Digital Service Innovation in Urban Waste Logistics: Evidence from Post-Pandemic Household Behaviors in Kathmandu

Suman Kharel[1]; Rewan Kumar Dahal[*]; Surendra Prasad Joshi[3]

[1]Tribhuvan University, Faculty of Humanities and Social Sciences, Central Department of Rural Development, Nepal
[2]Tribhuvan University, Faculty of Management, Nepal Commerce Campus, Nepal
[3]Tribhuvan University, Faculty of Management, Thames International College, Nepal
rewan.dahal@ncc.edu.np (Corresponding author)

Abstract. The waste management systems of rapidly growing cities face two essential problems because of their difficulties with waste collection services. The management of household waste has evolved because of work patterns, digital advancements and changes in human behavior. The research study investigated how sustainable waste disposal practices among households in Kathmandu Valley were affected by post-pandemic lifestyle changes and technological advancements. The study, which uses behavior and environmental communication theories analyzes and tests how four factors, which include remote work practices, digital eco-messages, e-waste knowledge and waste payment system perceptions, impact sustainable waste disposal practices. The researchers used a mixed-methods research approach, which enabled them to gather survey data from 385 households while they conducted six semi-structured interviews. The researchers used quantitative analysis to evaluate how the variables interacted with one another, while they used qualitative findings to investigate the current waste management systems and daily waste management practices. The results demonstrate that all four elements serve as essential indicators of sustainable waste management practices, with remote work and digital eco-messages being the two most influential elements. The study showed that telecommuting brought more people to their homes, which resulted in higher participation from residents in their regular waste disposal duties. Digital environmental messages which users received on a continuous basis established strong environmental protection norms among the users. E-waste awareness led to responsible disposal as well as informal recycling behaviors, and residents who considered smart payment systems to be beneficial decided to use organized waste collection services. The person interviews showed two things about the municipal waste system, which included actual infrastructure problems and growing environmental awareness among residents who wanted to use digital waste management solutions.

Keywords: Circular economy, digital nudging, environmental awareness, smart technology, service innovation, sustainable service system, waste logistics

1. Introduction

Sustainable urban development requires efficient waste management as its essential component. Municipal solid waste generation has increased because urban populations and consumption patterns have changed which creates major public health and environmental sustainability problems that municipal authorities need to address (Choon et al., 2017; Zia & Devadas, 2008). The absence of proper waste management systems has resulted in severe environmental destruction which includes water source pollution and air contamination and an increase in diseases that stem from waste. The Kathmandu study shows that organic waste accounts for 64.24% of total municipal waste which makes up the majority of household waste in the city according to the Asian Development Bank report cited in Dangi et al. 2017. The development of integrated waste management systems requires individual waste segregation methods and recycling programs and sustainable waste disposal techniques to be implemented.

Urban waste management requires effective public service delivery while it requires effective urban logistics operations. Waste management in a city depends on how well the collection and segregation and transportation and processing systems handle waste management operations. Households are essential for food waste reduction according to Giordano et al. 2019. Researchers have examined the factors that lead to food waste together with its measurement and the potential solutions to this issue since the last 30 years. The COVID-19 pandemic created changes in how people disposed of waste and how cities functioned. Waste management practices in urban areas depend on both social and physical aspects according to Principato et al. 2020 because these elements determine waste disposal patterns in city environments. Solid waste management problems continue to present major challenges. The research by Rodgers et al. 2021 showed that people produced less food waste during lockdowns because they cooked more meals at home and they planned their meals better. Research shows that making lifestyle changes leads to more sustainable environmental practices because people with behavioral tendencies will show different behavior. The study of solid waste potential increases provides valuable research opportunities.

The study by Roe et al. (2021) revealed that different waste disposal patterns developed in response to household activities since some families decreased their food waste while other families increased their waste through stockpiling, which proved that lifestyle changes bring about different waste disposal outcomes. This study primarily examines disturbances during the epidemic because researchers need to study both immediate effects and upcoming long-term behavioral changes. The research by Scacchi et al. (2021) proved that lockdowns increased public awareness about waste, although actual waste levels showed different results. The research shows that crises elevate public awareness, which helps drive sustainable behavioral transformations. The research demonstrated that remote workers established particular patterns for their daily activities. Furthermore, Scharadin et al.'s (2021) study proved that people who changed their daily time distribution through changed daily activities produced different amounts of food waste and total waste. The research remains open to discovering how different remote work levels impact household waste disposal methods and their subsequent effect on sustainable solid waste management. The research by Tchetchik et al. (2021) studied recycling motivations and discovered that people who face dangers and develop coping methods will adopt environmentally friendly habits. The research demonstrates that digital nudges which consist of specific messages or interventions, can improve waste management practices according to Shan et al. (2021). The research by Arkorful et al. (2021) proved that people need to understand their waste disposal duties which creates a major effect on their ability to manage their waste correctly. The research shows that targeted educational programs and specific behavioral nudges can change human behavior based on their perception of risks and their feeling of moral duty.

The pandemic brought about major changes to both the amount and type of waste that people generated. The research by Cai et al. (2021) discovered that the multiple lockdowns which occurred across various Euro-American regions led to a decrease in commercial waste but an increase in residential waste. The current waste streams show an increase in electronic waste and residential solid waste because people now work from home and shop online more frequently. Zaidan et al. (2025) show that, although food waste slightly increased after lockdowns ended, it stayed below pre-pandemic levels, and Grunert et al. (2021) and Khadka et al. (2024) demonstrate that some behavioral changes caused by the pandemic could have long-term effects. The food waste level stayed below the pre-pandemic mark although it experienced some minor growth after the lockdowns. The COVID-19 pandemic created an opportunity to advance sustainable consumption because it increased public understanding of environmentally friendly products and sustainable materials. Sustainable waste management requires behavior modification because pandemic waste management practices especially recycling and solid waste disposal processes fail to consider local waste management factors which emerge after a crisis. The relationship between environmental attitudes and sustainable behavior needs further study according to (Dahal et al. 2025) and (Leal Filho et al. 2022). Just as harmony is essential to tune a party, creating sustainable waste habits in cities requires all parts working together.

The research study conducted by Rychła et al. (2023) shows that different environmental actions emerge because of varying cost factors which create unique conditions that exist in each country. People at the household level use their knowledge together with their willingness to sort recyclable materials and use advanced waste management systems which require them to pay additional costs. The COVID-19 pandemic which spread across the world has transformed urban living patterns by introducing new behavioral patterns together with structural changes that affect waste production and waste management methods (Sharifi & Khavarian-Garmsir, 2020). Remote work has become common while people increasingly depend on e-commerce platforms which has caused urban households to generate new waste patterns that include different types of packaging materials and electronic waste. Research studies have identified mobile applications together with intelligent waste bins and recycling programs that use game elements as effective tools which help people develop sustainable waste management practices (Lidia et al., 2018; Shandiz et al., 2025). The question is, how do these post-pandemic changes affect household waste management behaviors and practices?

The research project investigates sustainable waste behavior as the main research variable while studying how remote work habits and digital eco-messages and e-waste awareness and smart waste payment systems impact waste management practices in urban areas to study their effects on environmental waste management. The rising amount of waste and the ongoing environmental crisis require development of effective waste management solutions. The research study supports sustainable development goals through its work on sustainable urban development and waste management and improved public health through solid waste management practices. The research study will help policymakers by showing them how people handle knowledge and technology and training and government support.

The study presents limitations in its research methods. Cross-sectional studies restrict causal inferences. The study selected its participants from urban areas which included the Kathmandu Valley thus restricting its use in rural territories. The mixed-method research study included six participants for its qualitative section, which limited the research team from observing all the different ways that people view things and use things according to their different backgrounds.

The research report is divided into six sections. The first section provides background information, which includes problem statement and research objectives, as well as study importance and research boundaries. The second section establishes the foundational concepts which explain the theoretical frameworks and the development of hypotheses that stem from existing literature variables. The third section explains the methodology through its design and sampling methods and data collection tools and analysis of reliability. Section four presents demographic data together with statistical results and thematic analysis, plus observed patterns. Section five interprets the findings in the context of previous research and theories. The final section presents future research directions while providing a list of references, which will be found at the paper's end.

