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Factors Determining Household Waste Segregation Behaviour: An Indian Case Study

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Abstract: Waste represents used things or materials that are no longer required or wanted. These articles are cast off as they have stopped working or because they have ceased to be of value. Human settlements inevitably generate waste. According to UNEP's Global Waste Management Outlook 2024, the quantity of waste being generated is growing each year due to augmented economic growth accompanied with untenable consumption and production practices. In fact, global municipal solid waste (MSW) generation per year is projected to grow from 2.1 billion tonnes in 2020 to 2.7 billion tonnes in 2030 and further to 3.2 and 3.8 billion tonnes in 2040 and 2050 respectively. According to the World Bank, more than a third of waste generated globally is not managed in an environmentally sound manner and emissions related to solid waste are likely to increase to 2.6 billion tons of carbon dioxide equivalent by 2050. The present study based in Delhi with a sample of 708 households aims to understand the factors influencing the adoption of the "practice of waste segregation" by households. From our SEM and Path analysis we conclude that environmental awareness, knowledge about waste segregation and the perception about actual task of waste segregation have a significant impact on the practice of waste segregation. Environmental awareness has the largest impact followed by knowledge about how to undertake the task of waste segregation. In the light of our results, it is important and imperative to create awareness about the negative environmental impact of not segregating waste as well as demystifying the actual task of practising waste segregation.

Introduction

Waste represents used things or materials that are no longer required or wanted. These articles are cast off as they have stopped working or because they have ceased to be of value. The Basel Convention has formally defined it as "Wastes are substances or objects which are disposed or are intended to be disposed of or are required to be disposed of by the provisions of national laws". According to environmental statistics as defined by the United Nations Statistics Division (UNSD), "Wastes are materials that are not prime products (that is products produced for the market) for which the generator has no further use in terms of his/her own purposes of production, transformation, or consumption, and which he/she wants to dispose. Wastes may be generated during the extraction of raw materials, the processing of raw materials into intermediate and final products, the consumption of final products, and other human activities. Residuals recycled or reused at the place of generation are excluded" (United Nations, 1997).

Human settlements inevitably generate waste. Rise in populations and greater economic development accompanied with urbanisation have led to rise in waste generation. Further, greater affluence, enhanced trade, and access to a wide range of products, as well as diffusion of a culture of disposable consumption have also amplified the problem. According to United Nations Environment Programme's (UNEP) Global Waste Management Outlook 2024, the quantity of waste being generated is growing each year due to augmented economic growth accompanied by untenable consumption and production practices. In fact, global municipal solid waste (MSW) generation per year is projected to grow from 2.1 billion tonnes in 2020 to 2.7

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billion tonnes in 2030 and further to 3.2 and 3.8 billion tonnes in 2040 and 2050 respectively. This indicates an unnerving jump of more than 1.8 times from 2020 to 2050. Further, in 2020 about 810 million tonnes of all municipal solid waste was uncontrolled (openly burned or dumped) and by 2050 this uncontrolled waste is predicted to rise to 1.6 billion tonnes (UNEP, 2024). Significantly, the most substantial increase in waste generation is anticipated to occur in rapidly developing nations such as India. It is concerning that in these economies, waste generation is already surpassing the ability to handle it. Further, this waste generation is posing a danger to the environment by furthering climate change, adding to existing levels of pollution as well as contributing to the loss of biodiversity due to dumping.

According to World Bank (2018), it is disturbing that over a third of waste generated globally is not being properly handled in terms of containing the environmental impact. Additionally, the emissions associated with solid waste are projected to rise significantly, reaching 2.6 billion tonnes of carbon dioxide equivalent by the year 2050 (Kaza et al., 2018). Several waste disposal facilities in developing nations are open dumpsites that have a detrimental impact on the environment in terms of not only contaminating air, water, and soil but also adding to already high levels of emissions (Elsheekh et al., 2021). Waste creation and management have become significant concerns that have far-reaching impacts on general well-being, environmental sustainability, poverty, food security, depletion of resources, ethical consumption and production, and overall economic viability (Van den Bergh, 2008; Wilson et al., 2015; Luttenberger, 2020; Kaur et al., 2023).

Waste management encompasses a series of interconnected procedures that revolve around the collection, transportation, and proper disposal of various types of waste, including garbage, sewage, and other waste products. Demirbas (2011) defines the purpose of waste management as "……. to provide sanitary living conditions to reduce the amount of matter that enters or leaves the society and encourage the reuse of matter within the society". Efficient solid waste management (SWM) is crucial for sustainable urban development, necessitating collaboration between government bodies and stakeholders. This involves the collection of waste from households and commercial establishments, transportation to a central collection point or transfer station, and ultimately, the proper treatment and disposal of waste. Waste management is becoming more widely acknowledged as a multifaceted concern that encompasses social, general well-being, and ecological aspects and has proliferating economic implications. By recovering waste and utilising land efficiently, significant financial savings can be achieved. Implementing proper SWM practices can help prevent the release of significant amounts of greenhouse gases, reduce the risk of waterborne diseases, and safeguard aquatic ecosystems.

