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Original Research Article

Factors Influencing Public Perception of Waste Separation at Source in Kathmandu Valley

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Abstract

Due to inadequate planning, limited awareness among residents, and insufficient resources, local municipal authorities face significant challenges in effectively managing solid waste, which has resulted in issues such as flooding and waterlogging. This study aims to develop a comprehensive understanding of the factors influencing people's perceptions of waste separation at the source. In addition, it seeks to identify the key challenges hindering the adoption of waste separation practices and to propose effective measures to support and enhance their implementation. This study adopts an explanatory research design. The research draws upon a comprehensive analysis of empirical studies and employs descriptive and inferential statistics to analyze the data collected from the general population in Kathmandu valley. Convenience sampling is employed to gather responses, resulting in a sample size of 419 participants. The data collection process utilizes self-administered questionnaires facilitated by the KOBO toolbox. Structural Equation Modeling (SEM) is utilized to analyze the perceptions of individuals regarding waste separation at the source. The findings reveals that attitude, perceived behavioral control, and moral norm significantly influence intention, while subjective norm does not. Furthermore, intentions have a significant impact on waste separation behavior. The study also identifies common challenges faced by respondents, including lack of education and awareness, financial incentives, access to infrastructure and facilities, availability of segregation-related materials, and inconsistent waste collection systems. To address these challenges, it is recommended to ensure easy availability of segregation-related resources, implement education and awareness programs, establish a consistent waste collection system, provide access to infrastructure and facilities, and incentivize good waste management practices. The study revealed that attitude, perceived behavioral norm, moral norm, and intention influences waste separation behavior. Furthermore, peoples face significant challenges such as lack of education and awareness, financial incentives, access to infrastructure and facilities, availability of plastics, bins and containers and inconsistent waste collection system.

Introduction

Environmental pollution due to the improper solid waste management is a

worldwide problem. The most common methods for waste treatment and disposal, mainly in low-income nations, are open dumping and burning (Ferronato & Torretta, 2019). The worldwide "take, make, and dispose" pattern has expanded waste production and resource exploitation, posing major dangers to the availability of resources and placing pressure on waste generation (Zhang et al., 2022). From 1900 to 2010, the pace of global solid waste output increased from less than 0.3 Mt per day to more than 3.5 Mt per day. By 2025 and 2100, this rate is expected to triple (Burke et al., 2012). According to the World Bank's "What a trash 2.0" report, around 2.01 billion tonnes of municipal solid trash are produced annually, of which 33% are not disposed of in an environmentally responsible manner (Kaza et al., 2018).

Waste is a concern in many nations throughout the world, and poor waste management can harm the ecology and aesthetics and this may even arise various problems when the government plans to manage waste remains unsuccessful. Even though the government has established a policy on waste, but owing to a lack of socialization, very few people are aware of how to handle waste effectively, so there are still numerous piles of trash across the street. People are less concerned about waste management as it is currently believed that the government has complete responsibility for it (Zainal et al., 2021). For the authorities in small and large towns in developing countries, managing solid waste is the most important task. The "garbage" or "trash" produced by domestics, known as household waste, makes up a portion of MSW. More than 60 tons of garbage are produced every second and total 2 billion tons of residential waste annually in the world (Cheng et al., 2022). A community-based strategy could be employed to address the trash issue, specifically at the household level (Widiyanto et al., 2019). The alternative to municipal solid waste management's substantial issues brought on by rapid urban population development is a domestic waste sorting system (Lu & Sidortsov, 2019). Even the present waste management directives of the European Union seek to encourage waste prevention and the implementation of a hierarchy of waste management practices, including preparation for zero waste, reuse, recycling, alternative recovery, and disposal and it also evaluates the waste operations of recycling, incineration, and dumping separately (Pires & Martinho, 2019).

The issue of waste presents a significant challenge to sustainability, as it has far-reaching effects on the environment, public health, and the financial performance of businesses (Filimonau & De Coteau, 2019). As sustainable waste management is a big global problem that poses unique challenges in every location. For improving sustainability on a global scale, developing nations should take into account the development of efficient solid waste management systems. The implementation of environmental legislation, successful investments, social inclusion, and public awareness are some of the obstacles that needs to be overcome as these are the important issues in many countries (Ferronato et al., 2019). When citizens incorrectly divide waste fractions, they cause harm to the environment and the economy. The introduction of sustainable waste management is a great chance to salvage energy and resources (De Feo et al., 2019). There is a need for more effective waste management and sustainable development integration strategies, as well as for trash prevention, collection, and disposal techniques such as waste separation at source as the need for waste sorting at source is emerging. Governments, municipalities, and citizens must work together to develop and put into practice more sustainable waste management methods in order to safeguard the environment and promote a healthy future for everybody.

In cities in developing nations, managing municipal solid waste is becoming a complex issue (Kaza et al., 2018). Even in Nepali cities, rapid and unchecked urbanization, a lack of public awareness, and inadequate municipal management have exacerbated environmental issues, including improper trash management and disposal. An estimated 50% to 75% of the total MSW produced comes from domestic garbage in general. According to the analysis of residential trash composition, organic waste accounted for the biggest percentage of garbage (66%), and many towns engage in open dumping (Asian Development Bank, 2013). Despite the fact that Nepal has established a number of solid waste management rules, the majority of the nation still burns garbage in the open as evidence of the effectiveness of the country's waste control measures (Das et al., 2018). As Nepal's economy shifts from a farm-based rural economy to an industry- and service-based urban one, the volume of MSW is showing an upward trend. Due to inadequate planning, low levels of resident knowledge, and a lack of resources, the local municipal authorities have had difficulty managing solid waste properly leading to flooding and waterlogging (Bharadwaj et al., 2020). Thus, this study will find the factor that mainly impacted in the waste

segregation, the challenges they face in segregating the waste and the remedial factor for the issues.

Research Method

Research Design

This study utilizes the research design as explanatory research design (Basnet et al., 2024; Singh et al., 2024). Understanding the causal mechanisms underlying events and the connections between variables are the goals of an explanatory research design. It is applied when it is necessary to give explanations and pinpoint the causes or contributing elements of particular outcomes or behaviors. Testing hypotheses and coming to conclusions through statistical analysis are common aspects of this sort of research methodology (Rahi, 2017). This research design focused on completely outlining the feature of the study and is often characterized by a great degree of flexibility and a lack of formal structure. This study is an illustration of explanatory research since it is built upon survey data and seeks to identify the relationship between dependent and independent variables. The objective of this study is to analyze the people's perception towards waste separation at source in Kathmandu valley.