2. Literature Review

This section shows the review of concepts/theories and the empirical studies to build the assumptions.

2.1 Conceptual Review

The COVID-19 pandemic has completely transformed urban living patterns, which demonstrate the urgent requirement for cities to adopt environmentally friendly practices, particularly in the area of solid waste management. The remote work transition during lockdown periods resulted in changes to all types of household waste, which led to different environmental habits for people living in homes (Hook et al., 2020). The increase in digital communication lets people use mobile notifications and application reminders to create nudge systems, which help them develop better waste management practices (Ghimire & Dahal, 2024; Joshi et al., 2024; Sunstein, 2020; Wilson et al., 2021). The increased use of digital technology by people resulted in greater electronic waste production, which created problems for proper home disposal and recycling (Forti et al., 2020). The development of smart waste management solutions requires new waste solutions through the combination of sensor-based waste bins and application software for waste collection planning.

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2.2 Behavioral Theories Underpinning Waste Practices

The theoretical foundation demonstrates how individual motivation systems and societal systems work together to create environmentally friendly conduct. The Theory of Planned Behavior (TPB) provides a psychological perspective which shows how three factors, the behavioral attitudes and the social norms and the perceived ability to control behavior work together to shape people's intentions and their subsequent actions (Ajzen 1991). People who keep positive views about recycling and composting sustainable practices, which they believe work better when they receive social support, will become more likely to take part in these activities because their self-efficacy grows. The Norm Activation Model (NAM) demonstrates how personal norms create links between individuals and their environment by

establishing eco-friendly behavior patterns (Abdullah et al., 2025; Onwezen et al., 2013). The research shows that people develop sustainable behavior through understanding waste disposal methods and recognizing their personal responsibility to protect the environment (Tchetchik et al., 2021). The pandemic created a situation where people became more aware of PPE plastic waste which caused them to become concerned about how waste affected the environment (Singh et al., 2020). The Circular Economy (CE) theory together with Sustainable Consumption and Production (SCP) principles develop complete systems that help people reduce waste by showing them how to reuse materials and recycle and recover resources instead of using the linear model which treats all waste as trash. The SCP framework promotes sustainable consumption practices which help organizations decrease waste while maintaining economic progress without causing environmental damage. Theoretical models show that people develop sustainable waste disposal habits through their personal beliefs and their waste disposal practices which exist within larger social systems that include political structures and technological advances.

2.3 Hypothesis Development

This section outlines the proposed assumptions formulated based on the literature reviewed and theoretical understanding.

Sustainable Waste Behavior

People today practice environmental responsibility through three main waste management practices, which involve reducing waste, reusing materials, and dispose of waste correctly. The practice of this behavior establishes patterns which determine how people utilize resources. The trend continues to affect people, who now work remotely because their work-from-home schedule increases their household waste production (Hook et al., 2020). The degree of online environmental content consumption by people creates awareness, which leads to their development of environmentally friendly behavior (Dahal, 2021; Peattie & Peattie, 2009). Human understanding and behavior connect to all cleaning activities, which include e-waste disposal and recycling operations. The issue has grown more important since the digital revolution began (Widmer et al., 2005). The second element of the system involves people assessing new waste payment systems, which show their opinions about how digital payment systems work for waste collection services in terms of operational efficiency, justice and environmental advantages, which will influence their acceptance of eco-friendly waste management methods (Guerrero et al., 2013). People who depend on e-waste management systems seem to have unstable sustainable waste practices because their e-waste management system needs to be improved. Waste management functions as a service system that extends beyond its basic logistics operations. The following participants share value through their activities: people who sort materials and dispose of them responsibly, local authorities who handle collection services and enforce laws, digital platforms that provide coordination and financial services and communication systems, and the informal sector that handles collection services and recycling operations.

Remote Work Lifestyle and Practices

Work patterns have been transformed by the rapid rise of remote work because employees now work from home instead of their office spaces. People now consume according to new patterns, which have led to changes in their disposal methods through recycling, composting, and single-use plastic reduction efforts. People who work from home for extended periods while their work responsibilities change will produce waste through their remote work activities because of these particular circumstances. Whitmarsh et al. (2018) found that home recycling rates reached 67% which exceeded the 39% recycling rate found at work. The home environment of remote work creates conditions that support sustainable waste management, according to this work. Digital service innovation represents the

primary element which determines how governments create transparent relationships with citizens through systems that facilitate payments and optimize routing, and support citizen engagement.

The research demonstrates that remote work leads to sustainable waste disposal practices among employees. Whitmarsh et al. (2018) showed that people prefer to recycle their waste at home, which results in better waste disposal practices for employees who work remotely. Coskun et al. (2022) studied 38 research papers during the COVID-19 pandemic and discovered that various countries experienced a decrease in household food waste because people developed better meal planning and cooking abilities through their increased time spent at home during remote work. Amicarelli and Bux (2021) reported that improved inventory control during lockdown periods enabled Italian households to decrease their food waste. The Bospar survey from 2022 discovered that 48 percent of remote employees practice recycling and composting while 42 percent of them reduce their usage of single-use plastics, which demonstrates their shift toward environmentally friendly practices. The research shows that remote work decreases paper usage because employees communicate through digital channels, which results in reduced waste production (Evreka 2021). The evidence shows that remote work helps people develop sustainable waste disposal practices because it allows them to manage their home waste more effectively.

The advantages existing in remote work actually create waste management problems because of their negative impact on sustainable waste management. Leal Filho et al. (2021) reported a 55% rise in household waste during pandemic lockdowns, including a 53% increase in plastic packaging waste and a 43% increase in food waste, driven by more online shopping and food delivery. Remote work and lifestyle changes that brought about a 30-45% increase in online orders resulted in higher garbage and recycling volumes in Toronto's multi-residential buildings (Ikiz et al., 2021). Kim et al. (2022) found that online shopping generates 4.8 times more packaging waste than traditional retail, which worsens plastic pollution problems. The electronic device usage increase for remote work purposes results in electronic waste production, with estimates reaching between 30-40% (Ene, 2020; Forti et al., 2020). The studies establish that remote work reduces particular waste types yet increases different waste categories, which creates an uncertain impact on environmental sustainability.

The sustainable waste behavior impact from remote work depends on the specific situation, which interacts with waste management infrastructure, personal waste disposal practices, and the waste management system of a community. Coskun et al. (2022) discovered that countries with advanced waste management systems experienced greater reductions in food waste compared to other countries. A Bospar (2022) survey found that 58% of people surveyed think office spaces create more plastic waste, which shows that remote work might reduce this problem in some situations. The pandemic created new difficulties for waste management because of increased personal protective equipment (PPE) waste according to Yousefi et al. (2021), which resulted in environmental contamination through improper disposal methods. The remote work situation creates different waste behavior patterns, which require organizations to establish sustainable methods that function in specific situations. Studies show not paradoxical but rather a case of different contexts in household activities, digital availability, and urban utilities. The research that affected the environment positively such as Whitmarsh et al. (2018) and Coskun et al. (2022) is based on the idea that working at home means less transportation and thus fewer emissions; more efficient waste sorting practiced at home due to less movement of waste; and greater willingness of people to adopt green practices since they are at home all the time. On the contrary, negative impact studies like Leal Filho et al. (2021) and Kim et al. (2022) consider that the primary problem is the increased consumption of household electricity, higher packaging waste from online shopping, and digital dependency, causing more waste. The remote work aspect concerning

sustainability is at the mercy of housing situation, digital proficiency, urban service provision, and prevailing cultural practices.

Research indicates that hosting recycling drives and utilizing digital signatures can help cut paper waste. Forti et al. (2020) highlight the importance of responsible e-waste recycling programs. Urban areas which experience frequent online shopping need better waste management systems to create environmentally friendly waste disposal practices. The methods presented in this study enable organizations to reduce their environmental damage from remote work while increasing their sustainable operational benefits. The research investigates the validity of the hypothesis, which it tests through experimental methods.

H1: Remote work lifestyle and practices significantly influence sustainable waste behavior.