SWM is everyone's business. Having a well-functioning system for managing solid waste is crucial for effectively accomplishing the Sustainable Development Goals. The Sustainable Development Goals (SDGs) were adopted by the United Nations in 2015 as a global initiative to address poverty eradication, environmental conservation, and the promotion of peace and prosperity for all by 2030. These goals outline a path towards a future that is sustainable for everyone, by tackling the common obstacles of poverty, inequality, climate change, environmental degradation, harmony, and justice. The global goals build on the Millennium Development Goals adopted in the year 2000 and intend to complete what the latter were not able to achieve with respect to certain dimensions of sustainable development. SWM plans and programs impact all 17 SDGs but to varying degrees. SDG 11 pertaining to Sustainable Cities and Communities is particularly affected by sustainable waste management. SDG 12 focuses on responsible consumption and production and focuses on the need to change conventional consumption, production and disposal methods. SDG 13- Climate Action is also directly impacted by cutting emissions through effective waste management. SDG 14- Life Below Water and SDG 15- Life on Land also are impacted by the sustainable use of ecosystems and resources. Any measures applied to support or organise SWM directly contributes to SDGs and thus, will help provide for a sustainable future. With increasing levels of waste generation on account of rising incomes, population growth, intensive use of packaging materials and disposable goods this quandary is challenging to address.

Waste mismanagement is degrading natural habitats and posing a threat to society at large in many ways (Kaza et al., 2018). It leads to contamination of groundwater, obstruction of gutters and sewers, flooding, pollution of oceans, transmission of diseases via the breeding of mosquitoes and leeches and increasing respiratory problems from burning waste. These all in turn affect economic development. Therefore, it is crucial for all members of society to take immediate action regarding unmanaged or improperly managed waste. Understanding the factors that influence waste segregation behaviour is crucial for driving positive

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societal change. Understanding how much waste is being generated, as well as the different types of waste that are being generated, is a key for selecting appropriate management methods. Preparing for expected increases in waste generation is essential to ensure growth sustainability. Proper planning can help convert this 'economic bad' into an 'economic good'. 'Solid Waste Management' can become 'Solid Resource Management' and benefit the Society at large. In this context it is important to not only expand treatment facilities for the waste generated but also create greater awareness on source segregation and ensure adaption of best practices to separate waste at source. Waste segregation, or source-separation, is the act of separating the various components of waste at the place where it originates. This is an effective strategy for managing waste. However, households and businesses in India have not adapted to facilitate the process of waste segregation.

Given the importance of ensuring adaption of practice of separating waste at source, the present study aims to understand the factors influencing the adoption of the "practice of waste segregation" by households. In this context, we examine the impact of "awareness about the environment", "knowledge about waste segregation" and "perception about the actual task of waste segregation".

Having given a context to the critical importance of appropriate waste management and waste segregation in this introductory section, the study presents a review of the literature on determinants of adoption of source separation/waste segregation practices next. This is followed by the section on Methods and Discussion. The last section concludes the study from a broad policy perspective.

Literature Review

Ensuring efficient SWM is important to conserve the environment, ensure sustained growth and maintain quality of life. In this regard, it is important to effectually oversee generation, collection, transportation, and disposal of waste (Erfani, 2020, 2023, 2024; Kihila et al., 2021). Source reduction strategies can help contain waste generation. Waste generation can also be minimised through creation of awareness as well as adoption of appropriate reuse and recycling measures. Waste segregation through separation of dry and wet waste can supplement waste management (Kaur et al., 2023). This essential practice can reduce the quantum of waste to be collected, processed and disposed.

Developed higher-income countries generate more waste and in general, there appears to be a positive correlation between income levels and waste generation (Kaza et al., 2021; Kaur et al., 2023). The composition of solid waste varies significantly between different countries, particularly between developing and developed nations. In developing countries, the majority of MSW is composed of organic material, followed by recyclable materials. In developed countries, the amount of recyclable materials surpasses that of organic ones, with an average of 34 per cent organic material and 49.4 per cent recyclables (Mohee and Bundhoo, 2015). Since waste composition differs between developing and developed countries the waste management strategies adopted are also different. Further, the level of education, awareness, government and citizen commitments, financial incentives and taxes determine the extent of waste segregation and waste handling at source. Given the differences in these determinants amongst developing and developed countries the waste collection systems and waste processing and treatment technologies and their efficacies also differ. This section provides a concise overview of the empirical research that examines the factors that influence household involvement in the separation of waste and managing waste.

