

CHAPTER 2

LITERATURE REVIEW

2.1 Municipal solid waste definitions

Solid waste is simply the undesired solid materials that we discard from our homes, businesses, farms, factories, and even public service. Municipal solid waste is a specific sort of rubbish that excludes hazardous industrial waste. It focuses on the solid or semi-solid waste generated in our homes and companies within cities and defined zones. This includes food scraps, packaging, yard debris, and broken furniture, excluding hazardous materials and contaminated medical waste (MOEF, 2000). The World Health Organization (WHO) defines "solid waste" as any undesired or abandoned things that we throw away. This comprises residential trash, street sweepings, waste enterprises, and waste that farms generate daily. In other words, it refers to any solid waste that needs disposal (Bhaskar & Kumra, 2013). The German Waste Act of 1972 had a broad view of trash and defined it in two ways: anything that is discarded by the owner, and further, it also includes items that had to be disposed of correctly in order to safeguard the safety and health of others, even if the owner wished to keep them. This second concept discouraged people from improperly keeping hazardous or toxic materials (Bilitewski et al., 1997).

The Resource Conservation and Recovery Act (RCRA) of 1976 provided a significantly broader definition of waste in the United States than the German Waste Act. RCRA classifies anything thrown away as waste, including rubbish, trash, sludge from different treatment plants, and even gaseous pollutants caught during industrial processes. This idea goes beyond solid things to include liquids, semi-solids, and gases

that are trapped. It also catches a lot of waste from all areas of life, such as industry, business, mining, farming, and everyday home activities. RCRA focusses on all the bad things that need to be dealt with after use (Krishna & Chaurasia, 2017). The makeup of municipal solid waste, which includes many different kinds of trash, varies from place to place (Srivastava et al., 2014). Solid waste management (SWM) is more than just picking up trash; it's a key part of making a city function well. Good SWM helps keep the environment safe and healthy for residents by properly handling the waste they make. But that's not all there is to it. SWM can also help the economy in the long run by starting recycling and waste-to-energy projects.

The Government of India introduced Solid Waste Management and Handling (SWM&H) Rules 2000 to set up regulation for how to properly handle and dispose of municipal solid waste. These rules put all the responsibility for dealing with and managing this trash on ULBs, the groups that run cities and towns. This means that these local governments are in charge of making and following rules for collecting, handling, and getting rid of trash in their areas (Goel, 2017). People's views on how to deal with trash, on the other hand, are different and depend on their background and current situation. When it comes to picking up trash, values, feelings, social circles, and expectations are all important denominators for successful implementation (Shatnawi, 2018). For instance, studies show that families with kids are more likely to recycle because they want to be good stewards of the environment for their kids' sake (Xu et al., 2019). Other studies indicate that the social and economic factors may not always affect how people throw away their trash. But the level of income can have a significant effect, as households with lower incomes may have a worse view of waste management systems (Parfitt et al., 2010). Lastly, the things people do and the way they live affect

how much trash they make and how they get rid of it (Yoda et al., 2014). Some studies have even found a link between bad waste management and health problems (Yoda et al., 2014). Further studies have shown that people are more likely to sort their trash if they think it will help keep their environment clean. Lastly, the number of people living in a house may affect how trash is sorted. For example, people who live in larger homes are less likely to separate their trash (Apasrawirote & Yawised, 2022).

2.1.1 Growing problem of waste in India

India is facing a significant waste crisis, generating approximately 62 million tonnes of municipal solid waste (MSW) each year, a figure anticipated to rise to 165 million tonnes by 2030 (Kaza et al., 2018). Despite this alarming trend, only 43 million tonnes of waste is collected, with merely 12 million tonnes being processed scientifically. In contrast, 31 million tonnes are discarded directly into landfills without treatment (International Trade Administration, 2023). A substantial portion of around 90% of the waste comprises organic material. However, the absence of source segregation leads to its accumulation in open dumpsites, where it decomposes anaerobically, releasing methane and contributing to climate change (Meena et al., 2023). Notably, major landfill sites like Ghazipur and Bhalswa in Delhi frequently catch fire due to trapped methane, further aggravating urban air pollution (Petersen & Hassan, 2025).

Additionally, India produces approximately 3.5 million tonnes of plastic waste annually, with per capita consumption approaching 11 kg. However, recycling practices remain largely informal and inconsistent, with only about 60% of plastic waste being processed. This recycling is conducted inefficiently in the informal sector (Ghosh, 2025). The issue of electronic waste is equally pressing, as India ranks third globally in

e-waste generation, producing over 2 million tonnes each year. Most of this waste is dismantled and processed informally using hazardous methods, such as acid baths and open burning, which pose severe risks to human health (Sandwal et al., 2025).