Conceptual Framework

In order to facilitate study, analysis, and interpretation, theories, concepts, and ideas are outlined and arranged in a conceptual framework. The study has reviewed several theories such as Theory of Planned Behavior (Ajzen, 2020, 2022; Harland et al., 1999;; Pakpour et al., 2014), Theory of Interpersonal Behavior (Ibrahim et al., 2018; Moody & Siponen, 2013; Salonen et al., 2014), Theory of Reasoned Action (Fishbein, 2008; Korir et al., 2018; Sarver, 1983; Schlegel et al., 1992; Tatlonghari & Jamias, 2010; Yang et al., 2011), Social Cognitive Theory (Bandura, 2002; Dace et al., 2019; Schunk & Dibenedetto, 2019; Wood & Bandura, 1989), Self-Efficacy Theory (Bandura, 1977; Bandura & Adams, 1977; Maddux & Stanley, 1986).

The TPB, created by Icek Ajzen, asserts that three variables—attitude toward the conduct, subjective norm regarding the behavior, and perceived behavioral control—determine behavioral intents. The TPB has been used to examine why people act in ways that are friendly to the environment, including ways that promote waste management and source segregation (Ajzen, 2020, 2022; Harland et al., 1999; Heinrich, 2016; Pakpour et al., 2014). The Limayem, Khalifa, and Chin-created TIB theory is a comprehensive framework that includes all TRA and TPB components as well as extras like habits, facilitating situations, social norms, and emotions. The TIB theory is acknowledged as a theoretical framework that can be used to explain any pro-environmental conduct (Ibrahim et al., 2018; Moody & Siponen, 2013; Salonen et al., 2014).

The TRA, created by Fishbein and Ajzen, is a broad theory of behavior that asserts a causal relationship from beliefs to attitude to the "social norm" and intention to behavior. The idea offers a framework for assessing how important attitudes are in influencing someone's propensity to engage in various activities. TRA can be used to assess how important attitudes are in foretelling solid waste management efforts. The idea of reasoned action places a lot of emphasis on subjective norms, which are an individual's perceptions of whether their friends, family, coworkers, and society at large believe they should or shouldn't engage in a specific conduct. A quantitative calculation or an explanation of the process underlying these behaviors have not yet been offered by the theory, despite the fact that it gives us a framework for understanding why people might not act in the interests of the environment (Fishbein, 2008; Korir et al., 2018;; Sarver, 1983; Schlegel et al., 1992; Tatlonghari & Jamias, 2010; Yang et al., 2011).

The self-efficacy theory, first put forth by Albert Bandura in 1977, contends that any alteration in a person's assessment of their own competence or efficacy is the cause of any behavioral or psychological change. People's decisions, efforts, and perseverance are all influenced by their perceptions of their own efficacy, and there are four basic sources of data from which they can draw these conclusions. These sources include verbal persuasion, bodily states, performance accomplishments, and vicarious experiences. The extent of increases in perceived self-efficacy is related to the validity of these experiential sources (Bandura, 1977; Bandura & Adams, 1977; Maddux & Stanley, 1986). Last but not least, Alberta Bandura's theory of social cognition contends that environmental, behavioral, and cognitive factors all influence learning. In especially when it comes to pro-environmental activities,

this theory emphasizes the importance of self-efficacy in anticipating and comprehending behavior (Bandura, 2002; Dace et al., 2019; Schunk & Dibenedetto, 2019; Wood & Bandura, 1989).

Among different theories, Theory of Planned Behavior founded by Icek Ajzen in 1991 which has been applied to analyze environmental and pro-environmental conduct is employed in this study. It is supported empirically as a theoretical framework for studying environmental behaviors and additionally offers an appropriate framework for the investigation of such behaviors.

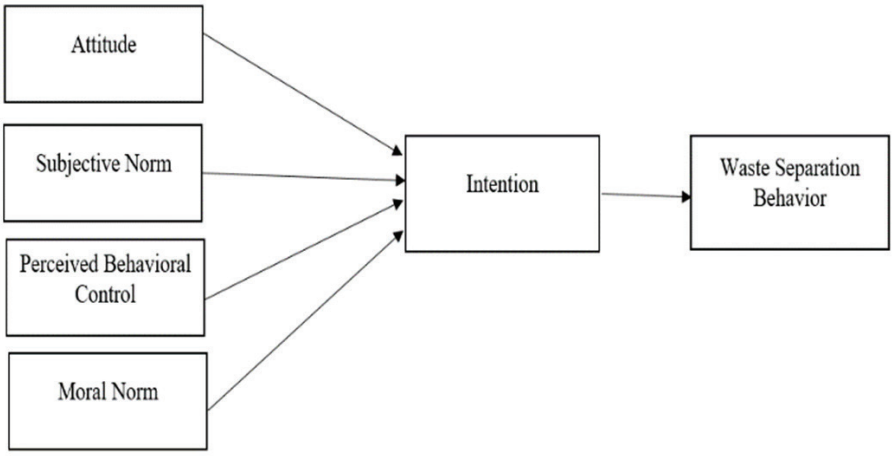

Figure 1: *Conceptual Framework of people's perception towards waste separation at source*
Source: Adopted and modified from (Razali et al., 2020), Varah et al. (2021)

The following hypotheses are proposed on the basis of given conceptual framework.

Attitude and Intention

The term "attitude" describes how someone feels or perceives carrying out a specific behavior (Teo et al., 2016). A person's attitude toward a behavior is influenced by their behavioral beliefs about the outcomes they expect from a behavior. The overall attitude, which may be favorable or negative, towards that consequence is determined by the degree of certainty that a conduct will result in that event (Ajzen, 2020). Attitudes toward a specific behavior exert their impact on behavior via intentions (Conner & Armitage, 1998). An individual's favorable or negative assessment of engaging in a certain conduct is expressed by their attitude toward the behavior (Godin & Kok, 1995). Attitude toward conduct is thought to be a product of easily accessible ideas about the anticipated outcomes of the behavior, known as behavioral beliefs. A behavioral belief is a person's subjective likelihood that engaging in an activity of interest will produce a particular result or give a particular experience (Ajzen, 2020). The way a person feels about themselves generally influences how they behave and it explains attitude as a cultivated propensity to react consistently favorably or unfavorably to a particular object (Conner, 2020). A person's attitude comprises not just how they would rate potential outcomes, but also how likely they think they are (Kaiser & Gutscher, 2003).