Hong (1999) studies the impact of price incentives on household solid waste generation and recycling in Korea. The study demonstrates that the implementation of a unit price system, together with proactive recycling initiatives, has a substantial influence on trash segregation and recycling. The research employs a simultaneous equation model that considers the reciprocal influences between the overall production of waste and the act of recycling. The findings are derived from data gathered from 3017 households in Korea. The study concludes that an increase in the waste collection price encourages households to recycle a greater amount of waste. However, this positive effect is somewhat counteracted by a drop in efforts to reduce waste at its source, because of feedback mechanisms. This indicates that the demand for solid waste collection services is not very responsive to changes in pricing.

Sujauddin et al. (2008) use a structured questionnaire to quantify and qualitatively investigate household solid waste generation across socioeconomic groups in Rahman Nagar household area, Chittagong, Bangladesh. They conclude that family size, education, and monthly income increase household solid waste. If provided adequate toolkits, 29.3 per cent of households would sort waste, whereas 12 per cent would consider recycling or reusing their waste before dumping it. If people know their part and the burden is dispersed by waste creation, source segregation can turn household solid waste into a resource, according to the study. Van den Bergh (2008)

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examines whether garbage reduction and recycling are complementary or alternatives in people's choices. The English study examines if increasing recycling or reduction boosts or decreases the marginal value of the other, determining whether they are complementary or substitutable. Structural equation modelling (SEM) and path analysis show that trash reduction and recycling are complementary due to positive reciprocal links. The study concludes that recycling policies indirectly reduce waste. Another interesting finding is that personal environmental opinions and concerns strongly influence waste reduction, making environmental education crucial for long-term waste reduction.

Kuo and Perrings (2010), examine household waste and recycling in 18 Taiwanese and Japanese cities. They combine household disposal and recycling statistics with municipal waste management data. The data covers 1998–2003. Their study seeks to identify household waste disposal and recycling elements. Using a fixed effects panel data model, they find that garbage collection costs predict recycling or landfilling. The time required for alternate garbage disposal affects these. Thus, while unit price of garbage is significant, recycling is mostly affected by time and opportunity cost. More frequent garbage pickup reduces recycling. Afroz et al. (2011) apply OLS regression to estimate household waste. Structured interviews were used to collect data on 402 Dhaka households' "knowledge and concern towards environment, knowledge and attitude towards waste management and recycling activity"; "recycling activity and waste disposal practices"; and "socio-economic information". The study revealed that factors such as household size, income, intensity of concern about the environment, and readiness to segregate waste had a significant impact on the amount of waste generated by families in Dhaka city. These aspects promote waste management, growth, and performance and prevent home waste and environmental degradation, according to the authors. In the study conducted by White and Hyde (2012) on Australian households' perceptions of themselves regarding their recycling behaviour, the goal was to predict the intentions to recycle and behaviours using the theory of planned behaviour framework. The study examined various factors, including subjective standards, perceived behavioural control, individuality, and conscience, to analyse plans for recycling and mindsets. The study involved 200 participants. SEM was used to analyse the connections between factors. Ramayah et al. (2012) used planned behavior theory to study 200 Malaysian university students' recycling habits. The research focused on environmental information and awareness, societal norms, perceived behavioural control, and recycling activity and concluded that environmental consciousness improves recycling attitudes and behaviour.

Czajkowski et al. (2014) in an interesting study of a Polish municipality- Podkowa Leśna, “shows that some households derive utility from the act of recycling itself, independently of impacts of their behaviour on the waste stream”. The conventional belief is that people are not keen on sorting their waste generated into different categories- paper, cans, bottles, compostables, etc. and that they would rather have this job done by someone else. The authors however find that there exists a significant group of Polish households for whom home sorting of waste is preferable. Their results are based on multinomial logit as well as a generalised multinomial logit model considering number of categories waste needs to be sorted into; number of times a month waste is collected; cost to the household per month, as independent variables. Amini et al. (2014) examine how economic instruments—rewards and penalties—affect Malaysian households' recycling intentions. Reward and punishment on Kuala Lumpur households' recycling intention are examined using questionnaire data from 384 participants. The authors find that reward and penalty affect household recycling intention using multiple regression analysis. “Reward and penalty both appear to have significant relationships with attitude, subjective norm, and perceived behavioural control, but reward and attitude are stronger and more significant than other variables”. The authors also argue for exploiting the weakest factor—perceived behavioural control—and suggest penalty-based policies and programmes to boost recycling intention in Federal Territory of Kuala Lumpur, Malaysia.

Nguyen et al. (2015) analyse Hanoi household waste separation intentions. Intents were measured by the fine each home was willing to pay for waste separation. They use multiple regression models to evaluate household waste separation intentions. Out of the 180 households polled, 130 families agreed to pay fines for separating waste programme violations. The econometric research reveals that "Trust" in the government to establish effective regulation, companies having appropriate facilities to solve waste problems, and community members willing to comply with waste separation at source legislation, influences home waste separation behaviour. These findings show that residents must be indoctrinated with trust and moral responsibility to properly manage solid waste in addition to enhancing

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institutional capacity and providing facilities and vehicles for garbage separation at source.