Exposure to Digital Eco-Messages

The digital eco-messages work to change people's attitudes through their educational content, which demonstrates how waste products impact the environment. The digital platform enables users to observe their friends and influencers who practice sustainable behavior which leads to users developing their personal sustainable habits. Digital platforms, especially social media platforms, use social proof to create motivation for users to copy the actions they see performed by others, according to social influence theories. The ability to design and distribute specific messages leads to better results, which help environmental preservation through waste management activities.

Research shows that digital eco-friendly messages lead to improved waste disposal practices among people who receive them. Sujata et al. (2019) demonstrated that people who use social media platforms show a strong connection to their recycling intentions, which, together with their attitudes and self-efficacy, drive community recycling activities. Jenkins et al. (2022) conducted a study of 17 different research papers which examined how social media platforms functioned in food waste reduction campaigns, finding that 11 of these studies produced favorable outcomes, which included greater awareness and decreased food waste. The use of Instagram and TikTok platforms proved most successful for people who wanted to take action through practices such as consuming their remaining food. A Unilever (2023) study showed that 75% of 6,000 participants were more inclined to adopt sustainable habits, such as reducing plastic or food waste, after viewing social media content—70% exposed to pragmatic content and 61% to optimistic content attempted new behaviors. The study by Jiang et al. (2021) found that social media advertising through data analysis methods brought about better results for household waste disposal, which resulted in a 431.8% increase in recyclable material collection and an 88.8% rise in the collection of biodegradable food waste after specific campaigns. The "Love Food, Hate Waste" mobile application serves as a digital nudge which reduces food waste because it provides users with instant feedback while enabling them to compare their progress against others (Olander & Thogersen, 2014). The campaigns succeeded because local policies which provided support to their operations. Tabibi (2024) reported that digital platforms, which include social media and mobile applications, enable users to reach wider audiences, but these platforms encounter difficulties due to their insufficient resources and the public's lack of interest in recycling.

Digital eco-messages extend their reach through social media to email and mobile application platforms. The application delivers sustainability information which helps customers choose grocery items while they track their waste through smart meter technology. The effectiveness of digital consumer education campaigns to promote recycling shows that interactive materials reach different audience segments (Tabibi, 2024). The research on nudging shows that digital tools provide cost-effective solutions

through social comparison feedback, which costs less than 5 cents per kWh saved in energy. The research demonstrated that digital nudges in food consumption showed carbon labels on menus increased sales of low-carbon options while social norm cues reduced food waste in hotels (Kallbekken and Saelen, 2012). Digital eco-messages work as effective waste management tools, which demonstrate their effectiveness in multiple waste management situations.

The evidence shows that digital eco-messages have the power to transform waste disposal practices, but their creation and implementation need to be executed with precise scheduling. Organizations should develop user engagement strategies through content creation, which produces engaging materials that provide authentic value to their audience, while organizations should identify their optimal content posting times. The combination of digital campaigns with local waste management systems and behavioral interventions will result in improved campaign performance. The study needs to investigate digital eco-message effects on humans during extended periods and develop methods to handle environmental obstacles which prevent recycling processes and create negative responses from the public. The following hypothesis statement guides the current study:

H2: Exposure to digital eco-messages as a form of information service significantly influences sustainable waste practices.

E-Waste Awareness and Practices

The increasing amount of electronic waste, which includes discarded devices like smartphones and computers and appliances, creates a serious environmental problem because 62 million tonnes of e-waste were produced worldwide in 2022 and only 22.3 percent of that waste was recycled according to WHO data from 2024. Proper disposal and recycling and waste reduction and waste reuse all serve as essential elements of sustainable waste practices, which help decrease the environmental and health dangers that e-waste presents. The TPB framework shows how people learn about e-waste and its impact on their sustainable waste disposal practices. The TPB states that three factors, which include attitudes and subjective norms plus perceived behavioral control determine how people behave (Ajzen, 1991). People who learn about e-waste develop positive recycling attitudes because social norms and recycling facility access give them better control, which drives them to take action. The theory of behavioral spillover asserts that people who practice one environmentally friendly behavior will develop additional sustainable practices and especially those which belong to the same area of sustainability as their initial behavior (Maki et al., 2019). Environmental self-identity exists when people identify themselves as environmentally responsible and this self-perception connects e-waste practices to complete waste management patterns (Nash et al., 2019). The research results show that analytical thinking leads to greater spillover effects than holistic thinking, according to research that emphasises the significance of mindset.

Research demonstrates that people who know about e-waste and follow e-waste regulations their knowledge creates waste disposal methods that help achieve sustainability goals. A meta-analysis conducted by Van De Wetering et al. (2022) demonstrated that environmental education which included e-waste awareness training enabled students to acquire environmental knowledge and develop positive environmental attitudes and implement sustainable waste management practices. In Saudi Arabia, Almulhim (2022) found that 70.1% of households did not have e-waste education yet88.35% of people showed willingness to participate in e-waste management after public information campaigns which proved to have a direct impact on their decision-making process.

The process of behavioral spillover serves as a central element here. Behn et al.'s (2025) review shows that engaging in one pro-environmental activity, like e-waste recycling, can boost the likelihood of adopting other practices, especially waste management. Ek and Miliute-Plepiene (2018) demonstrated that Swedish citizens who separated their organic waste produced decreased household waste, which resulted in positive spillover effects. The research conducted by Sintov et al. (2019) revealed that restaurant food waste reduction initiatives prompted customers to develop additional habits for waste reduction. Research across different locations in Brazil China and Denmark shows that people who care about the environment tend to exhibit within-domain spillover effects, which result in them recycling more and reducing waste.

The impact of e-waste awareness and practices varies and presents challenges. A study in India found that environmental concerns, together with government policies and financial incentives all operate as major factors which drive e-waste management intentions, yet awareness needs to be combined with actual implementation to produce results (Vijayan et al., 2023). Environmental sustainability depends on two essential factors, which include infrastructure development and recycling facility accessibility (Parra Orobio et al., 2024). The existing waste management systems create environmental damage in this situation, but the establishment of proper waste management systems will lead to better environmental outcomes.

The effectiveness of e-waste awareness programs depends on the educational methods and practical solutions which policymakers decide to implement. The WHO's initiatives to train health workers about e-waste risks demonstrate the value of targeted education (WHO, 2024). The Extended Producer Responsibility (EPR) policies which Saudi Arabia has adopted increase e-waste recycling while promoting sustainable practices throughout the country (Almulhim, 2022). The community workshops and financial incentives which Los Angeles proposes will increase community participation, according to Smith and Johnson 2024. The global e-waste policy review demonstrates that Extended Producer Responsibility and incentive-based recycling programs effectively promote environmentally friendly waste management practices (Naveen et al. 2025). The study results confirm the hypothesis developed in the research.

H3: Awareness and practices regarding e-waste greatly impact sustainable waste behavior.

Perception of Smart Waste Payment

Sustainable waste management activities depend on how humans perceive their own knowledge, their environmental attitudes and their level of environmental stewardship. The process of adapting to new ways of doing things leads to changes in both our psychological state and our economic situation. The current system operates under a Pay-As-You-Throw (PAYT) model, which charges residents according to the waste volume or weight they generate while following the polluter pays principle to encourage sustainable waste management practices. People who view PAYT systems positively develop better waste management practices. A Maine survey showed that after PAYT implementation 74 percent of residents increased their recycling efforts while 22 percent of residents composted more waste and 32 percent of residents purchased products with less packaging because they found the system to be both fair and easy to use (Blackmer & Criner, 2014). Italian municipalities that implemented PAYT systems achieved a 30 percent decrease in per capita waste production while their recycling rates increased by 40 percent because residents accepted the program's reward system (Rizzo & Secomandi, 2020). A Greek study found that people who understood PAYT and had positive views about it showed increased interest in participating in both waste reduction efforts and recycling (Emmanouil et al. 2022). The

community satisfaction levels with PAYT programs reached 75-85 percent among US residents, which resulted in higher recycling program participation rates (Skumatz, 2008). The results demonstrate that positive perceptions of waste management lead to sustainable waste management practices.