H1: There is significant relationship between attitude and intention.

Subjective Norm and Intention

There are basically two types of normative belief: injunctive and descriptive. Injunctive normative beliefs are expectations or subjective probabilities of whether a particular group(e.g., friends, family, spouse, coworkers, one's physician or supervisor) or person approves or disapproves of a conduct whereas descriptive normative beliefs concern whether influential people exhibit the conduct and the perceived general social pressure or subjective norm to engage in the behavior is influenced by both types of beliefs (Ajzen, 2020). Subjective norms quantify

the peer pressure that people feel to engage in a behavior, reflecting their perceptions of the preferences of their significant others (Conner & Armitage, 1998). The perceived subjective social norm (SN) captures an individual's understanding of the societal pressure to engage in a particular action (Godin & Kok, 1995). Subjective norms are ideas about whether influential people think one should undertake a behavior, and they gauge the social pressures people feel to do so. Usually, the level of important people's support for the behavior is gauged in this way (Conner, 2020). Subjective norms describe the potency of normative beliefs and the desire to uphold them (Kaiser & Gutscher, 2003).

H2: There is significant relationship between subjective norm and intention.

Perceived Behavioral Control and Intention

The term "perceived behavioral control" describes how simple or complex someone thinks an activity is to carry out. One's actual behavior is greatly influenced by their confidence in their capacity to carry out an activity and can determine if someone will carry out an action by looking at their perceived behavioral control and behavioral intention (Ajzen, 2022). PBC is the individual's perception of the extent to which performance of the behavior is easy or difficult. The TPB suggest that behavior is solely under the control of intention and depicts behavior as a function of behavioral intentions and perceived behavioral control (Conner & Armitage, 1998). Personal judgments about how simple or complex carrying out the behavior will likely be reflected in perceived behavioral control. It is considered that it reflects both internal (e.g., talent, skill, information) and external (e.g., availability of time or money, social support) aspects (Godin & Kok, 1995). The term "perceived behavioral control" (PBC) refers to how much control a person feels they have over their behavior. It is viewed as a continuum with behavioral goals that need resources, opportunity, and specialized skills at one end and easily accomplished behaviors at the other. Items measuring perceived confidence that you can engage in the action and that accomplishing the behavior is up to you typically tap into PBC (Conner, 2020).

H3: There is significant relationship between perceived behavioral control and intention.

Moral Norm and Intention

Moral norm is defined as people's feelings of moral duty and obligation toward the intention that ultimately led to that behavior (Razali et al., 2020). A person's view of the moral correctness or improperness of a certain behavior is referred to as their moral norm (Ajzen, 2022). According to previous research, morality is a crucial factor to examine since it has a positive impact on intention (Bortoleto et al., 2012). The moral standards that each person perceives influence their positive or negative evaluation, which finally manifests as behavior (Yuan et al., 2016). One of the most important factors influencing people's behavior toward recycling activities is moral norm. An individual's moral standards serve as the primary motivator for engaging in pro-environmental behavior (Chan & Bishop, 2013; Graham-Rowe et al., 2015; Largo-Wight et al., 2012; Stern, 2000).The personal norm generates pride and shame sentiments that control intention (Onwezen et al., 2013). It has been argued that when a behavior includes a moral or ethical component, it should be incorporated into the TPB model (Conner & Sparks, 2005). Recent studies in literature on the environment have discovered that adding moral norms to the TPB is a valuable addition. For instance, it has been demonstrated that moral norm strongly predicts recycling intention (Largo-Wight et al., 2012). TPB was criticized by Klöckner and Blöbaum (2010) for failing to include moral norm as one of the factors which influence the intention towards the behavior. As stated above, it is essential to research how moral norms influence behavior that promotes waste separation. As a result, this study will add a moral norm factor to TPB to further explain household waste separation at source behavior in Kathmandu Valley.

H4: There is significant relationship between moral norm and intention.

Intention and Waste Separation Behavior

Intentions are what motivate a person in the sense of their deliberate plan or choice to make the effort to carry out the activity. When measured with the same level of specificity in relation to the action, target, context, and time frame and when the time interval is brief enough to verify that intentions have not altered, it is believed that

intentions and behavior are tightly correlated (Conner & Armitage, 1998). Intentions show what drives an action and how much effort a person is willing to put forth to carry it through. Strong intentions make a behavior more likely to be carried out, but they only work if the behavior is voluntarily chosen to be performed. The effectiveness of conduct is also influenced by non-motivating factors like the accessibility of resources. The likelihood of success increases if a person has the necessary tools and wants to engage in the behavior (Ajzen, 2022).

The TPB suggest that behavior is solely under the control of intention and depicts behavior as a function of behavioral intentions and perceived behavioral control (Conner & Armitage, 1998). The relationship between intentions and behavior is more complicated, implying that we are more likely to carry out actions we have control over and are stopped from doing actions we have no control over. As PBC rises, behavior will be more likely to be carried out, assuming intentions stay the same (Conner & Armitage, 1998). The term "behavioral intention" refers to a person's motivation in the sense of a deliberate plan, choice, or self-instruction to try to carry out the goal activity. Items assessing likelihood of intending to perform the behavior tap into these (Conner, 2020). In the TRA, the immediate antecedent of overt conduct is intention to carry out the relevant behavior. Accordingly, intention is viewed as a result of people's attitudes toward carrying out a certain act and their subjective norms (i.e., their sense of the expectations of pertinent individuals) (Kaiser & Gutscher, 2003).

H5: There is significant relationship between intention and waste separation behavior.

Waste Separation Behavior

Intentions and perceived behavioral control work together to determine how well a behavior is performed. Intentions and perceived behavioral control must match the behavior to be predicted, be correct, and remain constant between the time of evaluation and observation (Ajzen, 2022).