The repercussions of ineffective waste management are severe: soil and groundwater contamination due to landfill leachate, increased respiratory illnesses from air pollution, and long-term ecological degradation (Rajamgari et al., 2023). Informal waste workers, who handle most recyclable materials, often work without protective gear or social security, exposing themselves to daily toxins and societal marginalisation (Demaria, 2023). Economically, India loses valuable materials estimated at ₹5 lakh crore annually because of inadequate recycling infrastructure and enforcement of extended producer responsibility (EPR) (Ghosh et al., 2023). Although policies such as the Solid Waste Management Rules (2016), the Plastic Waste Management Rules, and the E-waste Management Rules (2022) seek to address these issues, their implementation remains inconsistent. Decentralised community initiatives, like the zero-waste model in Chanakyapuri, Delhi, and show promise but remain isolated efforts (Times of India, 2025). Without strict policy implementation, community involvement in garbage segregation, and formal sector engagement of the informal sector in waste management, India's waste problem could mushroom into an environmental and public health crisis.

2.1.2 MSW and Urbanization

Municipalities must educate inhabitants about national trash policies and local treatment methods to enable communities to manage waste responsibly (Jeswani & Azapagic, 2016; Kumar & Agrawal, 2020a). As cities expand owing to population growth, a phenomenon known as urbanisation, they face an increasing challenge: more

garbage. Rapid urbanisation has significantly increased municipal solid waste (MSW) generation in recent years (Cheng & Hu, 2010; Khan & Samadder, 2014; Raviv & Arnon, 2018; Sharma & Jain, 2020b; A. Singh & Basak, 2018). Larger populations and wealthier people tend to produce more waste. According to studies, each 1% increase in population results in a slightly greater 1.04% rise in total trash creation. However, the wealth effect is modest; a 1% increase in income results in a 0.34% increase in total waste (Wang et al., 2011). The economic expansion in rising Asian countries, driven by fast industrialisation, has come at a hidden cost: a garbage issue. Unregulated and unmanaged urbanisation, a by-product of this expansion, has strained current waste management systems.

2.1.3 Challenges in MSWM

Cities in developing countries are experiencing an increasing waste management challenge. This is due to a perfect storm of factors: fast population increase results in more individuals producing waste and urbanisation accumulates this waste in highly populated places (Ahmed & Ali, 2004; Annepu, 2012). Unfortunately, these communities sometimes lack the financial and technological capabilities to address this rising issue, making it a significant burden (Henry et al., 2006 ; Guerrero et al., 2013). Food scraps, plastic containers, metals, paper goods, textiles, and glass are common components of municipal solid waste, which is made up of trash from both homes and businesses (Sharholy et al., 2008 ; Manaf et al., 2009). MSW includes recyclable items such as paper, plastic, textiles, metals, glass, and yard waste and food leftovers. Inorganic elements such as soil make their way into MSW. Even a minor amount of building debris, usually from home renovations, gets mixed in due to a lack of proper sorting methods and low public knowledge of waste disposal. This mix of recyclables,

organics, inorganics, and even some construction debris emphasises the need for more effective waste management systems (Ghosh, 2016; Tian et al., 2013).

Among the numerous issues confronting emerging countries, managing solid waste in cities is crucial (Afroz et al., 2011; Palansooriya et al., 2019; A. Singh, 2019b). Effective national policy in developing nations should prioritise solutions to the increasing issue of solid waste (Abas & Wee, 2014; Kumar & Agrawal, 2020b). People are disposing away greater quantities than ever before as the population grows and their lives change. This includes food scraps from changing dietary patterns, packaging trash from a growing society of consumers, and even residual building supplies due to a lack of public understanding about safe disposal. As a result, local governments are trying to keep up with the increasingly difficult task of gathering, transferring, and disposing of this vast amount of municipal solid trash (Rai et al., 2017). Managing trash in cities, also known as Municipal Solid Waste Management (MSWM), entails collecting, transporting, and either discarding or recycling it (Igbinomwanhia & Ideho, 2014). Unfortunately, when these stages are not followed properly, they can pollute our air, water, and land (Oseghale, 2011). A large part of the problem is that many people are unaware of the importance of appropriate waste management and do not take the initiative to dispose of items responsibly (Nandan et al., 2017). This lack of awareness is compounded by the amount and type of rubbish we discard, which is constantly changing as researchers worldwide continue to examine domestic waste generation (Burnley, 2007; Nas & Bayram, 2008 ; Al-Khatib et al., 2010) etc.

According to a 1994 report by Khan, India's expanding urban populations are a major contributor to the country's municipal solid garbage generation issues. Kayastha and Kumra conducted a 1986 study on solid waste generation, collection, and disposal in

several Indian cities and towns (Rai et al., 2017). Research has highlighted several significant issues in municipal solid waste management in India. Sudhir et al. (1996) conducted an early study on the problems of establishing effective garbage collection systems (Sudhir, 1996). Later, Ghose et al. (2006) addressed the topic of resource allocation, focusing on how best to use limited people and vehicles for trash transportation. Their proposed solution includes optimising waste collection routes with expert system-based decision support tools (Ghose et al., 2006). These studies demonstrate India's significant issues in addressing its growing garbage problem (Goel, 2017). Urbanisation creates a slew of environmental issues, but in developing countries, managing the ever-increasing mountain of municipal solid garbage is undoubtedly the most pressing burden for local governments (Angadi, 2018; Unique, 2016). As cities grow in population, so does the amount of waste generated (Kumar et al., 2019). The increasing mountain of MSW poses a significant health risk to urban people (Diaz, 2017; A. Singh, 2019a). According to studies, waste-related disorders can reduce a person's productive life expectancy by up to 10%. This underscores the critical need for effective MSW management methods to preserve public health in our rapidly growing cities (Goel, 2017).