In a study conducted in Jimma, Ethiopia (Batu et al., 2016), researchers analysed a sample of 200 households to assess their satisfaction with SWM services. The findings revealed that a significant number of households expressed dissatisfaction with the current level of services and expressed a willingness to pay for better doorstep garbage pickup services. The study employed various statistical methods including logistic regression analysis. The willingness of households to pay for improved SWM is influenced by factors such as household income, house ownership, and the amount of waste generated. Business owners and innovators should be encouraged to develop optimised provisions for collecting waste, according to the study's recommendations. It is important for the government to provide support and monitoring to business enterprises and institutions involved in SWM systems.

Wadehra and Mishra (2018) undertake a study in 15 Delhi localities to examine the impact of information, norms and economic incentives on households' waste segregation at source compliance. The household-level study employs field experiments to investigate the factors influencing the separation of waste behaviour, while also assessing if interventions have varying effects on different socio-economic groups. The field experiments were conducted in three phases. Firstly, a comprehensive survey was carried out to document the practices of household waste disposal. Secondly, the waste produced by households was measured and recorded. Lastly, three different types of interventions were implemented in various localities: information alone, information combined with social norms, and information combined with monetary incentives. The study's Probit regression analysis found that sharing knowledge about segregation and its benefits is effective in altering home waste separation behaviour. Additionally, the combination of knowledge and financial incentives plays a crucial role in motivating households to initiate separation at the source. The study emphasised the crucial significance of the waste collector and the necessity to provide them with education.

In their study, Chen and Lee (2020) utilise SEM to analyse the effects of both internal and external variables, specifically the attitude towards the separation of waste, on households' intention to separate waste in China. They also study the potential impact of various factors on waste separation attitude, including policy legislation, economic incentives, enabling circumstances, individual norms, ethical standards, self-assurance, and understanding of any repercussions Based on a sample of 371 individuals, their research indicates that policy regulation and knowledge of the effects have the most significant influence on attitudes towards waste separation at the source. In addition, factors such as enabling circumstances, personal standards, and ethical guidelines play a crucial role in determining attitude.

Akmal et al. (2023) study the influence of fundamental and external factors including environmental awareness and concern as well as government policy instruments on household's waste segregation intentions. The internal or fundamental components considered are beliefs, personal standards, and perceived behaviour control. The study uses data collected from 849 households located in Islamabad and Rawalpindi. Using confirmatory factor analysis and SEM, the study concludes that waste segregation decisions of households are impacted by awareness about the environment and concern for the environment as well as by government policy.

Economic costs and time play an important role in recycling and household waste disposal behaviour (Kuo and Perrings, 2010). Monetary incentives and penalties are also important factors influencing household waste segregation practices (Amini et al., 2014; Wadehra and Mishra, 2018). Further, recycling behaviour and household's WTP for recycling of solid waste are also critical determinants used by studies to judge how much households value such practices (Nguyen et al. 2015; Batu et al., 2016). In fact, appraising household's willingness to participate are a precursor to designing effective policies and putting together required infrastructure for effectual waste management. Behavioural factors are also important as knowledge and concern towards environment, knowledge and attitude towards waste management and recycling activity have been found to have significant impact on adopting source separation practices (Afroz et al., 2011; White and Hyde, 2012; Ramayah et al., 2012; Czajkowski et al., 2014; Akmal et al., 2023).

Based on the literature discussed the attitude towards and participation in various aspects of solid waste management, as well as behavioural and attitudinal factors, have a significant role in influencing household waste dispensation activities including source separation and recycling. Most studies use either different kinds of regression models or SEM to analyse the impact of observed or latent variables on household waste segregation behaviour.

The following section presents our empirical model based on SEM and path analysis discussing the factors

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influencing households' adoption of waste segregation practices.

Methods and Discussion

To understand the underlying factors influencing the household's adoption of practice of waste segregation factor analysis was undertaken. Factors pertaining to household's "awareness about the environment", "knowledge about waste segregation" and "perception about the actual task of waste segregation" were considered.

Factor analysis is a data reduction technique with an aim to extract factors underlying a theory. It is an interdependent multivariate technique. Items measured on the metric scale are analysed for the extraction of variances and arrive at a smaller number of factors. These items are rated on a scale and input in the form of a correlation matrix. The Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity are used to assess the sufficiency of the sample for the analysis being performed by examining the ratio of data to variables. Bartlett's test of sphericity evaluates the hypothesis that the correlation matrix is an identity matrix. Hence, it is crucial for this test to possess statistical significance, indicated by a significance value of less than 0.05. Based on the results of the KMO analysis and Bartlett's test, it has been determined that factor analysis is appropriate for our dataset.