The TPB suggest that behavior is solely under the control of intention and depicts behavior as a function of behavioral intentions and perceived behavioral control (PBC) (Conner & Armitage, 1998). The relationship between intentions and behavior is more complicated, implying that we are more likely to carry out actions we have control over and are stopped from doing actions we have no control over. As PBC rises, behavior will be more likely to be carried out, assuming intentions stay the same (Conner & Armitage, 1998). The less controlled an action is on purpose, the more its performance depends on the presence of the right contextual circumstances (Kaiser & Gutscher, 2003).

H6: Intention has mediating effect between attitude and waste separation behavior.

H7: Intention has mediating effect between subjective norm and waste separation behavior.

H8: Intention has mediating effect between perceived behavioral control and waste separation behavior.

H9: Intention has mediating effect between moral norm and waste separation behavior.

Table 1: *Variable used in the Study*

Constructs	Observed Variables	Indicator	Explanation	Remarks
Attitude	Household Waste Sorting	ATT1	I'm interested in separating my household waste.	(Razali et al., 2020)
	Waste separation advantages	ATT2	I find that waste separation at the source is beneficial	(Razali et al., 2020)
	Environmental benefits	ATT3	Waste separation at source is beneficial to the environment	(Razali et al., 2020)
	Lower cost to the nation	ATT4	Waste separation at homes can assist the nation in lowering the pollution control cost.	(Xu et al., 2017)
	Profitable Segregation	ATT5	I should do waste segregation as recyclable waste can be sold to earn money	(Xu et al., 2017)
	Weak policy	ATT6*	Our waste segregation policy is strict	(Pratap et al., 2020)

Constructs	Observed Variables	Indicator	Explanation	Remarks
Subjective Norm	Observe	SN1	I observe that many people practice segregation	(Pratap et al., 2020)
	Waste collector	SN2	I observe that the waste collectors separate the garbage in their pickup truck	(Pratap et al., 2020)
	Regular collection	SN3	The waste is regularly collected by collectors	(Pratap et al., 2020)
	Punishment	SN4	I think people are punished for not segregating waste in my community	(Pratap et al., 2020)
	Educated choice	SN5	Waste separation, in the opinion of my community (circle), is an educated choice.	(Razali et al., 2020)
	Reward	SN6	In my community, garbage separation is rewarded.	
Perceived Behavioral Control (PBC)	Easy Waste Separation	PBC1	Separating waste at home is simple	(Razali et al., 2020)
	Garbage Sorting Knowledge	PBC2	I am aware of how to sort my household garbage.	(Razali et al., 2020)
	Recyclable Waste Awareness	PBC3	I am aware of which household waste can be recycled.	(Razali et al., 2020)
	Garbage Storage Awareness	PBC4	I am aware of where to keep my home garbage after separation.	(Razali et al., 2020)
	Time	PBC5	It doesn't take a lot of my time to separate waste at my home.	(Razali et al., 2020)
	Cost effective & easy availability	PBC6	The plastic, bins and containers for garbage storage are cost effective and easily available.	
Moral Norm	Eco-Conscious Regret	MN1	I feel guilty if I don't separate my household waste	(Razali et al., 2020)
	Terrible Feeling	MN2	I feel terrible when I fail to perform waste separation	(Razali et al., 2020)
	Bin Misplacement Guilt	MN3	I feel guilty if I don't place biodegradable and non-biodegradable in the appropriate bins.	(Razali et al., 2020)
	Waste-Separating Advocate	MN4	I want to be known as someone who separates waste at home	(Razali et al., 2020)
	Moral	MN5	It is against my morals to not separate the waste.	(Razali et al., 2020)
Intention	Start or improve	INT1	I want to start separating garbage or get better at it in near future	
	Encourage	INT2	I'll encourage my family members and circle to separate the waste at home.	
	Motivation	INT3	If I am aware of the advantages of – [pseparation, it would motivate me to separate waste.	(Heidari et al., 2018)
	Informed Intent for Segregation	INT4	I intend to separate waste when I understand its advantages and significance	(Heidari et al., 2018)

Constructs	Observed Variables	Indicator	Explanation	Remarks
Waste Separation Behavior	Separate	WSB1	I normally separate my home garbage	(Razali et al., 2020)
	Routine	WSB2	I routinely separate and recycle household waste at my home	(Razali et al., 2020)
	Engage	WSB3	I engage in waste separation activities	(Razali et al., 2020)
	Practice		I have practiced waste separation for some time.	(Razali et al., 2020)

Study Area and Population

The study's geographic focus was the Kathmandu Valley. Bhaktapur, Lalitpur, and Kathmandu are the three major cities of Nepal. 899 square kilometers and 1,300 meters above sea level make up the Kathmandu Valley. It is located between longitudes 85° 11' 31" and 85° 31' 38" east and latitudes 27° 32' 13" and 27° 49' 10" north. The highest points are at Bhaktapur (2,166 meters), Kathmandu (2,732 meters), and Lalitpur (2,831 meters).

The Kathmandu Valley, which includes Kathmandu, Bhaktapur, and Lalitpur, is one of the few regions with the highest population density, and Kathmandu is the capital city of Nepal. The majority of individuals are living today either as a result of wise career decisions, quality education, or better work possibilities. Additionally, the Kathmandu Metropolitan City was where the trash separation at source effort was first launched. The general public makes up the study's population. As a result, respondents from the Kathmandu valley may be better informed and aware of the benefits of trash separation at the source, which will enable them to give accurate information on people's attitudes about garbage separation at the source and be helpful to the study. It is important to note that waste management practices in other areas outside the Kathmandu Valley are not as developed. These areas lack proper waste collectors and dedicated dumping sites, which limits the effectiveness of waste separation at source initiatives. Consequently, the benefits and feasibility of waste separation at source are not as significant in these locations compared to Kathmandu Valley. Therefore, the study primarily focuses on the specific context of Kathmandu Valley, acknowledging the unique challenges and opportunities present in this area regarding waste management.