The behavior of communities responds to subjective assessments of PAYT systems. The study conducted in Greece discovered that residents who considered PAYT violations to be unacceptable made more social control attempts because 89.3% of them would correct offenders who violated PAYT regulations. The study shows that people form their personal behavior patterns through their perception of the social standards, which enable them to maintain their expected behavior. A study conducted in Sweden showed that people who had positive views about weight-based PAYT systems tended to recycle more but their recycling success depended on their ability to understand the system through effective information delivery (Dahlen & Lagerkvist, 2010). In South Africa, residents who showed a willingness to pay for waste disposal services developed positive views about service fairness, which resulted in them improving their recycling habits (Omotayo et al., 2020). The studies demonstrate how people develop their sustainable waste disposal habits through their perception of the waste disposal process. The perception problems create obstacles that decrease the efficiency of PAYT despite its successful outcomes.

Public acceptance of your solution faces challenges because illegal dumping concerns create negative effects, yet actual environmental damage remains limited according to showing evidence. The study shows that infrastructure availability functions as an active factor which prevents people from engaging with PAYT programs because they do not understand the system (Chachami-Chalioti et al., 2024). The two elements show that perceptions create different effects, which depend on the existing situation. Research demonstrates that people who perceive PAYT systems assess their sustainability practices through their existing knowledge of these systems. The Michigan research demonstrated that recycling education, which included PAYT studies, increased pro-recycling attitudes while showing that awareness campaigns have become more popular. Municipalities which implemented PAYT systems achieved recycling rate increases between 20% and 50% because residents considered the system to be fair (Elia et al., 2015). The research demonstrates that PAYT systems become more effective when combined with collection systems that users find easy to operate.

The optimal method for increasing PAYT system effects on sustainable waste management practices requires policymakers to establish educational programs and supporting facilities. The public will become more accepting of PAYT when organizations provide clear information about its advantages. The Green Best Practice Community (2021) states that accessible recycling facilities enable people who hold positive recycling attitudes to engage in recycling activities. The program provides financial assistance through discount programs, which enable low-income families to experience decreased financial obligations. The existing PAYT programs demonstrate that community workshops and digital campaigns create social norm benefits which help build positive community attitudes. The theoretical and conceptual framework of the hypothesized statement derives from existing research.

H4: The perception of smart waste payment systems, representing a key service innovation in waste logistics, significantly influences sustainable waste behavior.

The research on digital tools is summarized in terms of their applications, which include mobile applications, IoT-enabled waste bins and smart payment systems and waste tracking platforms. The study evaluates the efficiency of these tools while measuring how well they engage citizens. The

research establishes a link between smart city frameworks and ICT-based environmental governance systems. The current study establishes its conceptual framework through post-pandemic behavioral research, which demonstrates how people behave in modern urban environments that experience digital and lifestyle shifts. The study develops its research framework using an existing knowledge base, which establishes fundamental understanding.
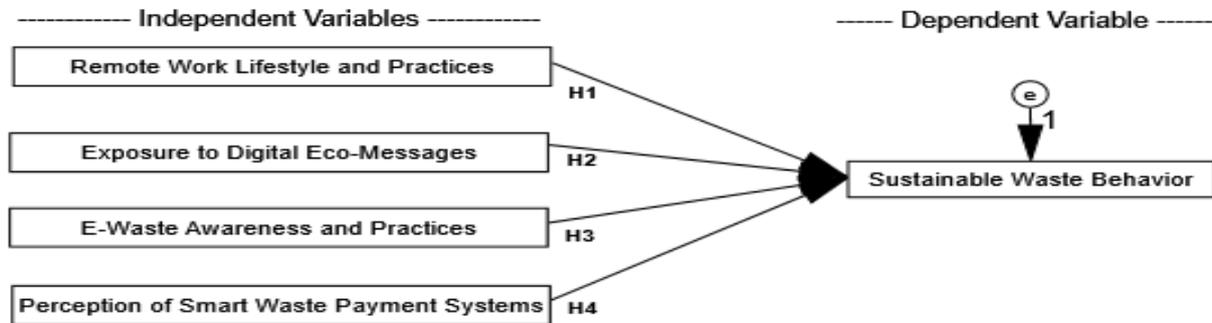

Fig. 1: Proposed Framework

3. Methodology

The research utilizes a mixed-method study design, which combines both quantitative methods and qualitative methods to investigate the elements that affect people to practice sustainable waste disposal. The research uses a triangulation approach that combines two research methods according to the framework established by Creswell and Plano Clark in 2017. The method achieves better measurement accuracy because it uses multiple different evidence sources which decrease the measurement error that occurs with single research method assessment. The quantitative survey data first establish statistical patterns which then guide researchers to create semi-structured interview questions that will be used to study the hidden operating processes. The six interviews conducted with participants from various roles within the waste ecosystem provided qualitative data, which established the context for research findings and established the patterns which created differences in survey results. The cross-verification method combines two different data analysis methods by comparing qualitative coding results with numerical data to create thematic improvements which solve existing inconsistencies.

The research aims to describe current conditions and document how people in Kathmandu Valley household waste management understand sustainable waste practices and their waste management beliefs. The research component focuses on investigating how independent variables affect the dependent variable which is sustainable waste behavior. The study uses regression analysis to examine two tested relationships and their impact on sustainable waste-related activities through statistical relationships between variables.

The target population for this study includes households within the Kathmandu Valley. The researchers selected 384 households through purposive sampling because they wanted to study the different characteristics found in various urban households. The researchers obtained behavioral insights by conducting six interviews with designated members of selected households. The survey and interviews used in this study led to statistical analysis and contextual interpretation of the findings.

A. Quantitative Data

The study uses primary data which researchers collected through two different research methods. The researchers used a structured questionnaire to collect quantitative data, which measured variables about sustainable waste behavior and its related influencing factors through Likert-scale items.

Measurements

The research uses a measurement framework which combines demographic factors together with psychometric measures to assess sustainable waste behavior and its associated1 factors. The researchers collected demographic information, which included age, gender, education level, household size, and employment status, to study behavioral differences among various household types. The study employed structured Likert-scale statements, which ranged from 1 (Strongly Disagree) to 5 (Strongly Agree), as its assessment tool to measure participant attitudes and behaviors regarding sustainable waste practices.

Researchers used four items which Subri et al. (2025) developed to assess sustainable waste behavior as their dependent variable. Researchers measured Remote Work Lifestyle and Practices through five items which they modified from Leapsome (n.d.), to evaluate remote work aspects, including structure and focus and productivity and boundary maintenance. Researchers used four modified statements based on Delcea et al. (2019) to assess how frequently and how intensely people interact with environmental content through digital platforms and social media. Researchers assessed E-Waste Awareness and Practices through four items from Gheorghe et al. (2023), which assessed respondents' understanding of e-waste toxicity and health effects and recycling advantages and their disposal practices. Perception of smart waste payment was assessed through four adapted items from Emmanouil et al. (2022), addressing perceptions of fairness, acceptability, and the influence on behavior of pay-as-you-throw systems. Table 1 presents the measurements designed to evaluate the behavioral, cognitive, and perceptual aspects of urban sustainability in the post-pandemic era.

Table 1. Details of Statements

Variables	Statements	Mean	SD.	Source
Sustainable Waste Behavior	I make an effort to reduce single-use plastics and other disposable items in my household.	3.57	1.112	Subri et al. (2025)
	I make an effort to reduce the amount of waste I produce each day.	3.63	1.075	
	I recycle regularly as part of my household routine.	3.39	1.199	
	I reuse containers and other items whenever possible to minimize waste.	3.58	1.056	
Remote Work Lifestyle and Practices	Having switched over to work-from-home mode, I have leaned on digital options to reduce the paper works.	3.70	1.173	Leapsome (n.d.)
	I am able to effectively structure my day when working remotely.	3.66	1.186	
	I find it easy to focus and resist distractions when working remotely.	3.74	1.201	
	I feel productive when working remotely.	3.67	1.120	
	I maintain a clear separation between my work time and personal time while working from home.	3.70	1.173	
Exposure to Digital Eco-Messages	I often see messages about eco-friendly products or environmental issues on social media.	3.71	1.081	Delcea et al. (2019)
	I often read posts by my friends on social media related to eco-friendly products or environmental topics.	3.79	1.070	
	I frequently encounter online advertisements or posts that promote sustainability and environmental protection.	3.83	1.091	
	I pay attention to environmental campaigns or "green" content that I find on the internet.	3.81	1.120	

E-Waste Awareness and Practices	I know that electronic waste (old gadgets, batteries) may contain substances that are toxic to the environment.	3.57	1.114
	I am aware that improper recycling or disposal of e-waste can harm human health.	3.57	1.075
	I understand the benefits of recycling old electronic devices properly.	3.62	1.039
	I properly recycle or donate my old electronic devices instead of throwing them away.	3.72	1.088
Perception of Smart Waste Payment	I think a pay-as-you-throw waste system (paying based on the amount of trash I produce) is fair.	3.47	1.199
	I support waste-management programs where higher waste generation incurs higher fees.	3.44	1.196
	I believe paying for waste disposal by volume would encourage people to produce less waste.	3.71	1.096
	I would be willing to use a smart waste payment system if it meant better waste management and recycling.	3.72	1.067

(Gheorghe et al. (2023); Emmanouil et al. (2022))

B. Qualitative Data

The researchers conducted six semi-structured interviews to gather qualitative data, which allowed them to explore household waste practices and the challenges and sustainable waste practices that people perceive.