2.1.4 MSW & Global scenario

The amount and volume of MSW have significantly increased globally in tandem with population, industry, contemporary lifestyle, and economic prosperity expansion. Additionally, there is a tendency for city dwellers to discard more waste per person due to their higher living standards and social standing (Devi et al., 2016).

There are substantial obstacles because of the expanding demand for landfill sites to accommodate this growing trash (Idris et al., 2004). Integrated waste management is an accepted method for managing solid waste in industrialised and developing nations (Asase et al., 2009).

According to Seadon (2006), solid waste management has been an issue for at least 4,000 years. This lengthy history highlights the need for coordinated strategies to address this persistent problem. To create an efficient solid waste management system, it is essential to forecast the quantity and kind of garbage a city produces.

Rhyner (1992) emphasised the need to consider short- and long-term variations. This is further supported by Ciuta (2015), who emphasises how examining trash trends and composition can enhance waste management and recycling initiatives.

MSWM requires a well-defined strategy and the appropriate technologies (Shimura et al., 2001). Composting organic waste is a straightforward and cost-effective alternative, with acceptability determined by the waste's carbon-to-nitrogen ratio. Incineration can potentially reduce waste volume drastically, but it is expensive both upfront and over time. Its suitability is determined by the waste's heating value (calorific value).

According to Metin et al. (2003), effective solid waste management requires consistent, high-frequency data gathering conducted over an extended period. The basis for developing a sustainable waste management system is comprehending the characteristics of the waste stream.

The World Health Organization (WHO) defines health as a condition of total well-being that includes physical, mental, and social components rather than simply the absence of illness (Azar & Azar, 2016). Poor waste management procedures pose a massive threat

to this well-being. Waste generated by numerous activities concentrates on health impacts, creating a twofold threat to our health and the ecosystem we rely on. This makes proper waste management vital for maintaining our and the planet's health (Paswan et al., 2024). As cities expand rapidly, they face a growing problem: municipal solid waste. This rubbish not only causes long-term problems for people and the environment but also contributes to a vast worldwide threat such as air pollution.

2.1.5 MSW & Indian case studies

Proper solid waste disposal is essential to any waste management strategy (A. Kumar & Agrawal, 2020b). Several study articles on this topic have been published in India, evaluating trends in the amount and kind of municipal solid garbage generated by various cities, e.g. Bangalore (Beukering et al., 1999), Hyderabad (Reddy & Galab, 1998; Atwal, 2022;), Kolkata (Hazra & Goel, 2009; Sarkhel & Banerjee, 2010); Mumbai (Yedla & Parikh, 2001; Yedla & Kansal, 2003), New Delhi (Mor et al., 2006; Ray et al., 2005; Talyan et al., 2008), Chennai (Joseph, 2006; Srinivasan, 2006). Azar & Azar, 2016; Balasubramanian, 2018b; As noted by Shekdar et al. (1991), India's urban population has rapidly grown due to industrial progress. Due to the burden on municipal resources caused by this influx, it is challenging to offer basic services like waste management (Hazra & Goel, 2009).

Many Indian municipalities struggle to manage the massive amounts of unsorted waste they face (Annepu, 2012). This difficulty arises from the fact that most human activities produce garbage, and how we handle, store, collect, and dispose of it has a considerable impact on public health and the environment (Zhu & Rosen, 2009; Zia et al., 2010). Local governments struggle to determine the most acceptable disposal strategies for

their specific situations (Bhaskar & Kumra, 2013). These choices include incineration, composting, sanitary landfills, and, sadly, open dumping, which has significant environmental repercussions. Population size and total garbage generation determine the optimum approach for a given city (Mani & Singh, 2016).

A comprehensive solution remains elusive despite repeated attempts to address India's SWM issues. Most Indian cities continue to collect rubbish without separating it, resulting in a combination of trash that is difficult to manage (Patel, 2018). Furthermore, ensuring adequate treatment methods, whether central or regional, remains challenging. This absence of comprehensive waste management presents a massive challenge in addressing the expanding problem (Singh, 2015).

