of waste in the current community Assessment with 22 respondents reporting generation of plastic waste. One of the respondents was observed to always separate waste and 15 respondents thought that recycling was important. Seven people knew of sustainable waste management, 14 people were ready to change their waste disposal. These are all findings that indicate there is both a behavioural challenge and opportunity for intervention in the community. It is possible that some people may see the benefits of sustainability and not have the circumstances to consistently practice it.

The study thus suggests that the sustainable waste management needs to be perceived under the Awareness–Action–Infrastructure concept. To sustain the behaviour, a clear sense of awareness equals knowledge and motivation, and infrastructure equals action. All three are required to have a successful intervention. Infrastructure is necessary to create awareness or else frustration will occur. The knowledge about infrastructure is not necessarily used. If behaviour changes without solid collection, it is not credible.

A circular economy perspective is added. The aim is not only to improve the cleanliness of disposal but to minimise unnecessary usage of materials and ensure that resources are kept in circulation. Local businesses can help by minimizing packaging, reusing appropriate materials, separating waste, promoting and engaging in recycling and waste recovery. These actions are small steps small steps, but big steps, when taken together.

There is a solid base of government programmes and policies. Plastic Waste Rules and Extended Producer Responsibility (EPR) focuss on responsibility in the value chain, whereas Swachh Bharat Mission–Urban 2.0 encompasses the concept of source segregation, collection and processing. NITI Aayog's Circular Economy Cell also illustrates the national shift towards planning for circular economy. However, implementation at the local level is needed. Policies are effective when the business community, the public, local governments, waste collectors, recyclers and producers can work together.

Listening is the key to positive environmental change, however, and the most important lesson of the project. Not only are community members receiving awareness messages, they also know about the practicalities which influence the possibility of sustainable behaviour. Future interventions should leverage this and practice the design of workable, business-specific and measurable solutions. No single campaign nor policy or stakeholder can make the transition from waste to resource. This is done by establishing a system that makes responsible behaviour comprehensible, easy, supported and worthwhile.

Appendix

The Community Survey and Field Observations are included in Appendix A.

Two structured questionnaires with 25 answers each were developed to investigate sustainable waste management among businesses and community citizens. The questionnaires included questions on waste generation, waste disposal, source segregation, recycling, awareness, barriers to sustainability and willingness to be sustainable.

Field observations and community interaction with local commercial establishments such as food stalls, grocery stores, restaurants and other small business establishments were done. These activities highlighted issues for practice including poor waste segregation, and a lack of separate dustbin and regular waste collection.

The results of the survey were reflected in the analysis of sustainable waste management and circular economy practices which is presented in the research paper, as well as the field observations were **reflected**.

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