Demographic Results

This section presents the demographic characteristics of the respondents who participated in the study.

Table 2. Respondents' Profile

Groups	Nos	%	Groups	Nos	%
Gender			*Age group*		
Male	227	59.0	18-30 Years	223	57.9
Female	158	41.0	31 to 43 Years	130	33.8
			44-60 Years	32	8.3
Education Status			*Income Level*		
SLC/+2	89	23.1	Below 10,000	109	28.3
Bachelors	174	45.2	11,000 to 21,000	90	23.4
Masters	122	31.7	22,000 to 32,000	122	31.7
			Above 33,000	64	16.6
Total of each section	385	100.0	Total of each section	385	100.0

Table 2 reveals that male respondents outnumbered female participants in the study, which produced results that show both groups had approximately equal representation. The age distribution showed that under 30 students formed the largest group, while middle-aged individuals made up the second largest group and people over 50 constituted the smallest group. The research findings probably reflect the opinions of younger and middle-aged people better than those of older adults.

Most respondents achieved undergraduate education, while a considerable portion obtained postgraduate degrees, according to educational status. A smaller portion completed secondary education. The sample mainly consists of educated individuals who will probably display different environmental

awareness and actions because of their educational background. Respondents entered different income brackets according to their income levels. Most respondents belonged to the middle-income group, while a substantial portion reported lower income, and only a few individuals reached the high-income category. This section presents demographic details which relate to sustainable waste management practices.

Validity and Reliability

The researchers conducted validity and reliability tests to verify data quality and accuracy. The study assessed internal consistency reliability through Cronbach's alpha method, which showed that all key constructs achieved satisfactory reliability standards ($\alpha \geq 0.70$). The study found that scale-based measurements exhibited both consistent and reliable performance.

Table 3. Reliability Results

Variables	No. of Statements	Cronbach Alpha
Remote Work Lifestyle and Practices (RWLAP)	5	0.899
Exposure to Digital Eco-Messages (EDEM)	4	0.713
E-Waste Awareness and Practices (EWAP)	4	0.864
Perception of Smart Waste Payment (PSWP)	4	0.705
Sustainable Waste Behavior (SWB)	4	0.837
Total	21	0.922

Table 3 displays the internal consistency results for all study variables, which were assessed through Cronbach's alpha method. The results prove that each set of statements which researchers used to evaluate the relevant variables shows dependable results. The constructs which represent remote work lifestyle and practices, together with e-waste awareness and behaviors and sustainable waste habits, show high reliability because their measurement items exhibit strong consistency. The variables which measure digital eco-message exposure and smart waste payment perception show good reliability to different degrees. The study measurement items show excellent reliability, which proves that the survey tool used in this study is both valid and consistent (Taber, 2018) for examining the impact of post-pandemic urban living factors on sustainable waste behavior.

4. Presentation and Analysis

This section presents the analysis of structured questionnaires and interviews. It includes both descriptive and inferential analyses to examine the relationship between sustainable waste behavior and various influencing factors. The findings are organized to provide descriptive information and the strength and direction of associations among the study variables. Thematic insights from qualitative interviews are also integrated to enrich the understanding of behavioral patterns and contextual challenges in post-pandemic urban environments.

4.1 Quantitative Results

This section includes a study's findings, which include descriptive results, correlation, regression analysis, and an explanation of the outcomes related to the research objectives.

Table 4. Descriptive Results

Variables	N	Minimum (Min.)	Maximum (Max.)	M	SD
Remote Work Lifestyle and Practices	385	1.00	5.00	3.6784	.96662
Exposure to Digital Eco-Messages	385	1.00	5.00	3.7870	.79943
E-Waste Awareness and Practices	385	1.00	5.00	3.6208	.90967
Perception of Smart Waste Payment	385	1.00	5.00	3.5870	.83066
Sustainable Waste Behavior	385	1.00	5.00	3.5429	.91133

Table 4 presents the descriptive statistics, which display how respondents perceive various aspects of their behavior. The participants demonstrated stronger agreement with the statements which assessed their environmental message exposure through digital platforms. The participants showed moderate positive attitudes and practices about remote work and their electronic waste management practices. The smart waste payment systems received positive ratings because users found them fair and useful, yet their responses showed slight differences. The sustainable waste behavior of the respondents showed a moderate level of engagement according to the study results, which found that respondents continue their sustainable waste practices while needing additional progress. The standard deviation values across variables highlight varying levels of response consistency, with some areas showing more agreement and others displaying more diverse opinions.

A correlation was performed in this section to examine the variables related to sustainable waste behavior.

Table 5. Relationship Among Dependent and Independent Variables

	Variables	RWLAP	EDEM	EWAP	PSWP	SWB
	RWLAP	1				
Pearson	EDEM	.495**	1			
Correlation	EWAP	.706**	.494**	1		
	PSWP	.323**	.362**	.353**	1	
	SWB	.724**	.444**	.777**	.360**	1

**. Correlation is significant at the 0.01 level (2-tailed).

Table 5 demonstrates that all remote work lifestyles and practices lead to positive results which include digital eco-message exposure and e-waste awareness and e-waste handling and smart waste payment perception and sustainable waste behavior. The connection between a remote work lifestyle and practices and sustainable waste behavior is positive and fairly strong. The study results show that people who successfully handle their remote work responsibilities while following their regular activities and experiencing social interaction through home-based work will practice sustainable waste management. The transition to remote work has established an atmosphere which encourages all household members to develop environmental awareness.

Digital environmental messages create a positive relationship with sustainable waste practices because people who frequently use digital platforms for environmental content like social media and blogs and online campaigns will become more aware of environmental issues and start practicing eco-friendly behavior. Digital communication methods prove effective for promoting sustainable development.

The connection between E-waste awareness and E-waste practices and sustainable waste disposal methods shows strong evidence of connection. People who know the environmental and health dangers of bad e-waste disposal methods will decide to recycle because they understand the dangers. The programs which teach people about electronic waste management work better when their awareness shows who needs to be taught.

The way people view smart waste payment systems affects their sustainable waste behavior at a moderate yet substantial level. People who perceive pay-as-you-throw waste management systems to be both just and efficient will adopt sustainable waste management methods. The results show that people who believe they have responsibility for their actions and will receive monetary benefits will make better decisions about waste disposal. People choose to manage their waste in sustainable ways because of their daily routines and what they know and their understanding of environmental issues and their financial beliefs about waste management.

Regression Analysis

This section examines how each independent variable influenced respondents' sustainable waste behaviors.

Table 6. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig.
					Change Statistics				
1	.818	.669	.666	.52667	.669	192.434	4	380	.000

Predictors: (Constant), Perception of Smart Waste Payment, Remote Work Lifestyle and Practices, Exposure to Digital Eco-Messages, E-Waste Awareness and Practices

b. Dependent Variable: Sustainable Waste Behavior

The multiple linear regression analysis results are summarized in Table 6. The model reported an R^2 value of 0.669 which demonstrates that the four predictors account for 66.9% of sustainable waste management behavior changes. The predictors establish a strong connection with the dependent variable which results in high model explanatory power. The coefficient of determination shows that remote work lifestyle and practices exposure to digital eco-messages e-waste awareness and practices and perception of smart waste payment account for a substantial part of the variation in sustainable waste behavior. The adjusted value enhances the model's robustness by considering the number of predictors and confirming the stability of the results. The change statistics demonstrate that the model's explanatory ability is statistically significant because the independent variables work together to predict sustainable waste behavior. The standard error of the estimates shows a small value because the actual measurements tend to group together the predicted regression line.