Sampling Technique and Sample Size

Sampling is a process used in statistical analysis in which a predetermined number of observations are taken from a larger population (Devkota & Phuyal, 2017). Since the study's population is unknown, the non-probability sampling strategy is used among these two methods. Convenience sampling, also known as accidental or haphazard sampling, is a type of nonprobability or nonrandom sampling in which members of the target population who satisfy certain practical requirements, such as easy accessibility, close proximity to the study site, availability at a specific time, or willingness to participate, are included for the purpose of the study. This study uses convenience sampling under the non-probability sampling technique (Maharjan et al., 2025). A convenience sampling technique was used to select participants for the study, as researchers randomly chose individuals from the general public who had knowledge about waste separation at the source. A total of 419 respondents were surveyed to gather data on garbage disposal practices. The purpose of conducting field observations was to validate or gather new information. In this regard, 419 respondents were conveniently selected from the Kathmandu valley.

When drawing conclusions about a sample's population, the sample size must be taken into account. Two factors should be taken into account when choosing a sample size: (a) the number of participants who can be attracted within the allotted time frame with the resources at hand; and (b) the final calculated figure must represent the minimum number of participants necessary to obtain a trustworthy answer to the research question (S & S, 2010). When determining the sample size for a study of this type, a number of factors are taken into account, including the study's breadth, the subject's nature, the quality of the data, the study design, and the use of shadowing data (Campbell et al., 2020). According to Paudel et al. (2020), determining sample size aids in the organization of the study by ensuring the ethical and effective use of research resources to provide statistically

meaningful results. The sample size for the investigation was calculated using the formula as ((Lawaju et al., 2024), where, $n_{0=}$ sample size for the study, standard tabulated value for 5% level of significance (Z)= 1.96, p= prevalence or proportion of an event 50% =0.50, q=1-p =0.50, allowable error that can be tolerated (e) =5%. Thus, sample size for the study n_0= = 384.16, non-response error 5% , i.e. 384.16 x 0.05 =19.20. In total the sample size for the study was (384.16 +19.20 =403.36)~403. However, the study collected the sample size of 419 observations due to better accessibility to participants.

Research Instrument and Data Collection

The main research tool in this study was a standardized questionnaire. A structured questionnaire on people's perception towards waste separation at source has been developed for the goal of obtaining data (Devkota et al., 2020). The researchers have linked questionnaires to help them reach the study's several objectives and created both open-ended and closed-ended questions. Researcher focused on the sequence and arrangement of the questionnaire. The formulated structured questionnaires are administered in Kobo Toolbox for data collection. The structured questionnaires that have been created are utilized to gather data for the Kobo Toolbox. A pilot survey with fifteen sample questions was conducted once the Questionnaire was submitted to Kobo Toolbox in order to evaluate the instrument's consistency and correctness. This survey was conducted on April 24, 2023, to May 14, 2023.

Results

Socio Demographic Analysis

Table 2: *Socio Demographic Variable*

Title	Category	Number	Percentage (%)
Gender	Male	238	56.8
	Female	181	43.2
Age	Below 20	31	7.4
	21-30	276	65.87
	31-40	74	17.66
	41-50	27	6.44
	51-60	7	1.67
	Above 60	4	0.95
Marital Status	Unmarried	266	63.48
	Married	151	36.04
	Others	2	0.48
Family Size	Small Family	301	71.84
	Joint Family	108	25.78
	Extended Family	10	2.39
Educational Level	Illiterate	23	5.49
	SLC/SEE	20	4.77
	Intermediate	51	12.17
	Bachelor's	151	36.04
	Master's and above	137	32.7
	Others	37	8.83
Occupation	Private Sector	165	39.38
	Government Sector	23	5.49
	Public Sector	15	3.58
	Self employed	74	17.66
	Unemployed	119	28.4
	Others	23	5.49

Title	Category	Number	Percentage (%)
Family's average annual income (NPR)	Less than 10 lakh	181	43.2
	10 lakh – 12 lakh	86	20.53
	12 lakh – 14 lakhs	47	11.22
	14 lakhs – 16 lakhs	22	5.25
	16 lakhs – 18 lakhs	29	6.92
	Above 18 lakhs	54	12.89

Total of 419 respondent are taken in the survey among them majority of the respondent are male (56.80%). In a similar study conducted by the (Razali et al., 2020), female participation was 61% which indicate the female participation is more than male. Among the total respondents most of the respondents are unmarried i.e. 63.48%. In a similar study conducted by Bardus and Massoud (2022) shows that 72.1% of the respondents were married and 11.4% were unmarried. Similarly, 71.84% of the respondents have a small family, 25.78%. Majority of the respondents were in the age group within 40 representing 83.53%. This representation is contradict with the study of Xu et al., (2017), (Issock et al., 2020) shows 38.9% of the respondent are in the age group of (31-40). In the survey educated people who have the bachelor and mastered participated (68.74%).

General Understanding of Waste Management

In this study respondent were asked about their understanding about Waste Management, how often does they throw waste, do they separate their garbage at home, if there is no waste collection in their area how do they dispose their garbage, whether or not the respondents have ever heard of garbage separation campaign initiated by Kathmandu Metropolitan City and have they ever lived in areas where it was compulsory to separate garbage at source. The result reveal that among the 419 respondents, 31.74% throws garbage once a week, 30.55% every three day, 18.85% every two days and 17.66% every day. Majority of the respondents show they separate their household waste (55.37%) whereas (44.63%) does not do the separates the garbage. Upon asking how do they dispose their waste when there is no waste collection in their area or the waste collector arrives late for waste collection, majority of the respondents 31.5% answered they dispose to nearby open dumb, 26.49% burn their garbage, 23.87% uses landfill, 5.41% dispose to nearby river and few even wait till the waste collector comes or call doko recycling to pick up their garbage. Out of 419 respondents, 55.37% of respondents separate their household waste and rest do not separate the garbage. Among 232 respondents, 36.75% separate their garbage to make fertilizer, 18.14% to sell for junk buyers, 11.93% to reuse, and others sort their garbage because it's good for the environment. And those who do not sort their garbage, out of 187 respondents, 26.25% of the respondents do not do the separation because there are no fines and penalties, 15.04% thinks it as a time-consuming process and others do no sort of their waste because the waste collector mixes the garbage and there is no such policy. Out of 419 respondents, 72.32% heard about the campaign and 27.68% did not hear about it. Also, upon asking whether they have ever lived in area where waste separation at source was compulsory, only 34.13% gave a positive answer and rest gave negative answer.