2.1.6 MSW and disposal-related issues

Modern landfills, which incorporate elements like leachate recycling and energy recovery (bioreactor landfills), have also demonstrated potential in MSW treatment (Srivastava & Chakma, 2022). However, these solutions are much more important in poorer countries. Rapid population expansion, higher standards of living, and lifestyle changes are all pushing up garbage output, putting pressure on already limited resources such as landfill space (Hazra & Goel, 2009; Menikpura et al., 2012). The issue of incorrect solid waste disposal in cities has been on the agenda for decades, with various studies outlining the consequences. Teotia et al. (1996) investigate the repercussions of improper waste management, whereas the World Health Organization (WHO) addresses the broader environmental and health issues accompanying it. Their 1950 study examined various elements, including clean drinking water, wastewater treatment, solid waste management, and even mosquito control, recognising the

connection of these concerns to public health (Rai & Nathawat, 2017). Researchers have studied solid waste disposal issues for decades, particularly in developing countries. Stread's early research (1960) investigated the relationship between technological improvements and the developing challenge of garbage disposal (Rai et al., 2017). Flintoff (1976) concentrated on identifying poor countries' most cost-effective waste management systems. John Pickford (1983) introduced another degree of complexity by exploring how climatic factors affect trash disposal issues in developing cities.

This collection of studies underlines the complexity of the situation and the need. Waste disposal pollutes the surroundings and endangers our health immediately and in the long run (Mattiello et al., 2013; Porta et al., 2009). People who live near dumpsites may suffer from birth abnormalities, asthma, respiratory infections (Kah et al., 2012), and overall discomfort such as tension, anxiety, migraines, and dizziness (Carpenter et al., 2008). Long-term garbage exposure leads to serious medical hazards, including chronic respiratory difficulties, heart disease, cancer, and damage to the brain, nerves, liver, kidneys, and bloodstream (Vrijheid, 2000). A variety of circumstances determines the intensity of these health effects. These include how waste is managed, the precise types of waste present, the habits of those living close to it, the length of time it is exposed, and whether any actions are taken to prevent or mitigate the problem. Proper waste management is critical to public health (Ferronato Navarro, 2018; Ziraba et al., 2016).

2.1.7 Impact of MSW on Health

Air pollution is expected to kill 7 million people prematurely each year, endangering public health worldwide (Jahra & Study, 2013). One major culprit is the unregulated

trash burning at dump sites (Annepu, 2012; Gupta et al., 2015; Ghosh, 2016). This activity emits fine particles and pollution into the atmosphere, significantly contributing to respiratory ailments. These microscopic particles, including dust, fumes, and smoke, can harm the lungs and create various respiratory issues. Finding effective waste management solutions is critical to protecting our health and the ecosystem from the risks of air pollution (Lingan et al., 2007). Dumpsites are environmental disasters. They expel a toxic brew of troubles. Methane, a potent greenhouse gas that traps heat, leaks from these places, contributing to climate change and unchecked burning leads to the destruction of the ozone layer.

Furthermore, landfills emit unpleasant aromas and leachate, a dangerous substance that can damage water sources. However, the most significant concerning impact is on human health pollution (Chakma & Mathur, 2017). Newborns and adults are exposed to various pollutants, including carbon monoxide, carbon dioxide, particulate matter, mercury, and toxic organic compounds.

2.2 Social/behavioural aspect studies in municipal solid waste management.

Chang and Pires (2015) and Ma and Hipel (2016) say that managing municipal solid waste (MSW) properly is a big environmental problem around the world, especially in countries that are quickly becoming industrialised, like China, where the amount of waste has skyrocketed. Huang and Feeney (2015) point out successful programs in Germany and Japan since the 1970s, stressing how important it is for people to be involved in these programs. Research by Ma and Hipel (2016) and Nguyen, Zhu, and Le (2015) using the Theory of Planned Behaviour (TPB) shows that attitudes, subjective norms, perceived behavioural control, and situational factors are very important in deciding whether or not to recycle. A study done in Hangzhou, China,

found that a number of outside factors, like market incentives, market facilitators, government incentives and facilitators, hold sway on how people separate their trash. The study used a survey of 631 households and partial least squares structural equation modelling (PLS-SEM) to figure out how well these factors worked. The results showed that most outside factors were positively related to people's plans to separate their waste, except for market incentives, which had no significant effect on plans (Guerrero et al., 2013). Social-demographic factors like gender, income, and social influence also had an effect on people's plans and actions to recycle. To make good waste management policies that get more people to recycle at home, it's important to study these outside factors (Minghua et al., 2008).

2.2.1 A Global Perspective on the Social and Behavioural Aspects of MSWM

Thøgersen (1996) reminds the idea that convenience, moral norms, and social interactions are important reasons, why people recycle. The study backs up the ABC Hypothesis by showing that moral norms matter less when recycling is easy, like when you can put it out on the curb. In early-stage systems, social norms have a big effect on recycling. This shows how community and interpersonal factors shape behaviour. Schutlz et al. (1995) suggest that legal norms are important for ascertaining regulatory dimensions, but it is debilitating in the long run. Thus, a need for reinforcing moral obligations and social norms is necessary for better early stage garbage disposal and recycling initiatives.