Items based on a-priori theory and extraction are grouped into latent factors. SEM draws a relationship between exogenous and endogenous construct. There are two types of SEMs, namely Variance-based and Co-Variance based. In the present research Co-Variance-based, SEM is used. Further, a maximum likelihood estimation procedure has been adopted to estimate the regression weights and loading of factors.

To estimate the effect of composite factors rather than individual items, Path Analysis has also been carried out. It is an extension of multiple regression technique to estimate the cause-and-effect relationship between independent and the dependent variables.

Empirical Findings: Rohini and Prashant Vihar were areas in northwestern Delhi where the survey was conducted. Convenience sampling based on availability and willingness of household representative to participate in the survey were primary considerations based on which the survey was conducted through personal interviews and filling of structured questionnaire. Sixty-one percent of the 708 household respondents were nuclear families with up to four members. The principal occupation of over 60 per cent of the households was business. The monthly family income of over two-thirds of the sample households was between ₹1 and ₹5 lakh rupees. Over 90 per cent of our sample consists of households that reside in flats, as the locality of Rohini selected is predominantly characterised by housing societies.

The study examined how families reported their behaviour regarding the separation of waste related to their awareness about the environment and perceived awareness about waste segregation. 17 questions asked families to assess these assertions on a scale of 1-5, with 1 representing extreme disagreement, 2 moderate disagreement, 3 neutral, 4 moderate agreement, and 5 strong agreement.

The dependability of a measurement relates to its consistency in measuring a notion, and Cronbach's alpha is a method for quantifying the strength of this consistency. Cronbach's alpha is a metric employed to evaluate the dependability or internal coherence of a collection of scale or test items. The determination is contingent upon the quantity of variables present in a questionnaire, as well as the interrelationships among these factors. According to Nunnally (1978), Cronbach's α is the primary measure used to assess reliability. The Cronbach's Alpha Index for our study is 0.746, which meets the statistical criteria for acceptability (Table 1). The KMO analysis for this dataset has determined that the KMO index of adequate sampling is 0.809 (Table 1). This result is significant ($p < 0.001$), indicating that factor analysis is appropriate.

Table 1. Reliability and Sampling Adequacy Tests.

Cronbach's Alpha Index	**0.746**	
Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.809	
Barlett's Test of Sphericity	Approx. Chi^2	3970.555^{***}
	DF	136
*Source: Authors' analysis based on primary data Notes: *, **, *** represent significance level of 10 per cent, 5 per cent, and 1 per cent*		

Based on theory we have extracted factors pertaining to: *Environmental Awareness (ENV_AW)*, *Knowledge about Waste Segregation (KNW_WS)* and the perception about *Actual Task of Waste Segregation (WS_Task)*. Further, perception towards the *Practice of Waste Segregation* (*WS_Prac*) has also been captured. The following table (Table 2) gives the statements used in our survey.

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Table 2. Statements Measuring Household's Attitude Towards the Practice of Waste Segregation.

Sl. No.	Statements
(i)	"Climate change or global warming is a very serious problem and its effect is happening".
(ii)	"The air quality in Delhi has been deteriorating very rapidly".
(iii)	"Waste segregation can help mitigate global warming".
(iv)	"Managing solid waste should be a priority as it affects the environment and human health".
(v)	"Mixing hazardous waste with other wastes could lead to toxic substance leakage causing harm to the environment".
(vi)	"Waste segregation is everyone's responsibility".
(vii)	"It is my duty to do waste segregation according to the prescribed rules".
(viii)	"Waste segregation is the duty of the government and municipalities, not me".
(ix)	"I have sufficient knowledge on waste segregation (organic waste, general waste, recyclable waste, hazardous waste)".
(x)	"MCD has helped spread information on waste segregation".
(xi)	"Media (Newspapers, TV, Radio) has helped spread information on waste segregation".
(xii)	"Our RWA has helped spread information on waste segregation".
(xiii)	"Waste segregation is time consuming".
(xiv)	"Waste segregation is too complicated".
(xv)	"Waste segregation takes up too much storage space making it difficult to do source separation".
(xvi)	"Even if we segregate waste, there is no guarantee that garbage collectors will not mix sorted waste with other waste".
(xvii)	"The garbage collectors are only interested in waste segregation so that they can make money out of the recyclable items".
Source: Questionnaire used for primary data collection in the present study	