Challenges Related to Waste Separation at Source

Respondent were asked whether they faced any barriers while separating waste at source. From the survey, 61.10% face the barriers while sorting their garbage at source and 38.9% do not face any barrier. Those who do not face any barrier are those peoples who segregates their waste into biodegradable and non-biodegradable (28.4%) or do not separates their garbage (10.26%). Majority of the people see it as a challenge because of lack of education and awareness about waste sorting in peoples(37.95%), lack of access to infrastructure and facilities to separate waste(30.79%) more challenges are listed in the figure 5.

Figure 2: *Challenges that households face when trying to separate waste at source*

Managerial Solutions Related to Waste Separation at Source

Respondent were asked whether the challenges related to waste separation at source were manageable or not and 54.18% of the respondent answers the challenges are manageable and can be managed by providing education and awareness programs(29.59%), implementing waste reduction and reuse programs(27.21%) (See figure 6). Respondents were also asked about the responsible person for mitigating the problem. Participated demonstrated as government are responsible (43.2%), municipality (35.56%), households (31.98%), and environmentalists (19.81%). Apart from this, some respondent think self-awareness towards waste management should be enough. The role of the government such providing policy support(30.07%), providing education and awareness programs(29.59%), providing funding(19.57%), providing bins and regular pickup(0.24%) and also by installing separate garbage bins on the streets(0.24%) are important. At last 50.84% of the respondents suggest to increase awareness, 49.88% to enforce regulations, 41.77% to provide education, 35.8% provide infrastructure, 33.17% provide resources, 32.94% implement campaigns, 32.46% involve community, 32.22% incentivize participation, 25.06% make it convenient.

Figure 3: *Solution for Waste Separation at Source*

Inferential Analysis

Common Method Bias (CMB)

The whole collinearity test is a thorough method for evaluating vertical and lateral collinearity at the same time. Therefore, the model can be regarded to be free of common method bias if all VIFs (outer model) from a full collinearity test are equal to or lower than 3.3 (Kock et al., 2021). The analysis revealed that the VIF was less than 3.3 (Tiwari et al., 2025), which suggests that single source bias is not a significant issue with data of table 3.

Table 3: *Full Collinearity Test*

Construct	ATT	INT	MN	PBC	SN	WSB
VIF	2.49	3.128	1.283	2.479	1.102	1.356

Measurement Model Assessment

Realibility is tested with the help of Internal Consistency Reliability. For this Cronbach's alpha (CA) and composite reliability (CR) are tested. Cronbach's alpha is calculated to provide a measurement of the internal consistency of the items. It has become widespread in research to figure out Cronbach's alpha for multiple-item conceptual

assessment. Those data that have Cronbach's alphas and composite reliability of the constructs more than 0.7 (Mahato et al., 2023) are considered to have adequate internal consistency (Taber, 2018). The values of composite reliability 0.7 is an acceptable value (Hair et al.,2020) where higher value indicate more reliability. Based on the analysis, the lowest CR is 0.880 and the highest CR is 0.975 which indicate all construct are acceptable.

Table 4: *Internal Consistency Reliability*

Constructs	Cronbach's alpha(CA)	Composite reliability (CR)
att	0.935	0.952
int	0.965	0.975
mn	0.931	0.948
pbc	0.943	0.955
sn	0.861	0.88
wsb	0.932	0.952

The constructs were measured using a set of items, and the table presents the loadings, and average variance extracted (AVE) for each construct. The outer loading, which shows the factor loading for each included indication, can be used to determine this value. The criteria of factor loading and AVE are observed for convergent validity in order to meet the standards stated by Aburumman et al. (2022) of an AVE value of 0.5 (Lawaju et al., 2024). According (Maskey & Nguyen, 2018), factor loading values of 0.7 and higher are preferred. Items having loading values of less than 0.4 should be dropped. The value of AVE is greater than 0.50. Convergent validity of the construct is established as a result.

Table 5: *Convergent Analysis*

Constructs	Indicators	Outer loadings	Average variance extracted (AVE)
Attitude	att1	0.913	0.798
	att2	0.936	
	att3	0.935	
	att4	0.909	
	att5	0.762	
Intention	int1	0.939	0.906
	int2	0.957	
	int3	0.958	
	int4	0.953	
Moral Norm	mn1	0.885	0.783
	mn2	0.893	
	mn3	0.904	
	mn4	0.87	
	mn5	0.874	
Perceived Behavioral Control	pbc1	0.876	0.781
	pbc2	0.917	
	pbc3	0.901	
	pbc4	0.908	
	pbc5	0.888	
	pbc6	0.808	

Constructs	Indicators	Outer loadings	Average variance extracted (AVE)
Subjective Norm	sn1	0.853	0.556
	sn2	0.81	
	sn3	0.757	
	sn4	0.725	
	sn5	0.79	
	sn6	0.478	
Waste Separation Behavior	wsb1	0.921	0.832
	wsb2	0.93	
	wsb3	0.924	
	wsb4	0.872	

To demonstrate the discriminant validity of the model, cross loadings, the Heterotrait-Monotrait Ratio (HTMT), and the Fornell-Larcker criterion should all be examined. The Fornell-Larcker criterion, which is satisfied in the current study (Al-Maroof & Al-Emran, 2018), states that the square root of AVE (diagonal value) for each variable should surpass the correlation of latent variables in order to meet the criterion. Each indicator's loading should be greater than the loadings of the indicators for its linked variables in terms of cross loadings (Ab Hamid et al., 2017). This study, therefore, conclude that the following table satisfies the cross loadings requirement and that the indicators give correct depictions of the underlying constructs. If the HTMT ratio is higher than 0.9 (Khadayat et al., 2024), there is a problem with the construct's discriminant validity (Rönkkö & Cho, 2022). The HTMT ratios for the pairwise correlations between the four constructs—att, int, pbc, mn, sn, and wsb are shown in the table 7. The data in the table suggest that the HTMT criteria is satisfied since all of the HTMT ratios are below the cutoff of 0.9. This demonstrates that the four constructs are well-differentiated and have strong discriminant validity. Thus, rather than being significantly related to one another, we can draw the conclusion that the study's constructs are unique and are evaluating various fundamental features.