The steady rise in global waste production is mostly due to people's inability to reduce the waste production at home. Barr (2003) stresses the need to encourage "downstream" waste reduction at the consumer level through recycling, reuse, reduction, and repair. Barr et al. (2005) talk about how psychological and situational factors, like convenience

and social norms, can affect how people act when it comes to reducing waste. Their 2013 study looks more closely at what stops people from recycling and reusing things, and they find that the main problems are a lack of knowledge and infrastructure. These studies show that to get people to recycle and reduce waste, we need to make big changes in education, infrastructure, and policies (Barr, 2003; Barr et al., 2005; Barr et al., 2013). This shows how important public campaigns and behavior-changing programs are, especially in developing countries where bad waste management has serious effects on health and the environment (Mosler & Martens, 2008 ; Bortoleto et al., 2012).

According to environmentally responsible behaviour (ERB), a mix of personal, organisational, and group factors that are important for good environmental management affect people's motivation to act in an environmentally responsible way. According to Bamberg and Möser (2006) and Osbaldiston and Schott (2011), personal factors like age, gender, and level of education, as well as self-efficacy, have a big effect on how people recycle. Also, things like the quality of recycling services and the size of the population are very important (Chen, 2010 ; Verdugo, 2012). Studies have shown that interactions between these variables can predict how people in a community will recycle. This suggests that self-efficacy is more important in communities where people don't believe in their own abilities. On the other hand, being happy with the quality of service has a bigger effect in communities where people believe they can make a difference (Sampson et al., 1997). By knowing about these different levels of influence, we can make national and international policies that support ERB and raise recycling rates (Kollmus & Agyeman, 2002; Jordan & Lenschow, 2010).

Another insight from Grazhdani (2015) portrays that waste management efficiency has become more important because of urbanisation and industrialisation, which has led to a linear consumption approach. This way of doing things leads to a lack of resources and damage to the environment. It is important to have sustainable development in waste management, like using waste as a resource (Ghisellinia et al., 2015). The European union EU's Waste Framework Directive ranks waste treatment activities by their effect on the environment. It encourages waste prevention in the order of reuse, recycling, and energy recovery (Gharfalkar et al., 2015). Harmonised waste management laws spell out what governments, municipalities, and producers must do (Bezzina & Dimech, 2011; Da Cruz & Marques, 2013). Citizens are very important for the circular economy because they separate their household waste for recycling (Singh & Ordonez, 2015). But differences in culture, economy, and society affect how well EU member states handle waste (O'Brien, 2013; Antanasijevic et al., 2013). For waste management to work, it needs personalised plans and people to get involved (Lindén & Carlsson-Kanyama, 2003; Karim Ghani et al., 2013).

Vassanadumrongdee and Kittipongvises (2017) study was conducted in Bangkok, Thailand. Their study entailed the use of a questionnaire to find out how willing Bangkok residents were to pay (WTP) for better MSW services and recycling facilities and how likely they were to separate their trash at the source. Building on the theory of planned behaviour, it found that perceived inconvenience and mistrust in MSW collection were major obstacles to source separation. Encouraging source separation at work could have a positive effect on people's plans to recycle at home. The results suggest that making people more aware of waste problems and making MSW collection

services better can increase residents' willingness to pay, which will help policymakers plan better recycling programs.

Studies in China by Chan et al. (2017) observed through their questionnaire study from 208 people and found that attitudes, subjective norms, perceived behavioural control, intentions, and situational factors were all important predictors. People's intentions are at the core of determining waste disposal. Situational factors like time constraints and inconvenience make it harder for people to participate in waste separation efforts. Socioeconomic factors, especially the level of education, affect how likely residents are to separate their trash. F. Huang et al. (2022) say that the study shows that future environmental campaigns should focus on moral obligations and make things easier to get people in the community to separate their trash. This is very important for managing municipal waste in a sustainable way in urban China.

Wan et al. (2018) say that a number of things, like social pressure, infrastructure, and moral obligations, can affect a person's desire to separate their household's solid waste. Gu et al. (2015) and Zhang et al. (2016) show that even though the Chinese government encourages people to separate their trash, very few people know about it and do it, with a municipal solid waste recovery rate of less than 2%. Pakpour et al. (2014) found that residents' recycling habits are strongly affected by things like how effective they think policies are, the condition of the facilities, and demographic factors. Also, Wan et al. (2014) found that age, perceptions of results, and government policies all affect how willing people are to pay for separate collection services. This shows how important it is to have a supportive environmental climate and convenient facilities. Chen and Lee (2020) say that this means that policymakers need to make sure that recycling programs and policies are effective at getting people to separate their waste.

Wang and Mangmeechai (2021) determine that resident's intention to sort their trash is very important for solving problems with municipal solid waste (MSW) disposal, especially in cities where the population and economy are growing quickly. This study adds to the theory of planned behaviour (TPB) by looking at young people's intentions to sort their MSW in Hubei Province, China, taking into account their concern for the environment and their sense of moral duty. It was found that personal moral obligation, perceived behavioural control, and subjective norms have a big effect on young people's sorting intentions, but attitude and environmental concern do not. There were also differences based on gender and where people lived.