Table 3. Results of Confirmatory Factor Analysis

Factor	Item	Factor Loading
Environmental Awareness (ENV_AW)	"Climate change or global warming is a very serious problem, and its effect is happening", (var1).	0.929***
	"The air quality in Delhi has been deteriorating very rapidly", (var2).	0.903***
	"Waste segregation can help mitigate global warming", (var3).	0.737***
Knowledge about Waste Segregation (KNW_WS)	"MCD has helped spread information on waste segregation", (var10).	0.634***
	"Media (Newspapers, TV, Radio) has helped spread information on waste segregation", (var11).	0.613***
	"Our RWA has helped spread information on waste segregation", (var12).	0.602***
Perception about Actual Task of Waste Segregation (WS_Task)	"Waste segregation is time consuming", (var13).	0.921***
	"Waste segregation is too complicated", (var14).	0.959***
	"Waste segregation takes up too much storage space making it difficult to do source separation", (var15).	0.717***
Perception towards the Practice of Waste Segregation (WS_Prac)	"It is my duty to do waste segregation according to the prescribed rules", (var7).	0.539***
	"I have sufficient knowledge on waste segregation (organic waste, general waste, recyclable waste, hazardous waste)", (var9).	0.668***
Source: Analysis based on data obtained from the primary questionnaire.		

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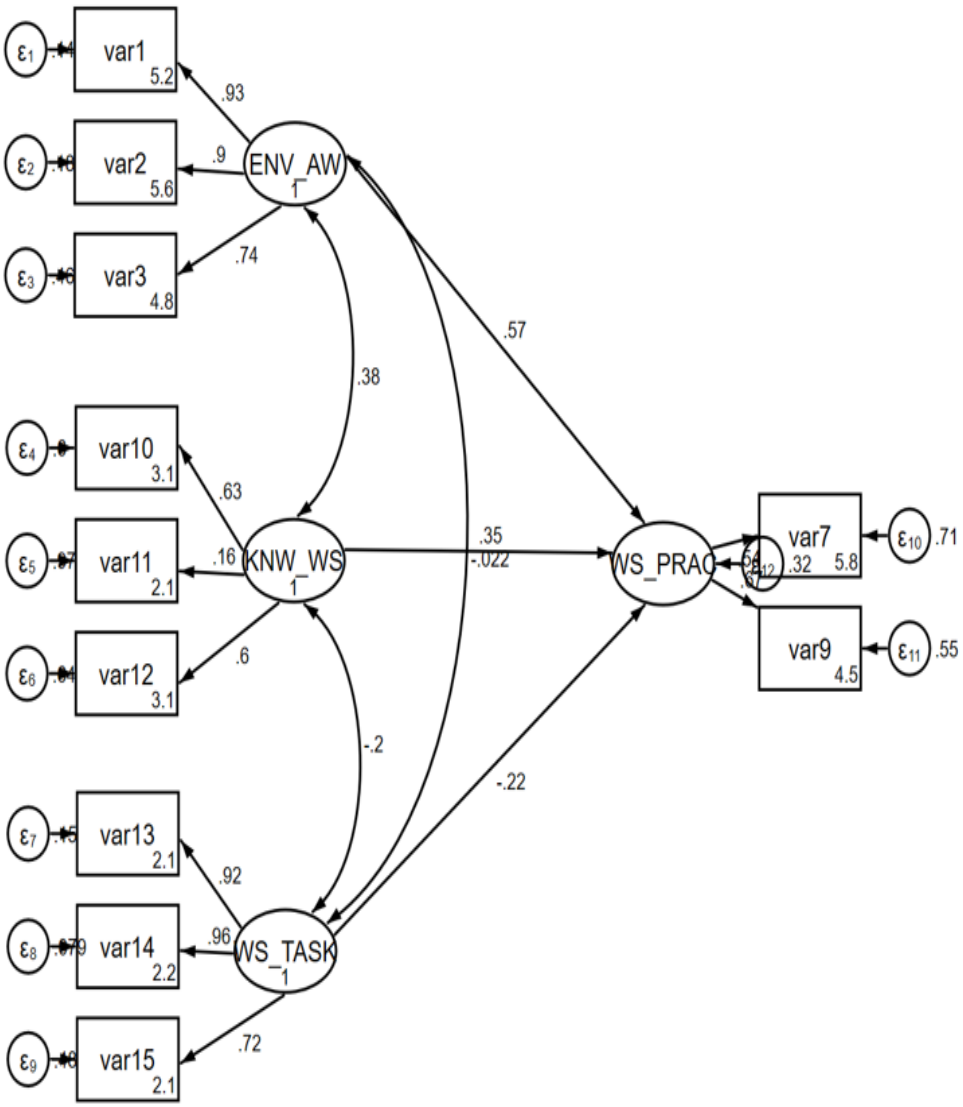

Figure 1. Structural Model for Household's Attitude towards Waste Segregation Practice (Source: Generated using Stata 15 GUI based on data obtained from the primary questionnaire).

Confirmatory Factor Analysis: We tested a four-factor model (Figure 1). The structural model comprising of the four variables namely *Environmental Awareness (ENV_AW)*, *Knowledge about Waste Segregation (KNW_WS)*, the perception about *Actual Task of Waste Segregation (WS_Task) and* perception towards the *Practice of Waste Segregation* (WS_Prac). These four constructs comprise of 11 statements.