Table 6: *Heterotrait-Monotrait ratio (HTMT) Results*

	att	int	mn	pbc	sn	wsb
att						
int	0.803					
mn	0.33	0.421				
pbc	0.699	0.769	0.31			
sn	0.177	0.164	0.434	0.172		
wsb	0.505	0.689	0.469	0.704	0.18	

Table 7: *Fornell-Larcker Criterion Results*

	att	int	mn	pbc	sn	wsb
att	0.893					
int	0.762	0.952				
mn	0.311	0.403	0.885			
pbc	0.66	0.735	0.295	0.884		
sn	0.125	0.203	0.417	0.175	0.746	
wsb	0.473	0.656	0.441	0.662	0.195	0.912

Model Fit: For a model to be fit, the SRMR value should be less than 0.1 in order to provide a decent model fit to the data (Sobaih & Elshaer, 2022). As a result, the value of SRMR for the estimated model in this study is 0.072 and 0.084, which is below the cutoff. As a result, the SRMR value is acceptable, which shows that our model's fit indices are good.

Structural Model Assessment

R^2 and path coefficients are the two most crucial variables in determining how well the structural model functions (Hamdollah & Baghaei, 2016). The model's predictive power is demonstrated by the R^2 value, which demonstrates how much of the endogenous variable's variance is explained by exogenous factors (Hair et al.,2019). R2 values of 0.75, 0.50, and 0.25 are significant, moderate, and weak, respectively(Hair et al., 2011).

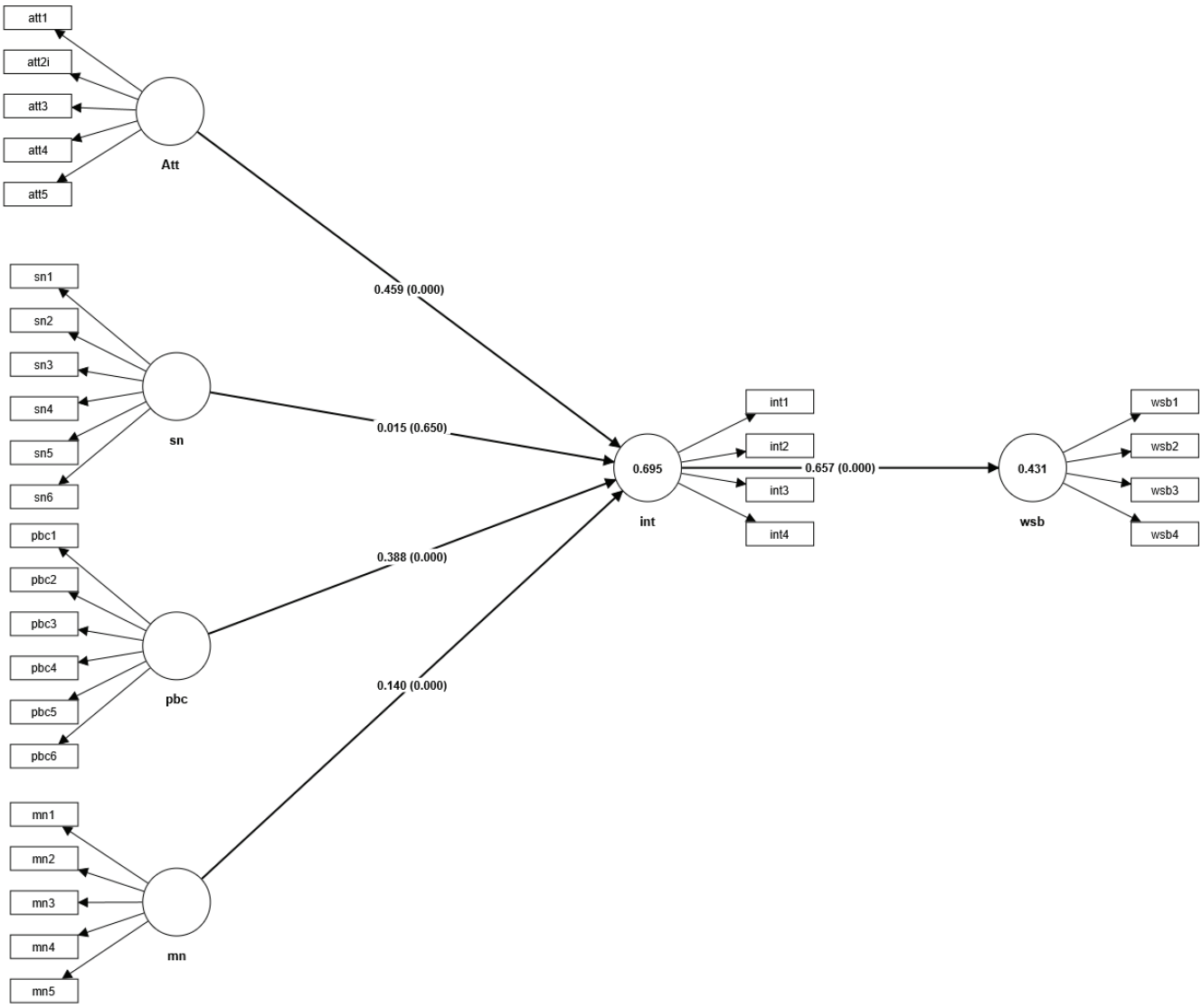

Figure 3: *Path Analysis*

Figure 7 shows the path analysis which is developed by using Smart PLS 4.0 which carries six constructs containing different items. This model is used to find the significant relationship among the varibale through bootstrapping having sample size 10,000. It shows the summary of the criterions this study have used to test the hypotheses developed. Figure 7 shows the path coefficient and R2 value of the structural model developed. As illustrated in the figure, R2 -value depicts the predictive power of the model, as it denotes the amount of explained variance of the endogenous construct in the model (Hair et al., 2017). The figure shows, the endogenous variables "Waste Separation Behavior" has R^2 value of 0.431. It means that 43.1% of the variation in waste separation behavior is explained by intention. Similarly mediating variable "Intention" has R^2 0.695. This means that 69.5% of variation in intention is explained by the independent variables, attitude, perceived behavioral control, moral norm and subjective norm.