Zhang et al. (2021) say that this study uses the Theory of Planned Behaviour (TPB) and the Attitude-Behaviour-Condition (A-B-C) theory states what affects, how people take care of their waste. The study uses structural equation modelling and survey data from 709 residents to find important internal (e.g., willingness to participate, environmental awareness) and external (e.g., accessibility to facilities, educational efforts) factors that affect people's choices about how to get rid of hazardous waste. Environmental facilities and services are very important for getting people to sort their trash and recycle. Even though the government efforts are being made, the effectiveness is seen only after mandatory enforcement. Their final suggestions suggest that better infrastructure, educational campaigns, and policy changes are needed to get more residents involved in environmentally friendly waste management practices.

Framework-based studies have been furthered by Kolodko et al. (2021), who have given a systematic, literature-based plan for making and judging behaviour change interventions that encourage pro-environmental behaviour. Their literature review shows that previous frameworks, like the 4-E model and MINDSPACE, have some

flaws. These frameworks have been found to be useful, but they rarely provide insights into making effective systematic interventions. On the other hand, Michie et al. (2014) came up with the Behaviour Change Wheel (BCW), which combines results from 19 frameworks and lays out a formal eight-step plan that includes choosing an intervention, selecting a function, aligning policy categories, and using behaviour change techniques (BCTs). The paper talks about the Theoretical Domains Framework (TDF) as a way to find out what makes people do things and what stops them from doing things. It focuses on theory-based methods. It also shows how important it is to use automatic and reflective processes to guide behaviour, which is something that past models have missed and that BCW wants to fill. The study adds to the body of research by showing how BCW can be used in settings other than health care, with a focus on digital pro-environmental behaviour like tweets that tell people not to litter. It also suggests that there is a need for more thorough studies of BCW-based interventions that have been reported in formative research but not often followed up with real-world evidence. The article shows that BCW-based interventions work better than simpler, norm-based ones by using diagnostic surveys, randomised controlled trials, and tests of intentions and actual behaviour.

According to Oduro-Appiah et al. (2022), despite promoting waste separation, most households do not segregate their waste, citing reasons such as lack of recycling facilities and affordability issues. The study employs a mixed-method approach to explore existing separation practices, identify barriers, and assess household willingness to separate waste. The results highlight the necessity of government action to control waste management, including the installation of separation bins and the application of bylaws. Environmental sustainability is supported by better waste

separation at the source. According to the United Nations Environment Programme (2024), it is in line with global sustainability objectives, which include lowering the production of solid waste and encouraging recycling and reuse by 2030.

2.2.2 Indian Perspective on the Social and Behavioural Aspects of MSWM

Urban Indian studies have been the primary focus for Waste management studies. Kumar and Nandini (2013) say that community involvement has a big effect on how well solid waste is managed. A study in Bangalore city found that 63% of households were willing to adopt better waste management practices. Of those, 97.8% wanted daily waste collection, and 82.5% were willing to separate their trash if they were given the right bins. Most households (71%) were willing to use recyclable products, which shows that they comprehend the principles of reduce, recycle, and reuse. Even though the community is willing, the lack of basic facilities and the lack of action by municipal authorities often leads to improper waste disposal practices. This shows that better education and infrastructure are needed to support effective waste management (Asnani, 2006). The community's willingness to pay for services also affects how well waste management strategies work and how reliable they are (Epp & Mauger, 1989).

Another study in Delhi by Wadehra and Mishra (2018) was focused on how people from different backgrounds and income levels segregate and dispose of their waste. The study found that education, income level, and awareness had a big impact on how people sorted their trash. Families with more education tended to sort their trash at the source because they knew it was better for their health and the environment. The study shows that women separate their trash more than men do, which shows that they are in charge of managing the trash. The report suggested that focused awareness and

educational activities could help people separate their trash at home. Cities could do a better job of dealing with trash, especially in low-income neighbourhoods, if people were more educated and aware. The study suggests that incentives for separating trash and penalties for not following the rules would encourage families to do a better job of managing their waste.

Wit (2013) examined how mental processes affect garbage sorting in Mumbai. The project collected comprehensive garbage segregation data by mixing quantitative surveys with qualitative focus group discussions. The report recommended educational programmes and community cooperation to segregate residential garbage. Community-driven efforts like neighbourhood awareness and rubbish management committees worked best in cities. The study showed how community involvement increased rubbish segregation in Mumbai areas. Researchers also highlighted that parent-child educational activities were essential to promoting waste segregation. Community workshops and school waste management classes help promote awareness of trash segregation in municipalities.

Kala and Bolia (2020) compared trash segregation attitudes in numerous Indian cities. The study explored public attitudes and actions towards waste segregation through surveys and focus groups. Public awareness campaigns dramatically changed segregation trends in cities. Cities with ongoing public awareness and education had greater waste segregation rates. Public opinion and waste management attitudes influenced segregation, which was conducted in the study. Cities with more public involvement and better waste segregation education have higher compliance rates. The study revealed that public education and awareness efforts were necessary to promote

waste segregation. The report recommends including community leaders and local influencers to boost awareness initiatives.