The model was tested using maximum likelihood estimation model. Unstandardized values are reflected in the structural diagram. To achieve the model fitness, the maximum likelihood (ML) values were examined and re-analysed to achieve a better model fit.

All factor loadings are statistically significant at 1 per cent, hence implying that all the indicator variables are significantly related to their respective factors (Table 3).

The model showed an acceptable fitness (Table 4). The chi-square goodness of fit test in our case is significant, $\chi^2(38) = 120.939$, with $p<.001$, and suggesting a poor fit of the model to the data. However, given the fact that structural equation modelling is a large sample procedure, researchers priortise other indices as this test is often rejected even in cases with minor misspecifications. The value of the Root Mean Squared Error of Approximation (RMSEA) is coming out to be 0.056 which is acceptable. The values of the incremental fit indices- Comparative Fit Index (CFI) at 0.975 and Tucker Lewis Index (TLI) at 0.964 are both greater than 0.95 indicating very good fit (Schumaker and Lomax, 2016).

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Table 4. Goodness of Fit Indices of Confirmatory Factor Analysis.

Index	Value
Chi Square (df) p-value	120.939 (38) 0.000
RMSEA	0.056
CFI	0.975
TLI	0.964

Source: Analysis based on data obtained from the primary questionnaire.

Path Analysis: Path analysis represents the regression values between the variables. Figure 2 presents the same for our survey data.

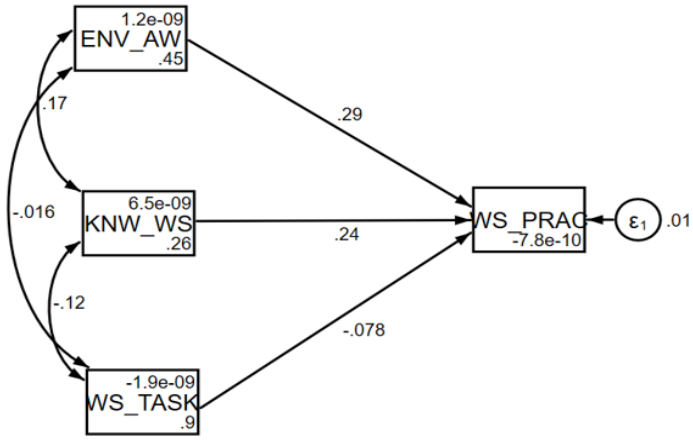

Figure 2. Path Analysis for Household's Attitude towards Waste Segregation Practice.

The covariance between environmental awareness and knowledge about separation of waste is positive, while that between perception about actual task of separating waste and environmental consciousness as well as between perception about actual task of separating the waste and its knowledge is negative (Figure 2).

It is evident that *environmental awareness (ENV_AW)*, *knowledge about waste segregation (KNW_WS)* and the assessment about *actual task of waste segregation (WS_Task)* considerably impact the perception towards the *practice of waste segregation* (WS_Prac). Further, environmental awareness appears to have the largest impact followed by knowledge about how to undertake waste segregation. The impact of the perception regarding the actual task of waste segregation is negative and smallest in absolute terms (Table 5).

Table 5. Findings from Path Analysis.

Factor	Coefficient Value
Environmental Awareness	0.289***
Knowledge about Waste segregation	0.239***
Perception about Actual Task of Waste Segregation	-0.077***

Source: Analysis based on data obtained from the Primary Questionnaire.
*Notes: *, **, *** represent significance level of 10 per cent, 5 per cent, and 1 per cent*

From our SEM and path analysis we conclude that environmental awareness, knowledge about separating waste and awareness about the actual task of waste separation have a significant impact on discernment towards the practice of separating waste with environmental alertness having the largest impact followed by knowledge about how to undertake waste separation. The impact of the perception regarding the actual task of waste separation is not only negative but also the least in absolute terms.

Discussion and Conclusion

Collaboration among various stakeholders is necessary to establish a robust and streamlined SWM system. Waste can be separated either at the place where it is produced (source segregation) or at the place where it is treated (secondary segregation). The former has clear benefits compared to the latter. Nevertheless, the process of source segregation necessitates a continuous effort to raise awareness and involve both individuals and institutions responsible for producing the waste. This involves initiatives to influence behaviour that go beyond social classes and levels of literacy. The issue of insufficient public engagement in source separation must be tackled. Therefore, it is crucial to raise knowledge about the negative outcomes of not segregating waste, as well as the advantages that come with waste segregation. It is crucial to promote, enhance, broaden, and intensify the implementation of waste segregation at the point of origin to have a sustainable and long-lasting effect.