Table 7. ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	213.512	4	53.378	192.434	.000[b]
	Residual	105.406	380	.277		
	Total	318.918	384			

a. Dependent Variable: *SWB*

b. Predictors: (Constant) *RWLAP, EDEM, EWAP, PSWP*

The ANOVA results presented in Table 7 show that the regression model maintains its statistical significance for testing purposes. The combination of independent variables demonstrates their ability to explain sustainable waste behavior according to the results of the study. The F-value shows statistical significance which proves that the model provides accurate predictions between its independent variables and dependent variable.

Table 8. Coefficients

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B		Collinearity Statistics	
	B	Std. Error	Beta			Lower Bound	Upper Bound	Tolerance	VIF
(Constant)	.239	.155		1.545	.123	-.065	.544		
RWLAP	.320	.040	.339	7.895	.000	.240	.399	.471	2.121
EDEM	-.005	.041	-.005	-.127	.899	-.085	.075	.681	1.468
EWAP	.516	.043	.515	11.919	.000	.431	.602	.465	2.150
PSWP	.077	.036	.070	2.170	.031	.007	.147	.826	1.211

a. Dependent Variable: SWB

The multiple regression analysis results displayed in Table 8 demonstrate that each independent variable shows its own unique ability to predict sustainable waste behavior. The coefficients indicate the strength and direction of each relationship while controlling for other variables in the model.

The remote work lifestyle and practices have a statistically significant and positive impact on sustainable waste behavior. The unstandardized coefficient indicates that every one-unit increase in remote work practices brings about a positive change in sustainable waste behavior. The standardized beta value shows a moderate effect size, and the significance level confirms the relationship's high importance. The research shows that people who work remotely while maintaining effective time management with their daily schedules and work tasks tend to practice environmentally friendly waste disposal at their residences.

Digital eco-messages show no statistically significant impact on people's waste disposal practices because of their environmental content. The p-value is well above the usual significance level, showing that increased exposure to environmental content on digital platforms does not reliably predict sustainable actions in this sample. The study results show that people need more than basic exposure to material because they need active participation or pertinent material for behavior change.

The strongest positive relationship between waste behavior and its predictors exists between e-waste awareness and recycling practices. The unstandardized coefficient is quite large, and the standardized beta value is the highest in the model, indicating a significant influence. Researchers consider this result highly dependable because the statistical significance and restricted confidence interval establish its accuracy. The study demonstrates how environmental awareness and especially electronic waste disposal knowledge create sustainable home practices.

The perception of smart waste payment has a statistically significant positive relationship with sustainable waste behavior, although the effect size is smaller than that of other significant predictors. The positive coefficient shows that people who think smart waste payment systems (pay-as-you-throw models) operate fairly and effectively will increase their responsible waste management activities. The

significance level confirms the importance of financial incentives and perceived accountability in encouraging household sustainability.

4.2 Qualitative Results

This subsection presents the interview results, which are thematically analyzed based on perception, challenges, and sustainable waste management behavior of residents.

4.2.1 Study Participants

The interview participants were chosen through a selection based to three criteria, which included age and gender and educational background to demonstrate typical urban household characteristics found in Kathmandu. The group included three males and three females, with ages ranging from 22 to 60 years. The participants in this study represented two educational levels, which included secondary school and postgraduate studies, to present different viewpoints from teenagers who completed their education and adults who possess work experience. The participants' complete details are shown in Table 9, which presents their characteristics.

Table 9. Characteristics of Focus Group Participants

Code	Age	Sex	Academic Qualification
Participant 1	28	Female	Bachelor's in Education
Participant 2	35	Male	Intermediate (10+2)
Participant 3	45	Female	Secondary School (SLC/SEE)
Participant 4	52	Male	Master's in Information Technology
Participant 5	22	Female	Bachelor's in Environmental Science
Participant 6	60	Male	Higher Secondary (10+2)

4.2.2 Thematic Analysis

The study included six interviews, which researchers conducted with residents of Kathmandu who came from different cultural backgrounds. The participants answered three semi-structured questions, which asked about their (1) household waste practices (reduce– reuse–recycle) and (2) sustainable waste management difficulties and (3) their opinions about technological solutions (remote work, digital eco-messages, e-waste, smart waste fees).

Interview Questions: 1. Household waste behavior: "How do you manage waste at home? For example, do you reduce waste, reuse items, or recycle?" 2. Management challenges: "What challenges do you face in managing waste sustainably?" 3. Technology and environment: "What do you think about technology or modern ideas, for example; remotely, receiving environmental messages on your phone, e-waste disposal, or paying waste fees digitally?"

Awareness and Responsibility

Participants showed waste problems and their solutions as vital matters which they needed to address personally. Young people showed greater awareness of waste issues according to most participants who identified media and school programs as the main sources of their knowledge.

Participant (1) viewed waste as everyone's duty: "I often hear on TV that we must sort and recycle, and it's not just the city's job." Most Nepali respondents from the study research show that they believe waste management responsibility belongs to all people (Khanal et al., 2023). The interviewees observed that environmental campaigns and school programs had increased their activities, but they showed that people still required complete environmental knowledge.

As Participant (2) explained, "I have learned in school and community meetings about the harm of burning plastic. Now we know it is important to avoid waste." Some people acknowledged that older people and busy individuals do not have the same level of awareness. The study findings showed that participants knew about waste problems, while they believed that both individuals and families needed to work together to solve these issues.

Waste Reduction and Reuse Practices

All participants reported they practiced waste reduction through reuse methods, which they implemented in their homes. People commonly used reusable containers and cloth bags while they composted their waste.

Participant (6) mentioned, "I always bring my own cloth bags to the market and avoid plastic bags whenever possible." Participant (3) explained, "I keep old glass jars and use them to store grains or pickles instead of purchasing new plastic containers." Participant (4) shared that they compost vegetable scraps, noting, "Every evening we collect carrot peels and food waste in a separate bucket; my wife then uses it as compost for our small roof garden." Participants practiced recycling through two methods, which they described as selling recyclable materials and giving materials to scrap collectors. Participant (3) explained, "We set aside bottles and plastic; a local ragpicker comes every weekend to pick them up."

The existing recycling programs continue to operate with insufficient capacity. The interviewees reported no access to curbside recycling, which resulted in them reusing items through informal methods that included saving jars for future use. Participant (1) reported that their lane lacked a paper and plastic waste bin, which resulted in them collecting recyclables to wait for someone to pick them up. The data demonstrates that 80% of Nepalese households practice waste sorting according to their needs, which shows their dedication to environmental protection. The respondents demonstrated their commitment to waste reduction by eliminating single-use plastics and their dedication to waste reuse through container repurposing, yet the recycling process depended on individual efforts and unregulated buyers instead of established public recycling systems.

Barriers and Challenges

The interviewees named multiple significant obstacles which prevent sustainable waste management practices from being implemented. The study results showed that infrastructure deficiencies existed because the area had only one mixed-waste bin and no scheduled collection service.

The municipal waste collection operates on a schedule which limits its service to two weekly pickups according to Participant 5. The waste collection system from Kathmandu suffers from overload because of increasing waste production, according to various studies (Challenges Abroad, 2025; Khadka, 2025).

Participant 3 also mentioned the lack of facilities for recycling and composting: "We don't have separate bins for plastics or organic waste in our area." People believe that without proper garbage collection systems all discarded materials will either go to landfills or be thrown away in public spaces. The historical reports demonstrate that most waste material ends up in open dumps which are then set on fire.

People lacked knowledge about environmental issues, which created an obstacle. Residents who belong to older age groups or possess less knowledge about waste management practices. Participant (2) lamented, "People here still think waste vanishes by itself. People in this area lack understanding about why mixing waste and burning plastic materials creates environmental harm." Many Nepali families lack environmental education according to The Challenges Abroad report from 2025 because they do not understand the environmental hazards linked to plastic burning or recycling methods.