A novel study by Ravi (2013) investigated how the informal sector sorts garbage. The primary focus of the study was ragpickers. This study reveals that ragpickers are critical to the segregation and recycling of Delhi's trash. The study employed ethnographic approaches, that is, participant observation and interviews, to learn about ragpickers' achievements and challenges. The findings indicated that ragpickers were critical to waste sorting but occasionally operated in hazardous conditions without rewards or support. Experts suggest that ragpickers should be integrated into municipal rubbish management policies. Through proper training, better protective equipment, and a fair wage, municipal authorities can further enhance waste sorting and recycling. The research encouraged policies integrating the informal sector into official waste management structures to enhance ragpickers' working conditions and livelihoods.

2.3 Integration of Behavioural Studies into Municipal Solid Waste Management

History: A Systematic Chronological Analysis

Integrating societal and behavioural aspects into Municipal Solid Waste Management (MSWM) literature marks a significant shift from purely technical and regulatory approaches to recognising the *human element* as central to effective waste management systems.

Table: 2.1 Timeline and progression in the study of Public Behaviours in Municipal solid waste management.

Time Period	Primary research focus	Key findings on public behaviour	Major shift in literature	Key References
1970s-1980s	Awareness, Attitudes, Initial Participation Rates	<ul style="list-style-type: none"> • High awareness and positive attitudes towards waste problems/recycling. • Significant attitude-behaviour gap. Low initial participation despite positive views. Convenience is a major factor. 	Initial Recognition: Acknowledging that public behaviour is a variable, not a constant. Move beyond blaming "ignorance".	<ol style="list-style-type: none"> 1. Witmer & Geller, 1976- First field experiments on recycling behaviour 2. Jacobs & Bailey (1982) - Quantified participation gaps 3. Derksen & Gartrell (1993) - Social context of recycling 4. De Young (1986) - Conservation psychology foundations
1990s	Barriers to Participation, Demographics, Simple Interventions	<ul style="list-style-type: none"> • Convenience is paramount (ease of access, collection frequency). Information/education alone has a limited impact. Space constraints, habits, and socio-economic factors (income, home ownership) strongly influence participation. Recycling participation is easier to achieve than waste reduction. 	<p>Descriptive Phase: Shift to understanding <i>why</i> people behave as they do. Identifying key barriers and correlates.</p> <p>Recognition that infrastructure design drives behaviour.</p>	<ol style="list-style-type: none"> 1. Vining & Ebreo (1990) - Recycler vs. non-recycler profiles 2. Oskamp et al. (1991) - Multivariate barrier analysis 3. Hornik et al. (1995) - Meta-analysis of 67 recycling studies 4. Gamba & Oskamp (1994) - Curbside program design impacts 5. Schultz et al. (1995) - Situational vs. personal factors
2000s	Applying Social Theories (TPB, NAM), Policy Evaluation	<ul style="list-style-type: none"> • Economic incentives (PAYT) are highly effective for waste reduction and recycling if well-designed. Perceived social norms significantly influence individual behaviour. 	<p>Explanatory & Early Predictive Phase: Using psychological frameworks to explain and predict behaviour. Rigorous evaluation of policy impacts. Understanding the power of social influence.</p>	<ol style="list-style-type: none"> 1. Taylor & Todd (1995) - Theory of Planned Behaviour model 2. Schultz (1999) - Normative feedback experiments 3. Thøgersen (2003) - Economic incentive effectiveness

Time Period	Primary research focus	Key findings on public behaviour	Major shift in literature	Key References
	(PAYT), Social Norms	<ul style="list-style-type: none"> Theory helps predict intentions/behaviour. Contextual factors (culture, local infrastructure, policy) heavily moderate the effectiveness of interventions. Trust in authorities influences compliance. 		<p>4. Barr (2004) - UK household decision-making</p> <p>5. Tonglet et al. (2004) - Recycling vs. minimisation drivers</p>
2010s-Present	Nudges, Field Experiments, Habits /Identity, Prevention /Reuse, Digital Tools	<ul style="list-style-type: none"> Well-designed "nudges" (feedback, defaults, simplified choices, salient messaging) can be cost-effective. Real-time feedback (e.g., weight) boosts recycling/reduction. Habits are strong drivers, requiring disruption and new routines. Linking behaviour to personal/group identity and values is key for challenging behaviours (prevention, reuse). Digital tools (apps, gamification, and smart bins) show promise for engagement and feedback but raise equity concerns. Emphasis on "upstream" behaviours (avoidance, reuse) is growing but challenging. Equity and accessibility are critical considerations. 	Intervention & Systems Phase: Proactive design of behavioural interventions using insights from behavioural science. Emphasis on experimental rigour (RCTs). Integration with technology. Recognition of behaviour as part of complex socio-technical systems. Focus on harder, upstream behaviours.	<p>1. Allcott (2011) - Social norm field experiments</p> <p>2. Varotto & Spagnolli (2017) - Meta-analysis of 70 interventions</p> <p>3. Muralidharan & Sheehan (2016) - Plastic bag fee psychology</p> <p>4. Sintov et al. (2019) - Food waste behaviour spillover</p> <p>5. Noiki et al. (2021) - Smart bin effectiveness review</p>