Among the 5 direct hypothesis hypothesis H2 is not supported in the study rest of the hypothesis is significant

in the study. To test the mediation hypotheses, this study follows the suggestions of Preacher and Hayes (2008) by bootstrapping the indirect effect. To be significant the p-value must be less than 0.5. in the mediation analysis the hypothesis H8 is not supported as the p-value is greater than 0.5.

Table 8: *Hypothesis Testing*

Hypothesis	Beta (β)	SD	t values	p values	LL=2.50%	UL=97.50%	Decision
Att -> int (H1)	0.459	0.049	9.279	0	0.36	0.553	Supported
sn -> int (H2)	0.015	0.033	0.454	0.65	-0.051	0.078	Not supported
pbc -> int (H3)	0.388	0.053	7.37	0	0.289	0.495	Supported
mn -> int (H4)	0.14	0.033	4.207	0	0.077	0.207	Supported
int -> wsb (H5)	0.657	0.04	16.513	0	0.571	0.729	Supported

Note: This study uses 95% confidence interval with a bootstrapping of 10,000

Table 9: *Mediation Analysis*

Hypothesis	Beta (β)	SD	t value	p value	LL=2.50%	UL=97.50%	Decision
Att -> int -> wsb (H9)	0.302	0.034	8.745	0	0.236	0.371	supported
sn -> int -> wsb (H8)	0.01	0.022	0.454	0.65	-0.034	0.051	not supported
pbc -> int -> wsb (H6)	0.255	0.041	6.234	0	0.181	0.342	supported
mn -> int -> wsb (H7)	0.092	0.023	4.011	0	0.05	0.14	supported

Discussion

The first hypothesis (H1) claimed that attitude (att) and intention (int) have a significant relationship. With a p-value of 0.000 and a beta coefficient of 0.459, the investigation indicated that this hypothesis was supported. This shows that attitude can change the intention of peoples to separate waste at source. Ma et al., (2018) also discovers that attitude is favorably and significantly correlated with intention of waste separation at source (β = 0.69). The second hypothesis (H2) stated that there is insignificant relationship between subjective norm (sn) and intention (int). With a p-value of 0.65 and a beta coefficient of 0.015, the study discovers that this hypothesis is not supported. This shows that subjective norm cannot change the intention of peoples to separate waste at source. Ma et al., (2018) also discovers that subjective norm is not significantly correlated with intention of waste separation at source (β = -0.05).

The third hypothesis (H3) stated that there is significant relationship between perceived behavioral control (pbc) and intention (int). With a p-value of 0.000 and a beta coefficient of 0.388, the study discovered that this hypothesis was also supported. This shows that perceived behavioral control can change the intention of peoples to separate waste at source. Ma et al., (2018) also discovers that attitude is favorably and significantly correlated with intention of waste separation at source (β = 0.69). Contrary to prior study Ma et al. (2018) discovers that, perceived behavioral control is negatively connected to the intention (β= -0.06). The fourth hypothesis (H4) stated that there is significant relationship between moral norm (mn) and intention (int). With a p-value of 0.000 and a beta coefficient of 0.14, the study discovered that this hypothesis was also supported. This shows that moral norm can change the intention of peoples to separate waste at source. Similarly, Chan and Bishop (2013) have shown that moral norm is positively and strongly correlated with intention (β=0.33). The fifth hypothesis (H5) stated that there is significant relationship between intention (int) and waste separation behavior (wsb). With a p-value of 0.000 and a beta coefficient of 0.657, the study discovered that this hypothesis was also supported. This shows that waste separation behavior of people's can be determine by their intention. Ma et al.(2018), have shown that the intention is positively and strongly correlated with waste separation behavior (β= 0.282).

These results generally imply that attitude, moral norm, perceived behavioral control, and intention can affect the waste separation behavior in Kathmandu Valley. The findings of this study have significant ramifications for waste management campaigns and policies in Nepal, emphasizing the need for careful consideration in their formulation and implementation. Policymakers and administrators have a vital role to play in promoting a

sustainable environment and enhancing the effectiveness of government initiatives by prioritizing waste separation at the source.

Conclusion

This study provides comprehensive insights into people's perception and behavior toward waste separation at source in Kathmandu Valley by applying an extended Theory of Planned Behavior (TPB). The findings confirm that attitude, perceived behavioral control, and moral norm significantly influence individuals' intention to separate waste, whereas subjective norm does not exert a significant effect. This indicates that waste separation behavior in Kathmandu Valley is largely driven by personal conviction, perceived ease, and moral responsibility. Furthermore, intention is found to have a significant and positive effect on waste separation behavior, highlighting its critical mediating role between psychological determinants and actual household practices.

The structural model demonstrates strong explanatory power, with intention accounting for a substantial proportion of variance in waste separation behavior. The mediation analysis further confirms that intention significantly mediates the relationships between attitude, perceived behavioral control, moral norm, and waste separation behavior. These findings reinforce the relevance of TPB in explaining pro-environmental behavior while also validating the inclusion of moral norm as an important extension of the model in the context of waste management. The study identifies several challenges hindering effective waste separation at source, including lack of education and awareness, inadequate access to infrastructure and segregation materials, insufficient financial incentives, and inconsistent waste collection systems. Despite awareness campaigns initiated by local authorities, gaps in enforcement and service delivery weaken sustained behavioral change.

The study concludes that effective waste separation at source in Kathmandu Valley requires strengthening individual-level psychological drivers particularly attitudes, moral responsibility, and perceived control while simultaneously addressing structural and institutional barriers. Policymakers, municipalities, and urban planners should prioritize consistent waste collection systems, improved access to segregation facilities, targeted education and awareness programs, and incentive-based mechanisms to translate positive intentions into sustained waste separation behavior.

Future research could be adding the new variables in the framework such as the propensity to pay extra, concern for the environment, awareness of consequences, fines and penalties, incentives such as rewards and recognition to improve the understanding of waste separation behavior. Further research should also examine the role of local governments and municipalities in influencing waste management behavior, particularly their capacity to implement, monitor, and enforce waste separation policies effectively. In addition, exploring the perspectives, experiences, and operational challenges of waste service workers would provide valuable insights into the practical limitations of the current waste collection and disposal system and help inform more effective waste management strategies.

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