The situation developed through both economic factors and real-life limitations. People encountered waste management problems because they lived in busy urban areas according to the statement: "I live in a small apartment, so it's not easy to compost much or store things. Participant (5) explained that he needed to stop working because he became too fatigued to do proper waste disposal. Participant (4) explained that people face cost problems because "Composting requires space or a bin, and that costs money. The primary obstacles to the process involved three main factors: The process faced challenges because municipal authorities failed to establish waste collection services for recyclable materials which resulted in low public recycling knowledge and insufficient reward programs. The participant explained that "The city provides us with no support, so we must develop our own solutions. Until waste management becomes a priority for officials and businesses, people can only do so much." The research demonstrates that people recycle less because they lack proper recycling systems (Practical Action Nepal, 2008).

4.2.3. Technology and Innovation Perspectives

Participants held varied yet considerate opinions on technology-related solutions.

Remote work

People recognized that decreased commuting times would lead to less pollution, but they pointed out that Nepal still lacks proper digital infrastructure (Prasain, 2023). The participant (6) explained that working from home provides an appealing option because of our bad traffic, but he faced internet outages at that location. The speaker mentioned that he still needs dependable Wi-Fi and mobile network access throughout all locations. The report confirms that Nepal lacks remote work readiness because of its inadequate internet infrastructure (Prasain, 2023). Some young participants found that their remote work and remote classes improved their understanding of environmental issues which they shared with others in their social circles.

Digital eco-messages

Few had received official environmental alerts on their phones, but several relied on social media or news for tips. Participant (2) explained how he sees NGO posts about plastic bans and Earth Day on Facebook. Participant (6) explained that a radio program occasionally discusses Bagmati River cleanup activities. However, most participants said these messages were irregular and not enough to change habits. Participant (5) stated that "Digital reminders would help if they were consistent but people currently learn about waste issues through word of mouth and schools". The current situation shows that more organized digital outreach should be implemented because it presents an opening.

E-waste

The majority of people showed doubt about their knowledge. The majority of people provided no information about their e-waste disposal methods. Participant (4) explained: "Old gadgets just pile up. I know there are shops that buy old mobile phones, but I have no knowledge about how to dispose of TVs and batteries because I throw them away with my regular garbage." Participant (6) said: "I had an old computer monitor, but I waited until a charity truck came and gave it away. I do not know about any existing e-waste collection centers." Nepal faces a mounting problem because electronic waste has become the fastest-expanding waste stream in the country (Pandey et al., 2022). The participants wanted assistance that would enable them to process electronic waste in a correct manner.

Smart waste payment

The results of the survey showed different opinions about pay-as-you-throw programs. Participant (1) stated that he would pay extra for garbage bags because he believed the solution would reduce waste and deliver better street cleanliness. Participant (1) stated that he would pay extra for garbage bags because he believed the solution would reduce waste and deliver better street cleanliness. Participant (6) described the system, which he had heard about, when he said that people paid for waste disposal according to their actual bag usage. The system might work because it would decrease waste but the enforcement process in this location presents major obstacles. The system might work because it would decrease waste, but the enforcement process in this location presents major obstacles. The system might work because it would decrease waste, but the enforcement process in this location presents major obstacles. The system might work because it would decrease waste, but the enforcement process in this location presents major obstacles. Research findings show that residents of Kathmandu support unit-based waste disposal fees according to a study, which revealed that most households were willing to pay higher fees for 1 L and 20 L waste bags according to the study results (Ghimire et al., 2024). The interview participants recognized potential opportunities for operation, but they required people to see through their processes and make bag purchases without effort. The interview participants recognized potential opportunities for operation but they required people to see through their processes and make bag purchases without effort. The interview participants recognized potential opportunities for operation but they required people to see through their processes and make bag purchases without effort.

Tech solutions received cautious optimism from interviewees who recognized existing infrastructure problems. The interviewees approved of remote work and pay-by-weight waste systems as theoretical concepts, but they identified inconsistent internet access and weak system enforcement as factors that would diminish their operational efficiency. The participants recommended initiating their recycling programs through small-scale community applications and SMS alert systems, while testing digital billing in selected wards. Participant (2) concluded, "Technology can help, but only if people have access and know-how. Our immediate focus revolves around two essential needs: dependable waste collection and understandable waste management information."

The interviews show that individuals have strong waste reduction awareness, but they face ongoing challenges due to established systems. People of all ages and backgrounds used items again while they stayed away from plastic materials and took part in informal recycling activities, which supported research showing that Nepali people want to separate their waste. All participants noted shortcomings in municipal services and public education. The lack of regular sorted waste collection together with missing recycling instructions makes it hard for dedicated householders to recycle their materials. The combination of technology and innovation presents valuable solutions while the interviewees supported work-from-home arrangements to decrease commuting emissions and digital campaigns with modern waste-fee systems received positive feedback from many participants. The same participants warned

that Nepal's digital deficiencies which include unstable internet service and public knowledge gaps will prevent these solutions from succeeding. Urban households demonstrate waste management concern through their efforts to reduce waste and reuse materials, but they face challenges because waste collection occurs irregularly and recycling facilities are insufficient and public education remains inadequate.

People believe that waste management requires joint responsibility yet they demand additional backing from the government. Digital and policy innovations provide benefits according to people but their success requires better infrastructure and greater public participation. The community needs awareness programs together with dependable services and gradual implementation of pay-as-you-throw systems to develop recycling practices. The participant summarized their statement by saying "We want Kathmandu to be cleaner. We want to help but we require proper tools and systems to perform our work." The findings demonstrate that households can establish sustainable practices when they receive distinct environmental regulations together with proper facilities according to recent research.

4.2.4 Identified Categories

The qualitative analysis of the collected material identified four main categories of sustainable waste management behavior and their subcategories. The categories show how urban households manage their waste through their sustainable waste management practices and their existing challenges. The findings are based on residents' experiences, which include both their proactive actions and the systemic obstacles they encountered. Table 10 summarizes the identified categories.

Table 10. Categories and Subcategories Identified

Categories	Subcategories
Household Waste Behavior	1) Waste reduction practices; avoiding single-use plastics.
	2) Re-use and repurposing of materials
	3) Informal recycling habits
Barriers to Sustainable Practices	4) Lack of infrastructure and services
	5) Limited environmental education
	6) Space and economic constraints
Perceptions of Digital and Remote Tools	7) Awareness of digital eco-messages
	8) Attitudes toward remote work and environmental impact
	9) Interest in digital platforms for environmental learning
Attitudes Toward Policy and Innovation	10) Support for smart waste payment systems
	11) Concerns about fairness, implementation, and enforcement
	12) Desire for government-led initiatives and incentives

Thematic analysis of the interviews produced Table 10, which presents the identified categories and subcategories that deliver essential information about urban residents' sustainable waste disposal methods. Participants explained their household routines which included waste reduction through reusable materials and they participated in informal recycling and they avoided single-use plastics. The study discovered multiple obstacles, which included insufficient infrastructure and environmental education resources and financial and spatial limitations. Some participants understood environmental content which was circulated through digital channels while they showed interest in using online platforms for environmental educational purposes and their remote work were divided about its environmental advantages. The participants showed support for waste payment systems which use smart

technology, but they raised doubts about the systems' equitable treatment of people and about how their waste operations would be executed and their progress would be tracked. The participants showed strong support for government programs which include educational initiatives and special rewards systems because these programs would help create more environmentally friendly practices. The research demonstrates how individual behavior combines with institutional restrictions and governmental policies to create an effect on waste management practices in urban areas of Nepal.