Source: compiled by author

2.3.1 Key Findings & Reflective Note:

- **The gap between attitude and behaviour:** The gap between attitude and behaviour has been consistently recognised as a fundamental challenge since the 1980s. Despite significant public concern regarding waste, the constant and accurate implementation of separation, reduction, and reuse behaviours is intricate and affected by various obstacles, including convenience, habitual practices, infrastructure, social norms, and perceived effort.
- **The primacy of Convenience:** Research consistently shows that making the desired behaviour the easiest option is crucial. This includes convenient drop-off points, user-friendly home sorting systems, reliable and regular collection services, and clear, direct instructions.
- **Beyond Information:** Although essential, merely disseminating information regarding *what and why* of recycling and reduction is inadequate to effect behavioural change. The literature has developed to indicate that information must be actionable, timely, comprehensible, and frequently accompanied by additional interventions such as convenience, incentives, and standards.
- **The efficacy of incentives and penalties:** Economic mechanisms such as Pay-As-You-Throw (PAYT) have significantly reduced waste production and enhanced recycling rates when used equitably. Deposit-return methods demonstrate efficacy for particular streams. Conversely, penalties for non-compliance can inhibit specific behaviours see Table 2.1.
- **Social Influence is Vital:** Perceived behaviours of others (descriptive norms) and others' expectations about appropriate actions (injunctive norms) significantly influence individual behaviour. Utilising social norms via messages like ("9 out of 10 individuals in your neighbourhood recycle") or observable participation (clear recycling bins) has emerged as a significant strategy.

- **Influence of Habit and Identity:** Recent studies highlight that a significant portion of waste behaviour is habitual (automatic routines). Altering it necessitates the disruption of fixed habits and the formation of new ones. Moreover, waste prevention or reuse habits are frequently more closely associated with personal ideals and identity ("I am an environmentalist") than with basic recycling activities.
- **Context is Crucial:** No one-size-fits-all solution exists, as the effectiveness of interventions depends heavily on local culture, existing infrastructure, socio-economic conditions, governance structures, and the characteristics of the waste stream. Strategies effective in a densely populated urban apartment complex vary from those suitable for a suburban community or rural town areas.
- **Emergence of Behavioural Interventions ("Nudges"):** Utilising behavioural economics ideas has resulted in several low-cost, subtle interventions. Offering performance feedback, modifying default settings (opt-out versus opt-in), streamlining options, enhancing the visibility of preferred behaviours, and incorporating gamification components have demonstrated favourable outcomes in field trials.
- **Shift Upstream:** Although recycling research has predominated for decades, there is an increasing focus on comprehending and encouraging behaviours that prevent waste formation initially (refusing, decreasing, reusing, mending). These frequently entail more intricate, value-oriented behaviours necessitating diverse solutions.
- **Digital integration:** Applications offering feedback, incentives, collection notifications, and educational insights, together with intelligent bins tracking fill levels, signify a novel advancement. They offer significant capacity for customisation and interaction; however, we must resolve digital disparities and privacy issues.

Table 2.1 shows integrating behavioural studies in the history of MSWM represents an important field development. From the beginning, regarding the public as part of the problem or as passive recipients, literature acknowledges citizens as engaged actors whose multifaceted motivations, routines, and social environments are key to crafting effective, sustainable, and fair waste management systems. The development illustrates a clear trend: from measuring human behaviour to understanding their motivations to actively developing systems and treatments based on behavioural science principles to guide behaviour towards more sustainable outcomes. This shift acknowledges that technology solutions and legislation, while crucial, are insufficient without factoring in the human element. Future development relies on ongoing interdisciplinary investigations, treatment according to context, ethical use of behavioural knowledge, and increased focus on upstream prevention and reuse strategies under the framework of a Circular Economy.

Despite this progressive shift in global literature toward integrating behavioural insights into municipal solid waste management (MSWM), a significant gap remains in the Indian context. While international research increasingly emphasises citizen agency, motivational psychology, and socio-cultural variables in shaping sustainable waste behaviours, Indian studies largely continue to focus on infrastructural deficits, technical efficiencies, and policy compliance. A paucity of empirical work rigorously engages with the behavioural, cultural, and psychological dimensions of waste practices in diverse Indian settings. As a result, interventions often fail to resonate with local realities or achieve lasting behavioural change. This gap underscores the need for context-specific, interdisciplinary research that maps what people do, deeply explores why they do it, and how systems can be co-designed with communities to support more sustainable, inclusive, and ethically grounded waste practices. The present study addresses this need by foregrounding the behavioural dimension of MSWM within the Indian socio-cultural landscape.