An integrated solid waste management system relies heavily on efficient waste sorting and collection programmes. It is imperative to instil in waste generators a sense of moral obligation to foster a lasting transformation in their resource utilisation habits. It is of utmost importance to encourage recycling and reusing practices in this situation. Sorting and collecting waste that has been separated into different categories, and then recycling it, can have a positive impact on generating income. Efficient management of macrobiotic waste and the availability of composting sites within every neighbourhood, serving approximately 100 to 150 families, is of utmost importance. Having identified the key components required for the effective implementation of waste administration systems, we now present the specific policy implications that have arisen from our study.

Based on our empirical analysis, environmental awareness, knowledge of waste segregation, and perception of the actual task of waste segregation all have a significant influence on individuals' perception of waste

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segregation practices. Specifically, environmental awareness has the greatest impact, followed by knowledge of how to properly undertake waste segregation. The perception regarding the effort involved in the actual task of waste segregation has a minimal and predominantly negative impact. In this context the following policy implications emerge:

 # Creating Awareness about the Environment: To initiate successful behavioural change, it is crucial to generate awareness about the environment and factors including waste management which can help mitigate climate change. Quantitative literature has cited waste prevention behaviour and waste segregation adaption to be influenced by concern and awareness about the environment (Bortoleto et al., 2012; Wang et al., 2022). Creating more awareness about the environment can be achieved by implementing instructional programmes in educational institutions, organising workshops and seminars facilitated by non-profit organisations and dissemination of information by local government bodies through public service announcements. These activities and campaigns should propagate the link between climate change and inefficient waste generation and management strategies and the negative impact of the latter on our natural resources. In fact, early environmental education promotes sustainable living (Agut et al., 2014). Also, a recent household-based study conducted in Delhi found that awareness about the need for separating waste as well as adapting this practice are significantly higher in households with larger proportions of senior citizens (Kaur et al., 2023) in households. Hence, there seems to be a need to bridge the environmental-knowledge gap between the young and the old. Thus, to push the former towards adapting environmentally sustainable practices formal environmental education from a young age appears to be an essential requirement.

 # Spreading Knowledge about Waste Segregation: To initiate appropriate changes in attitude towards waste separation at source, it is important to spread knowledge about how to undertake this important task. Studies have found that awareness and knowledge about separation of trash have a significant impact on families adapting such practices (Moh and Manaf, 2014; Sahoo et al., 2022; Kaur et al., 2023). Educational intervention and involvement of self-help groups, NGO's and non- profit organisations can also augment community orientation and waste segregation literacy. Mere distribution of different coloured dustbins will not suffice in spreading awareness about waste separation at source.

 # Demystifying the Actual Task of Practicing Waste Segregation: To propagate the adoption of waste separation behaviour at source it should be ensured and advocated that these practices are inexpensive, context-specific, socially acceptable and participatory. Dissemination of simple segregation strategies should be warranted. It is important to establish effective communication networks and carry out interactive extension and outreach activities to create awareness amongst the stakeholders. In this regard, it is important to involve the informal sector, especially in the case of developing economies like India wherein all unofficial waste disposal and removal services including the collection and sale of recyclables is undertaken by these individuals or small businesses (Aparcana, 2017). Effective communication and outreach initiatives are essential in keeping all relevant stakeholder groups well-informed and prepared to meet local solid waste management regulations. Considering and including the informal sector is crucial when planning a sound SWM programme. Typically, the informal sector is made up of individuals, groups, and small businesses who participate in informal waste removal services by collecting and selling recyclables, often with the help of middlemen or intermediaries. Income is generated by these workers through the sale of recyclables to industries operating within the paradigm of the formal sector. Alternatively, these waste goods are sold to other participants in the informal sector who repurpose the materials for use in other processes or as parts for repairing paraphernalia. Hence the informal sector has the potential to make a significant impact by sorting resources and selecting which waste should be collected. Additionally, it is important to educate all stakeholders involved in the waste management process, about the importance of their respective positions in the overall chain. In India, the waste management system operates differently compared to other developed countries. Here, the person who generates the waste receives payment for their waste. As a result, the revenue flow is reversed: the homeowner receives payment from the local informal sector collector who in turn receives payment from the recyclers for providing the essential components for the recycling process. It is crucial to provide proper incentives to all parties involved to optimise waste collection, reduce dumping, and enhance waste disposal and recycling efforts. Implementing consistent and efficient local initiatives can have a significant impact on improving how waste is handled at various levels. Local stakeholders play a vital role in implementing and enforcing waste management and can support the growth of local circular economies by helping enterprises to

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repurpose waste and encouraging environmentally friendly practices among the community.

The waste management sector in the city is in dire need of a complete overhaul. The task at hand is undeniably immense, but it is within reach. It is crucial that we engage in urgent and collaborative planning to encourage the needed shift in behaviour. Indeed, citizen participation and engagement are crucial. Establishing a suitable structure for institutions, combined with clear policy-level guidance, will be instrumental in facilitating the required transformation.

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Conflict of Interests

The authors of this research declare that there is no conflict of interest regarding the publication of this paper.

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