5. Discussions

The research established that remote working patterns and their associated activities created positive effects for sustainable waste management practices. Home-based workers who established their work schedules maintained work concentration through their established home office practices showed better recycling results because they reduced single-use plastic items and successfully sorted their home waste. The research results support Whitmarsh et al. (2018), who found better home recycling practices compared to workplace recycling, and Coskun et al. (2022) and Amicarelli and Bux (2021) who reported that people reduced food waste during the pandemic because they improved their home recycling habits. The research from Bospar (2022) shows that remote workers tend to practice environmentally friendly methods, which include composting and reducing their plastic waste. The remote work setup results in less paper consumption because of its digital work environment according to research from Evreka, 2021. The results create both positive and negative effects. The research by Ikiz et al. (2021) and Leal Filho et al. (2021) discovered that household waste increased during lockdowns because people ordered products online and requested food deliveries. The research found that packaging waste and electronic waste both increased during this period according to Kim et al. (2022) and Forti et al. (2020). The research results show that remote work effectiveness varies based on specific environments which determine the use of local infrastructure and personal choices. A household that produces waste has two options to establish a waste-free residence or to devise a new system for waste processing. The environmental development process restricts people from establishing their beneficial practices because their waste management systems remain incomplete. The remote work sustainability advantages need support through dedicated policies which help with environmental education and improve waste management systems. The new transition brings changes to both waste creation patterns and collection route design which serves as a fundamental aspect of waste management operations.

The research showed that people who received digital environmental messages developed better waste recycling habits although their results stayed below statistical significance. The research showed that people who used environmental content on the internet showed better understanding of the topic but their actual behavior did not show any measurable changes according to the study. The findings of this research study contradict previous research which demonstrated that online platforms have the ability to drive people toward environmentally friendly behavior. The findings confirm service science principles which state that information transfer requires more than mere data distribution because actual value creation happens through service ecosystem development which includes digital platform use and user feedback mechanisms. The environmental education programs in Nepal suffer from two major obstacles because their students have no access to learning resources and the country lacks adequate educational facilities. The public loses interest in the message, which results in decreased power of the message. The research reveals that digital eco-messages can achieve success only through local factors and their success needs to be combined with community programs and incentive programs and outreach activities. Sujata et al. (2019) discovered that Malaysians who used social media platforms demonstrated higher recycling intentions. Jiang et al. (2021) found that recycling and biodegradable waste collection improved significantly in Shanghai after the city implemented social media outreach

campaigns. Unilever (2023) found that their digital content led 75 percent of participants to develop sustainable behaviors. The results of the study match the findings of Jenkins et al. (2022) which show that digital campaigns achieve their greatest impact through combination with multiple intervention techniques instead of using digital campaigns as standalone solutions.

The research shows that people who understand e-waste together with their waste management methods will achieve better waste disposal results, which scientists have proved through their extensive research work. The Theory of Planned Behavior (Ajzen 1991) together with behavioral spillover theory (Maki et al. 2019) serves as a theoretical framework that shows how people who know about e-waste dangers develop positive views and practice sustainable behavior. The findings of this study match the research conducted by Van De Wetering et al. 2022 who demonstrated that environmental education leads to better waste management attitudes and behaviors while Almulhim 2022 discovered that increased awareness boosts participation in e-waste recycling programs. Effective e-waste management requires policy measures together with financial incentives, according to research by Yuan and Yabe 2020 and Sharma and Jha 2023 who present this evidence. The online transformation of work and studies started to take place after software and hardware upgrades brought about new media coverage, which expanded existing media coverage.

The research established a strong connection between two variables which indicated the existence of a significant service gap and an underdeveloped severe logistics channel for electronic goods in Kathmandu. The effectiveness of awareness depends on two factors, which are infrastructure support and actual implementation activities. Vijayan et al. (2023) and Parra Orobio et al. (2024) established that people need proper recycling facilities together with support systems to change their behavior through knowledge acquisition. The Global South faces similar problems because inadequate infrastructure systems prevent effective waste management operations (Ferronato & Torretta, 2022). The combined strategies which include education together with policy incentives that extend producer responsibility (Almulhim, 2022) and community participation (Smith & Johnson, 2024), need to be implemented for maximum effectiveness. The research demonstrates that increasing e-waste awareness serves as an essential initial step to advance sustainable waste management, but requires proper solutions together with infrastructure development to achieve success.

The research findings demonstrate that the perception of people determines their choice of environmentally friendly waste disposal methods. People see these systems as modern service solutions which enable them to comprehend waste management expenses in a more equitable manner. The Theory of Planned Behavior (Ajzen, 1991) describes how residents develop waste reduction intentions through PAYT programs, which operate on three elements: attitudes, social norms and perceived control. Residents who considered PAYT to be fair and easy to handle increased their recycling, composting, and waste reduction activities according to research studies conducted in the United States (Blackmer & Criner, 2014; Skumatz, 2008), Italy (Rizzo & Secomandi, 2020), and Greece (Emmanouil et al., 2022). The research demonstrates that social enforcement of PAYT norms leads to better community compliance while people create sustainable habits according to Botetzagias et al. (2020). The three factors of simplicity, openness, and decreased physical interaction led to better adoption results.

The success of PAYT relies on three essential components which include effective communication and proper system implementation and the economic conditions of the community. The study by Skumatz from 2008 found that people tend to reject programs because they think illegal dumping will increase and costs will rise for low-income residents. The World Economic Forum and Emmanouil et al. 2022 study found that educational programs, together with appropriate incentives which provide discounts

for vulnerable groups, represent essential elements to solve existing obstacles. The presence of user-friendly recycling stations brings additional support for the successful implementation of PAYT programs (Green Best Practice Community 2021). The research demonstrates that effective PAYT systems lead to environmentally friendly waste disposal practices when combined with strong governmental regulations and active community participation according to international research findings.

6. Conclusion

The research shows that digital platforms together with innovative services create significant impacts on waste management methods used by urban areas in Nepal after the pandemic. The effects specifically appeared in three areas, which included remote work arrangements, e-waste educational programs and smart payment systems. People have not changed their behaviors despite receiving numerous eco-friendly digital messages because design problems and literacy shortcomings still exist. The results enhance service science through their examination of waste management as a multi-actor co-created service system, while providing logistics support through their identification of digital tools which assist with route optimization and reverse logistics. The practical results include three main elements which are integrated service platforms, digital literacy campaigns and better coordination among formal waste management systems and informal waste management systems. The limitations of the study are non-probability sampling, a small qualitative sample, and the risk of common method bias. To address these issues, future research should focus on the differences in platform adoption between cities, the long-term impact of changes in behavior, and the role of informal waste workers in digital service ecosystems.

Theoretically, the research provides specific recommendations for a wide range of urban waste management stakeholders. Urban planners will have to change their waste collection practices and routing plans based on the increased household activity during the daytime caused by teleworking, according to the results. The adoption of PAYT schemes that are based on the moderate perception score of smart waste payment systems can be made by creating equitable and socially sensitive pay-as-you-throw schemes, especially by introducing sliding-scale tariffs or household-size–based pricing that will shield low-income households. The support for e-waste awareness that the study gave is also encouraging e-waste return programs to be strengthened through rebates or designated drop-off incentives. The very low or non-significant digital eco-message influence of the research may be there for campaign designers; the message framing should now be changed to switching from general environmental reminders to more localized, action-oriented, and norm-based nudges that speak to the increased screen time of remote workers. The waste service providers in a municipality can promote lifestyle change based on waste separation by launching smart bin systems in areas where digital payments are more accepted and by making available real-time service dashboards that are user-friendly and assist with transparency. The activities show people how their ability to understand post-pandemic changes in lifestyle and technological development will improve waste management systems that need to be fairer and more sustainable.

7. Future Scope

The shifting context of urban living and waste management offers promising directions for future research at the intersection of logistics, informatics, and service science.

- *Logistics Informatics:* Future research should investigate how waste collection systems can use Internet of Things (IoT) waste sensor data to develop optimized collection routes which help reduce

fuel consumption and enhance operational performance when waste patterns change due to remote work.

- *Service Design and Platforms:* Research needs to design and test digital service platforms which will unify eco-messaging systems with waste collection scheduling and feedback systems and smart payment methods into one user-friendly application.

- *Reverse Logistics and Service Ecosystems:* The research designer needs to assess e-waste reverse logistics business models with their corresponding service blueprints because the study's primary focus investigates how the informal sector operates within established circular economy systems.

Researchers need to study how pay-as-you-throw systems operate because their service economics create financial advantages for municipalities and their pricing models need to create fair charges for low-income residents. The growing field requires experts from different fields to work together in order to create advanced waste management solutions which operate efficiently and protect the environment.

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